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# Revisionary Synopsis of the Baetidae (Ephemeroptera) of North and Middle America

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ABSTRACT

Considerable nomenclatural revision of the North and Middle American Baetidae has resulted from comprehensive research aimed at formulating a phylogenetic classification. The 17 Nearctic species in *Pseudocloeon* not previously assigned to *Acentrella* or *Apobaetis* are newly placed in *Baetis* or *Barbaetis*. *Cloeon* in the area is restricted to *C. cognatum*, while two species previously in *Cloeon* are placed in *Centroptilum* and nine in *Procloeon*, a genus considered for the first time in the Nearctic. Definitions of *Centroptilum* and *Procloeon* are modified, both now incorporate species with hindwings and species without hindwings, and 19 species are transferred from *Centroptilum* to *Procloeon*. *Pseudocentroptilum* s. auctt. in North America is synonymized with *Procloeon*. *Neocloeon* is recognized as a synonym of *Centroptilum* s. str. and removed from synonymy with *Cloeon*. *Dactylobaetis* is placed in synonymy with *Camelobaetidius*, and all species, including those from South America, are newly combined. Two species of *Baetis* are transferred to *Acerpenna*, and two to *Fallceon*. A checklist includes 154 currently recognized species among 19 genera in the area, and incorporates 21 new species synonyms and 57 new combinations. The names *Baetis armillatus* and *Baetis cinctutus* are substituted for *Pseudocloeon parvulum* and *Pseudocloeon cingulatum*, repectively, which otherwise attain homonymic status. Regional distributions for each species and abbreviated synonymies since 1976 are annotated to the checklist. Brief discussions of each genus include information on species diagnosis, revisionary bases, status, and needs. A guide to all nomenclatural changes and added taxa since 1976 provides the bibliographic sources of all such information and serves as a ready index to name equivalencies resulting from extensive recent and present revisions.

## INTRODUCTION

Since the last comprehensive listing of North and Central American mayflies (Edmunds et al., 1976), numerous changes in the classification of the Baetidae have been made. Unfortunately, for those systematists who work with baetids on an infrequent basis and for nonsystematists, such as stream biologists, who must identify baetids, these nomenclatural

changes may be a source of frustration. The revisions, however, have been sorely needed in this difficult family of mayflies, as was dramatically indicated by Edmunds' et al. (1976:155) reference to, "the absurdity of the present classification."

This paper is written for two purposes. The first is to present additional systematic changes required in the classification of the baetids, particularly reflecting several new generic concepts. The second purpose is to provide workers with a complete guide and necessary references to the recent and present revisions and the current nomenclature of the North and Middle American baetids.

The primary bases of such revisions are recently published studies and additional detailed data to be published elsewhere (Waltz and McCafferty, manuscripts). Our considerable attention to the analysis of larvae from around the world has provided us with valuable and often extensive character sets for deciphering phylogenetic relationships. Phylogeny, deduced by cladistic methodology (Ross, 1974), is paramount in our scheme, since we seek a phylogenetic classification (sensu Hennig, 1966; Wiley, 1981) of the family. Type specimens have been examined for all world genera for which types are available. When determining the application of existent generic names, comparative material other than types was used as available, but only if it was clearly consistent with type characterization.

We find it interesting that Traver's (1937) statements regarding the future of world Baetidae classification have proven to be quite prophetic. She predicted that a large number of new genera would be found in Baetidae and that they would become obvious only when both the larva and adults of the various species became known.

One result of our research that has broad implications for the classification of the baetids given herein has been the verification of several workers' beliefs (e.g., Spieth, 1933; Day, 1955; Edmunds et al., 1976) that hindwings may have been lost independently many times within different baetid lineages. We have found that many of the past groupings of baetids based on the presence or absence of hindwings, or pads, are unnatural and not consistent with a phylogenetic classification. Thus, for example, recognition of *Cloeon* from *Centroptilum*, or *Pseudocloeon* from *Baetis* based on the absence of hindwings is not followed. In fact, we have found these four groupings, as they have been known, to be polyphyletic and to have contained elements of at least 11 different nominal world genera, seven of which involve North and Middle American species. The deception caused by using the presence or absence of hindwings as a generic delineator is underscored by the fact that at least three species of Baetidae in the Western Hemisphere have been found to have males with hindwings and females without hindwings (Edmunds et al., 1976; McCafferty and Provonsha, unpublished).

A second result of our research that has direct implications for the classification of world baetids is the discovery of an important synapomorphy shared by *Baetis* and its closest allies (the *Baetis* complex of Waltz and McCafferty, 1987d). This is the presence of the villopore on the femora (a new name for the ventral femoral patch sensu Waltz and McCafferty, 1987c) of the larvae. The genus *Baetis*, as historically composed, was not a holophyletic taxon, and certain Nearctic species placed in it lack the apotypic villopore and thus represent other lineages (Waltz and McCafferty, 1987c). The villopore can be variously developed, being conspicuous in some genera, while appearing almost rudimentary in others. Close scrutiny is therefore called for when examining the ultrastructure.

The holophyletic *Baetis* complex is primarily Holarctic with more derived lineages extending into the Oriental and Afrotropical regions, but thus far it is unknown from the Neotropics.

A third result of our research has implications for species level taxonomy. We and others

(e.g., Berner and Pescador, 1988) have been of the opinion that the historical reliance on color patterns for establishing species in baetids results in narrow typological concepts and the over-estimation of numbers of species. Experimental data (McCafferty and Pereira, 1984) and field data (Kondratieff and Voshell, 1984) from other families of mayflies support this conclusion. Slight variations in color patterns of adults and/or larvae appear to be easily acquired in many baetid populations as either spatial or phenological gradients. We thus maintain that significant morphological differentiation in at least one of the life stages are most likely to typify species of baetids.

We have not yet resolved all of the species level synonymies that potentially exist in the classification of the North and Middle American fauna. For example, our examination of many collections of baetids from the Western Hemisphere indicates that the number of populations with distinct larval morphology does not correspond to the much larger number of species names based on adult typological concepts in certain genera, such as *Camelobaetidius* and *Procloeon*. Therefore, it is likely that more synonymies will be required when larval-adult associations become available. Since many of the species of *Baetodes* are weakly differentiated as larvae and unknown as adults, we also anticipate some synonymies in that genus. We have, however, been able to elucidate many necessary synonyms herein for such genera as *Callibaetis*.

We are cognizant that from a purely utilitarian point of view, presentation of a more modern classification and nomenclature results in a rather immediate need for updated taxonomic keys. This paper therefore will be followed by a revised and illustrated key to the Holarctic genera of Baetidae (Waltz and McCafferty, in manuscript).

## FORMAT

We provide an alphabetical checklist of all currently recognized genera and species of Baetidae occurring in North and Middle America (= Central America plus the Greater Antilles). New combinations, new synonymies, and new names resulting from our research are defined within the checklist. In the case of new combinations, the previous genus is indicated parenthetically under the new binomial. Also annotated to the checklist is an abbreviated, alphabetical (not chronological) synonymy bracketed under pertinent species. This indicates any nomenclatural history since the classification and listing of baetids of North and Central America that appeared in Edmunds' et al. (1976) generally used book.

Distributions are also annotated to the checklist by way of regional distributions that appear abbreviated after each species name. These regions in North and Middle America are depicted in Figure 1, but require some additional explanation as follows.

The Mesoamerican Region (MA) as used herein includes the Greater Antilles of the West Indies, Central America, and southern Mexico south of the Tropic of Cancer.

The Southwestern Region (SW) is bounded on the south by the Tropic of Cancer and in the west by the Pacific Ocean. It is bounded on the North by a line extending from the northern borders of Oklahoma, New Mexico, and Arizona west to the Pacific Ocean at Monterey Bay, California, with a slight northward deviation to incorporate the Mojave Desert region of southwestern Utah. The eastern boundary is a line along eastern portions of Oklahoma and Texas, so that the more arid region of these states are included but areas such as the Big Thicket of Texas and the Oklahoma Ozarks, which contain faunal elements more typical of eastern areas (e.g., McCafferty and Provonsha, 1978, unpublished), are excluded.

The Northwestern Region (NW) adjoins the Southwestern Region and shares the common

boundary described above. The northern boundary is a line represented by the northern borders of British Columbia, Alberta and Saskatchewan (60 degrees north latitude). The western boundary is the Pacific Ocean. The eastern boundary is a line running along the eastern border of Saskatchewan and roughly connecting the the eastern border of Colorado, so that both the Black Hills of South Dakota and the Sand Hills of the panhandle of Nebraska, which mainly contain western mayfly faunal elements (McCafferty 1990; McCafferty and Provonsha, unpublished), are included.

The Northeastern Region (NE) shares the eastern boundary of the Northwestern Region described above. The southern boundary begins at the northern border of Oklahoma, extends northward into Missouri, so as to exclude the Missouri Ozarks, then across the southern tip of Illinois, following the Ohio River and ending along the southern borders of Pennsylvania and New Jersey at the Atlantic coast. The northern boundary is the 60th parallel north latitude at the northern border of Manitoba west of Hudson Bay; however, east of Hudson Bay, all of Quebec and Newfoundland are included.

The Southeastern Region (SE) is bounded on the east and the south by the Atlantic Ocean and the Gulf of Mexico, respectively. Its northern and western borders are shared with the Northeastern Region and the Southwestern Region, respectively, as described above.

The Far North Region (FN) includes Alaska and Canada west of Hudson Bay and north of Hudson Straight. It is bounded on the South by the line demarcating 60 degrees parallel north latitude west of Hudson Bay. East of Hudson Bay, the region includes only Baffin Island, north of mainland Quebec.

These regions are based on our current knowledge of natural distributions of mayflies and represent our attempt to delineate general faunistic tendencies typical of mayflies. In other words, in most cases, if a species occurs in one part of one of our regions, it is highly probable that it may occur in other parts as well. There are, of course, species that are highly restricted ecologically and are not ubiquitous throughout a region, (e.g., big river species discussed by McCafferty et al., 1990). Such patterns are not necessarily ever expressed by broad geographical regions. In some instances, two or more of our regions are strongly linked by common physiographic components, particularly mountain ranges. Thus, montane species are often common to the Northwestern and Southwestern Regions, to the Southwestern and Mesoamerican Regions, and to the Northeastern and Southeastern Regions because of the north-south continuities of montane habitats.

Following the annotated checklist, we have provided a short discussion of each genus. We have attempted to indicate the best available sources of species keys or diagnoses for both larvae and adults. Various general remarks are also given for each genus as appropriate, and these may include additional information on nomenclatural history, diagnostic habitats, systematic status, and future research needs. While the grounds for generic revisions are summarized herein, they are based on the referenced published research of Waltz and McCafferty or more detailed research results to be published elsewhere (Waltz and McCafferty, manuscripts). Rationales for new species synonymies are given herein as necessary.

Following the discussion we provide a guide to all of the name changes and new taxa that have been added since the classification of Baetidae in North and Central America as it appeared in Edmunds et al. (1976). That book serves as a useful baseline because it was the last major reference work for the geographic area of coverage.

Genera and species names are listed alphabetically and include any names found listed in Edmunds et al. (1976) but that since, including herein, have been recombined with different genera, synonymized, substituted, or corrected in orthography. When generic concepts have

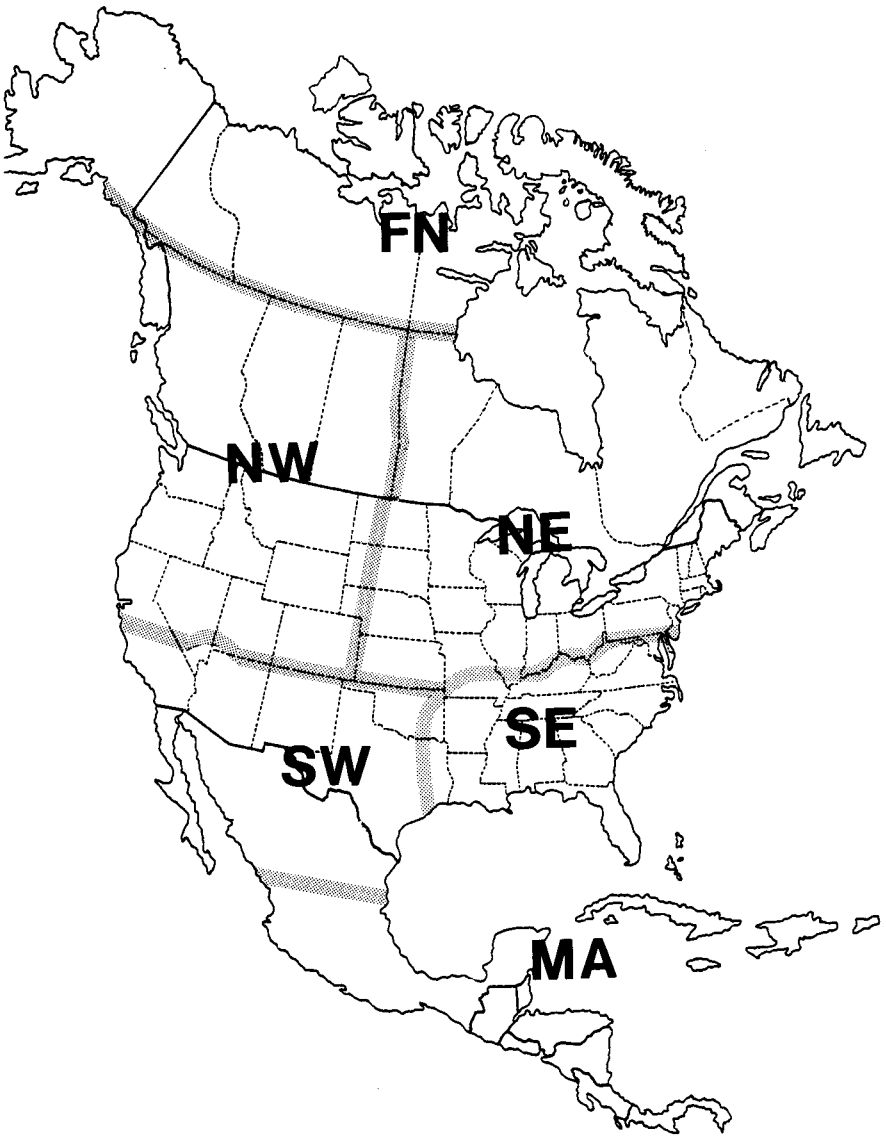


Fig. 1. Geographic regions of North and Middle America used for citing baetid species distributions.

changed, the current equivalencies are run alphabetically under the name exactly as it appeared in 1976. Under each previous species name, any names that have applied since 1976 are chronologically listed. Thus the single- or last-listed new name is the current name. The bibliographic sources of genus and species changes are referenced parenthetically after the change notation. If the change has been given in this paper, it is referenced simply as: (herein).

New taxa are incorporated into the alphabetical guide. These names (differentiated by an asterisk) reflect any newly discovered mayflies described since 1976. The bibliographic source for each new taxon appears after its name. A few new taxa are included not because they were described since 1976, but because they are from the Greater Antilles and were not included in Edmunds et al. (1976). These are noted as: (geographic addition herein). If any of the new taxa have undergone taxonomic revision since their description, new names are listed below them as they were for other names that have been changed, as described above.

Use of the guide along with the checklist will give any user a complete cross index to any recent nomenclatural changes and will make revisionary results tractable for nonspecialists.

## ANNOTATED CHECKLIST

**Acentrella** Bengtsson, 1912
*Acentrella ampla* Traver, 1932 -NE,SE-
[=*Baetis amplus* (Traver)]
*Acentrella carolina* (Banks), 1924 -FN,NE,NW,SE-
[=*Pseudocloeon carolina* (Banks)]
*Acentrella insignificans* (McDunnough), 1926 -FN,NW,SW-
[=*Baetis insignificans* McDunnough]
*Acentrella lapponica* Bengtsson, 1912 -FN-
[=*Baetis lapponicus* (Bengtsson)]
*Acentrella turbida* (McDunnough), 1924 -NW-
[=*Pseudocloeon turbidum* McDunnough]

**Acerpenna** Waltz and McCafferty, 1987
*Acerpenna akataleptos* (McDunnough), 1926, **n. comb**. -NW-
(formerly in *Baetis*)
*Acerpenna harti* (McDunnough), 1924, **n. comb**. -NE-
(formerly in *Baetis*)
*Acerpenna macdunnoughi* (Ide), 1937 -NE,SE-
[=*Baetis macdunnoughi* Ide]
*Acerpenna pygmaea* (Hagen), 1861 -NE,SE-
[=*Baetis pygmaeus* (Hagen); =*Baetis spiethi* Berner]

**Apobaetis** Day, 1955
*Apobaetis etowah* (Traver), 1935 -SE-
[=*Pseudocloeon etowah* Traver]
*Apobaetis indeprensus* Day, 1955 -NE,NW-

**Baetis** Leach, 1815

*Baetis adonis* Traver, 1935 -SW-

*Baetis alachua* (Berner), 1940, **n. comb**. -SE-
(formerly in *Pseudocloeon*)

*Baetis alius* Day, 1954 -NW-

*Baetis armillatus* McCafferty and Waltz , **n. name** -NE,NW,SE-
(formerly *Pseudocloeon parvulum* McDunnough 1932:210, a secondary homonym, not *Baetis parvulum* Crass, 1947)

*Baetis bicaudatus* Dodds, 1923 -FN,NW,SW-

*Baetis bimaculatus* (Berner), 1946, **n. comb**. -SE-
(formerly in *Pseudocloeon*)

*Baetis brunneicolor* McDunnough, 1925 -NE,SE-
[=*Baetis anachris* Burks, 1953; =*Baetis hiemalis* Leonard, 1950; =*Baetis phyllis* Burks, 1953]

*Baetis caelestis* Allen and Murvosh, 1983 -SW-
[=*Baetis* sp. A Morihara and McCafferty, 1979]

*Baetis caurinus* Edmunds and Allen, 1957 -NW-

*Baetis cinctutus* McCafferty and Waltz, **n. name** -NE-
(formerly *Pseudocloeon cingulatum* McDunnough 1931:85, a secondary homonym, not *Baetis cingulatus* Stephens, 1835; not *Baetis cingulatus* McDunnough 1925:216, a homonym and junior synonym of *Baetis flavistriga* McDunnough)

*Baetis dardanus* McDunnough, 1923 -NW-
[=*Baetis elachistis* Burks, 1953]

*Baetis diablis* Day, 1954 -NW-

*Baetis dubius* (Walsh), 1862, **n. comb**. -NE,SE-
(formerly in *Pseudocloeon*)
[=*Pseudocloeon chlorops* (McDunnough), 1923, **n. syn**.]

*Baetis elliotti* (Daggy), 1945, **n. comb**. -NE-
(formerly in *Pseudocloeon*)
[=*Pseudocloeon ida* (Daggy), 1945, **n. syn**.]

*Baetis ephippiatus* Traver, 1935 -NE,SE-

*Baetis flavistriga* McDunnough, 1921 -NE,SE-
[=*Baetis levitans* McDunnough, 1925; =*Baetis nanus* McDunnough, 1923; =*Baetis phoebus* McDunnough, 1923; =*Baetis quebecensis* Hubbard, 1974]

*Baetis foemina* McDunnough, 1936 -FN-

*Baetis frondalis* McDunnough, 1925 -NE,SE-
[=*Baetis australis* Traver, 1932; =*Baetis baeticatus* Burks, 1953]

*Baetis futile* (McDunnough), 1931, **n. comb**. -NW-
(formerly in *Pseudocloeon*)

*Baetis hudsonicus* Ide, 1937 -FN-

*Baetis intercalaris* McDunnough, 1921 -NE,SE-

*Baetis longipalpus* Morihara and McCafferty, 1979 -NE,SE-

*Baetis macani bundyae* Lehmkuhl, 1973 -FN-
[=*Baetis bundyae* Lehmkuhl]

*Baetis magnus* McCafferty and Waltz, 1986 -NW,SW-
[=*Baetis* sp. B Morihara and McCafferty, 1979;
=*Baetis libos* Allen and Murvosh, 1987, **n. syn**.]

*Baetis moffati* Dodds, 1923 -NW-
*Baetis notos* Allen and Murvosh, 1987 -SW-
[=*Baetis* sp. C Morihara and McCafferty, 1979]
*Baetis ochris* Burks, 1953 -NE-
*Baetis palisadi* Mayo, 1952 -NW-
*Baetis parallelus* Banks, 1924 -NW-
*Baetis persecutus* McDunnough, 1939 -NW-
*Baetis piscatoris* Traver, 1935 -NW-
*Baetis pluto* McDunnough, 1925 -NE,SE-
*Baetis posticatus* (Say), 1824 -NE-
*Baetis propinquus* (Walsh), 1863 -NE,SE-
*Baetis punctiventris* (McDunnough), 1923, **n. comb**. -NE,NW,SE-
(formerly in *Pseudocloeon*)
[=*Pseudocloeon anoka* Daggy, 1945, **n. syn**.; =*Pseudocloeon edmundsi* Jensen, 1969, **n. syn**.; =*Pseudocloeon myrsum* Burks, 1953, **n. syn**.]
*Baetis rubrolaterale* (McDunnough), 1931, **n. comb**. -NW-
(formerly in *Pseudocloeon*)
*Baetis rusticans* McDunnough, 1925 -NE-
*Baetis sinuosus* Navas, 1924 -MA-
*Baetis sulfurosus* Day, 1954 -NW-
*Baetis thermophilos* McDunnough, 1926 -NW-
*Baetis tricaudatus* Dodds, 1923 -NE,NW,SE,SW-
[=*Baetis incertans* McDunnough, 1925; =*Baetis intermedius* Dodds, 1923; =*Baetis jesmondensis* McDunnough, 1938; =*Baetis sonora* Allen and Murvosh, 1987, **n. syn**.; =*Baetis vagans* McDunnough, 1925]
*Baetis veteris* (McDunnough), 1924, **n. comb**. -NE-
(formerly in *Pseudocloeon*)
*Baetis virile* (McDunnough), 1923, **n. comb**. -NE-
(formerly in *Pseudocloeon*)

**Baetodes** Needham and Murphy, 1924
*Baetodes adjustus* Cohen and Allen, 1972 -MA-
*Baetodes arizonensis* Koss, 1972 -SW-
*Baetodes caritus* Cohen and Allen, 1972 -MA-
[=*Baetodes veracrusensis* Mayo, 1972]
*Baetodes deficiens* Cohen and Allen, 1972 -MA-
[=*Baetodes bellus* Mayo, 1972]
*Baetodes edmundsi* Koss, 1972 -SW-
*Baetodes fortinensis* Mayo, 1972 -MA-
*Baetodes fuscipes* Cohen and Allen, 1972 -MA-
[=*Baetodes furvus* Mayo, 1973]
*Baetodes inermis* Cohen and Allen, 1972 -MA,SW-
*Baetodes longus* Mayo, 1973 -MA-
*Baetodes noventus* Cohen and Allen, 1972 -MA-
*Baetodes obesus* Mayo, 1972 -MA-
*Baetodes pallidus* Cohen and Allen, 1972 -MA-
*Baetodes pictus* Cohen and Allen, 1972 -MA-

*Baetodes tritus* Cohen and Allen, 1972 -MA,SW-
*Baetodes velmae* Cohen and Allen, 1978 -MA-

**Barbaetis** Waltz and McCafferty, 1985
*Barbaetis benfieldi* Kennedy, 1985 -SE-
*Barbaetis cestus* (Provonsha and McCafferty), 1982, **n. comb.** -NE-
(formerly in *Pseudocloeon*)

**Callibaetis** Eaton, 1881
*Callibaetis americanus* Banks, 1900 -NW,SW-
[=*Callibaetis coloradensis* Banks, 1900, **n. syn.**; =*Callibaetis carolus* Traver, 1935, **n. syn.**; =*Callibaetis evergreenensis* Thew, 1959, **n. syn.**; =*Callibaetis hebes* Upholt, 1936, **n. syn.**; =*Callibaetis nigritus* Banks, 1918, **n. syn.**]
*Callibaetis californicus* Banks, 1900 -NW,SW-
*Callibaetis centralis* Peters, 1959 -NE-
*Callibaetis completa* Banks, 1924 -MA-
*Callibaetis ferrugineus* (Walsh), 1862 -NE-
*Callibaetis floridanus* Banks, 1900 -SE-
*Callibaetis fluctuans* (Walsh), 1862 -NE-
[=*Callibaetis traverae* Upholt, 1937, **n. syn.**]
*Callibaetis montanus* Eaton, 1885 -MA-
*Callibaetis pallidus* Banks, 1900 -NW-
[=*Callibaetis semicostatus* Banks, 1914, **n. syn.**]
*Callibaetis paulinus* (Navas), 1924 -MA-
*Callibaetis pictus* Eaton, 1871 -MA,NW,SW-
[=*Callibaetis doddsi* Traver, 1935, **n. syn.**; =*Callibaetis pacificus* Seeman, 1927, **n. syn.**; =*Callibaetis signatus* Banks, 1918, **n. syn.**]
*Callibaetis pretiosus* Banks, 1914 -SE-
*Callibaetis skokianus* Needham, 1903 -NE-
[=*Callibaetis brevicostatus* Daggy, 1945, **n. syn.**]
*Callibaetis undatus* (Pictet), 1845 -MA-

**Camelobaetidius** Demoulin, 1966
[=*Dactylobaetis* Traver and Edmunds, 1968, **n. syn.**]
*Camelobaetidius arriaga* (Traver and Edmunds), 1968, **n. comb.** -MA-
(formerly in *Dactylobaetis*)
*Camelobaetidius cepheus* (Traver and Edmunds), 1968, **n. comb.** -NW,SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius chiapas* (Traver and Edmunds), 1968, **n. comb.** -MA-
(formerly in *Dactylobaetis*)
*Camelobaetidius jenseni* (Traver and Edmunds), 1968, **n. comb.** -MA-
(formerly in *Dactylobaetis*)
*Camelobaetidius mexicanus* (Traver and Edmunds), 1968, **n. comb.** -NE,SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius musseri* (Traver and Edmunds), 1968, **n. comb.** -MA-
(formerly in *Dactylobaetis*)
*Camelobaetidius navis* (Allen and Chao), 1978, **n. comb.** -SW-

(formerly in *Dactylobaetis*)
*Camelobaetidius salinus* (Allen and Chao), 1978, **n. comb.** -SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius sinaloa* (Allen and Murvosh), 1987, **n. comb.** -SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius trivialis* (Allen and Chao), 1978, **n. comb.** -SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius warreni* (Traver and Edmunds), 1968, **n. comb.** -SW-
(formerly in *Dactylobaetis*)
*Camelobaetidius zenobia* (Traver and Edmunds), 1968, **n. comb.** -MA-
(formerly in *Dactylobaetis*)

**Centroptilum** Eaton, 1869
[=*Neocloeon* Traver, 1932, **n. syn.**, placed as synonym of *Cloeon* Leach, 1815, by Edmunds et al. (1976)]
*Centroptilum alamance* (Traver), 1932, **n. comb.** -NE,SE-
(formerly in *Cloeon sensu* Edmunds et al., 1976)
*Centroptilum bifurcatum* McDunnough, 1924 -NW-
*Centroptilum selanderorum* Edmunds, 1954 -NW-
*Centroptilum semirufum* McDunnough, 1926 -NE-
*Centroptilum triangulifer* (McDunnough), 1931, **n. comb.** -NE,SE-
(formerly in *Cloeon* )
*Centroptilum victoriae* McDunnough, 1938 -NE-

**Cloeodes** Traver, 1938
*Cloeodes consignatus* Traver, 1938 -MA-
*Cloeodes excogitatus* Waltz and McCafferty, 1987 -SW-
*Cloeodes macrolamellus* Waltz and McCafferty, 1987 -SW-
*Cloeodes maculipes* Traver, 1938 -MA-
*Cloeodes peninsulus* Waltz and McCafferty, 1987 -SW-

**Cloeon** Leach, 1815
*Cloeon cognatum* Stephens, 1835 -NE-
[=*Cloeon dipterum* (Linnaeus), 1761, misidentification of Nearctic material]

**Diphetor** Waltz and McCafferty, 1987
*Diphetor devinctus* (Traver), 1935 -NW-
[=*Baetis devinctus* Traver]
*Diphetor hageni* (Eaton), 1885 -NE,NW-
[=*Baetis hageni* Eaton; =*Baetis parvus* Dodds, 1923]

**Fallceon** Waltz and McCafferty, 1987
*Fallceon garcianus* (Traver), 1938, **n. comb.** -MA-
(formerly in *Baetis*)
*Fallceon poeyi* (Eaton), 1885, **n. comb.** -MA-
(formerly in *Baetis*, transferred from *Centroptilum* by Edmunds, 1974)
*Fallceon quilleri* (Dodds), 1923 -NE,NW,SE,SW-
[=*Baetis buenoi* Allen, 1985; =*Fallceon buenoi* (Allen), **n. syn.**; =*Baetis byblis* Allen

and Murvosh, 1983; =*Fallceon* byblis (Allen and Murvosh), **n. syn.**; =*Baetis cleptis* Burks, 1953; =*Baetis eatoni* Kimmins, 1934; =*Fallceon eatoni* (Kimmins), **n. syn.**; =*Baetis endymion* Traver, 1935; =*Baetis erebus* Traver, 1935; =*Baetis leechi* Burks, 1954]

**Guajirolus** Flowers, 1985
*Guajirolus ektrapeloglossa* Flowers, 1985 -MA-

**Heterocloeon** McDunnough, 1925
*Heterocloeon berneri* (Müller-Liebenau), 1974 -SE-
*Heterocloeon curiosum* (McDunnogh), 1923 -NE, SE-
*Heterocloeon frivolus* (McDunnough), 1925 -NE,SE-
[=*Baetis frivolus* McDunnough]
*Heterocloeon petersi* (Muller-Liebenau), 1974 -SE-

**Moribaetis** Waltz and McCafferty, 1985
*Moribaetis macaferti* Waltz, 1985 -MA-
*Moribaetis maculipennis* (Flowers), 1979 -MA-
[=*Baetis maculipennis* Flowers]
*Moribaetis salvini* (Eaton), 1885 -MA-
[=*Baetis salvini* Eaton]

**Paracloeodes** Day, 1955
*Paracloeodes minutus* (Daggy), 1945 -NE,NW,SE-
[=*Paracloeodes abditus* Day, 1955, **n. syn.**]
*Paracloeodes portoricensis* (Traver), 1938 -MA-

**Procloeon** Bengtsson, 1915
*Procloeon album* (McDunnough), 1926, **n. comb.** -NE,SE-
(formerly in *Centroptilum*)
*Procloeon asperatum* (Traver), 1935, **n. comb.** -SW-
(formerly in *Centroptilum*)
*Procloeon bellum* (McDunnough), 1924, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon caliginosum* (McDunnough), 1925, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon conturbatum* (McDunnough), 1929, **n. comb.** -NW-
(formerly in *Centroptilum*)
*Procloeon convexum* (Ide), 1930, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon elsa* (Traver), 1935, **n. comb.** -NW-
(formerly in *Centroptilum*)
*Procloeon fragile* (McDunnough), 1923, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon hobbsi* (Berner), 1946, **n. comb.** -SE-
(formerly in *Centroptilum*)
*Procloeon implicatum* (McDunnough), 1924, **n. comb.** -NW-
(formerly in *Cloeon*)

*Procloeon inanum* (McDunnough), 1924, **n. comb.** -NW-
(formerly in *Cloeon*)
*Procloeon ingens* (McDunnough), 1923, **n. comb.** -NW-
(formerly in *Cloeon*)
*Procloeon insignificans* (McDunnough), 1925, **n. comb.** -NE-
(formerly in *Cloeon*)
*Procloeon intermediale* (McDunnough), 1931, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon mendax* (Walsh), 1862, **n. comb.** -NE-
(formerly in *Cloeon*)
*Procloeon minor* (McDunnough), 1926, **n. comb.** -NE-
(formerly in *Cloeon*)
*Procloeon oreophilum* (Edmunds), 1954, **n. comb.** -NW-
(formerly in *Centroptilum*)
*Procloeon ozburni* (McDunnough), 1924, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon pennulatum* (Eaton), 1885, **n. comb.** -NW-
(formerly in *Pseudocentroptilum*)
[=*Centroptilum infrequens* McDunnough, 1924]
*Procloeon quaesitum* (McDunnough), 1931, **n. comb.** -NW-
(formerly in *Centroptilum*)
*Procloeon rivulare* (Traver), 1935, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon rubropictum* (McDunnough), 1923, **n. comb.** -NE-
(formerly in *Cloeon*)
*Procloeon rufostrigatum* (McDunnough), 1924, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon simile* (McDunnough), 1924, **n. comb.** -NE-
(formerly in *Centroptilum*)
*Procloeon simplex* (McDunnough), 1925, **n. comb.** -NE-
(formerly in *Cloeon*)
*Procloeon venosum* (Traver), 1935, **n. comb.** -SW-
(formerly in *Centroptilum*)
*Procloeon vicinum* (Hagen), 1861, **n. comb.** -SE-
(formerly in *Cloeon*)
*Procloeon viridocularis* (Berner), 1940, **n. comb.** -SE-
(formerly in *Centroptilum*)
*Procloeon walshi* (McDunnough), 1929, **n. comb.** -NE-
(formerly in *Centroptilum*)

**Pseudocentroptiloides** Jacob, 1986
*Pseudocentroptiloides usa* Waltz and McCafferty, 1989 -NE-

## DISCUSSION

### **Acentrella** Bengtsson

*Species identification.*— Larvae (as *Baetis lapponicus* group): Morihara and McCafferty (1979a). Adults (as *Baetis*): Traver (1935).

*Remarks.*— The genus *Acentrella* is mainly a northern boreal group with some proclivity for circumpolar species distributions. There has been some difference of opinion regarding its taxonomic status. Muller-Liebenau (1981, 1982) and Waltz and McCafferty (1987a,d) recognized *Acentrella* as a distinct monophyletic group related to *Baetis*. Novikova and Kluge (1987) have regarded it as a synonym of *Baetis*.

### **Acerpenna** Waltz and McCafferty

*Species identification.*— Larvae (as *Baetis*): Morihara and McCafferty (1979a). Adults (as *Baetis*): Traver (1935), McCafferty and Morihara (1979).

*Remarks.*— Larvae of this distinctive genus are easily distinguished by the apically pointed gills of abdominal segment seven. Species were previously considered in *Baetis*; however, *Acerpenna* is not part of the *Baetis* complex because larvae lack the villopore of the femora (Waltz and McCafferty, 1987c).

*Acerpenna macdunnoughi* and *A. pygmaea* are common stream species throughout much of eastern North America. McCafferty and Morihara (1979) discovered that *A. macdunnoughi* was facultatively parthenogenetic, being parthenogenetic in northern populations at the fringe of its range, but with males common in southern populations.

### **Apobaetis** Day

*Species identification.*— Larvae and adults: Day (1955). Adults: Waltz and McCafferty (1986).

*Remarks.*— Male adults of *Apobaetis* are unique in the Nearctic realm by being the only known two-winged baetid mayflies with paired marginal intercalaries in the forewings and a prominent penes plate. The larva of *A. etowah* is unknown.

### **Baetis** Leach

*Species identification.*— Larvae: Morihara and McCafferty (1979a,b), Soluk (1981). Adults: Traver (1935), considering synonymies in Morihara and McCafferty (1979a); (as *Pseudocloeon* in part): Traver (1935), Daggy (1945), Burks (1953).

*Remarks.*— Numerous specific names that had been applied to North American *Baetis* were necessarily synonymized by Morihara and McCafferty (1979a) (see Guide below). Waltz and McCafferty (1987c) removed certain species from *Baetis* because, in addition to being distinct in other characteristics, they importantly lacked a villopore on the larval femora and therefore were not thought to have shared an immediate common ancestor with other *Baetis* spp. Several Middle American species that previously would have been assignable to *Baetis* are more appropriately placed in other genera, such as *Moribaetis* and *Fallceon* (Waltz and McCafferty, 1985b, 1987c).

Many Nearctic species previously considered in *Pseudocloeon* s. auctt. have been placed in *Baetis* (see Checklist above). In fact, all Nearctic species previously assigned to *Pseudocloeon* have been reassigned to other Nearctic genera (see Guide below). The

transfers and synonymies are based on extensive revisionary studies, including Waltz and McCafferty (1985a, 1986, 1987a,d,e). Type materials representing all specific names that have been associated with *Pseudocloeon* in North America have been examined. South American species described as *Pseudocloeon* are not congeneric with the type species but await generic reassignment until their status is more thoroughly studied (see also Waltz and McCafferty, 1987a; Flowers, 1987). Recombinations of Neotropical species could include *Apobaetis*, *Baetis*, *Baetodes*, *Cloeodes*, *Paracloeodes* and possibly other.

*Baetis*, as constituted, now contains species with hindwings and species without hindwings. In addition to these variations, however, McCafferty and Provonsha (unpublished) have discovered an undescribed species of *Baetis* from Indiana in which the males possess hindwings but the females do not. Such a phenomenon in Baetidae was first noted by Edmunds et al. (1976).

Morihara and McCafferty (1979a) suggested several species groups within North American Baetidae, a system somewhat modified from that formulated for European species by Müller-Liebenau (1970). These groups will require reevaluation in light of revisionary work since that time. The lapponicus group is basically equivalent to *Acentrella*; the rhodani, vernus, fuscatus, and propinquus groups are essentially still valid concepts; and the muticus group equals *Diphetor* at least in part. Novikova and Kluge (1987) evidently would prefer to recognize some of these groupings or parts of them as subgenera of *Baetis*.

Flannagan and Flannagan (1982) listed all Manitoba species that had been known as *Pseudocloeon* under the name *Baetis*, presumably on the basis of a suggestion by Keffermüller (1980) that *Pseudocloeon* was entirely equivalent to *Baetis*. However, a formal synonymy was not made by Keffermüller, and no formal recombinations of names had been made at that time. Also, it should be kept in mind that we have thus far found that species previously classified in *Pseudocloeon* belong variously to *Acentrella*, *Apobaetis*, and *Barbaetis*, as well as *Baetis* (see Guide below). In addition, Edmunds (1974) found one species of Nearctic *Pseudocloeon* to belong to *Paracloeodes*.

### **Baetodes** Needham and Murphy

*Species identification.*— Larvae: Cohen and Allen (1978). Adults: Flowers (1987).

*Remarks.*— The ventrally oriented gills and outspread legs of the larvae of *Baetodes* make them very distinctive among the Baetidae. Adults can be difficult to identify. However, Flowers (1987) described newly associated adults of three species and provided a revised generic diagnosis for the adult stage. The genus is undoubtedly of Neotropical origin, but with many Central and South American species. Species level revisionary research is required.

### **Barbaetis** Waltz and McCafferty

*Species identification.*— Larvae: Waltz, McCafferty, and Kennedy (1985), Provonsha and McCafferty (1982). Adults: Provonsha and McCafferty (1982).

*Remarks.*— The striking color pattern of the larvae, including the prominent dark band of the abdomen and cerci, provides a useful field character in distinguishing species of this genus from other Nearctic species (see whole larval figure of Provonsha and McCafferty, 1982). Larvae of this specialized Nearctic genus are found in medium sized to large rivers, usually in association with erosional zones and a pea gravel type of substrate (Provonsha and McCafferty, 1982; Waltz et al., 1985). Their color pattern may be an adaptation for living

in such habitats, possibly providing them with some cryptic protection from predators. The adult of *B. benfieldi* is unknown.

### **Callibaetis** Eaton

*Species identification.*— Larvae: No reliable key to the larvae is available. Adults: Traver (1935) must be used tentatively, and considering synonymies given herein.

*Remarks.*— Species of this Western Hemisphere genus can be difficult to identify in either the larval or adult stage. Although color patterns of the wings of *Callibaetis* adults are often striking, they are not particularly good specific characters, being somewhat variable and highly prone to sexual dimorphism. Numerous species synonyms are given herein. We anticipate that even more synonyms will be discovered as more material becomes available for study. Comparative study of the species concepts applied in this genus indicate that many of the previously proposed species merely represent different geographic populations, either with some color variation or with no perceptible variation.

The genus *Callibaetis* is very distinctive among the Baetidae. Some workers (e.g., Riek, 1973; Gillies, 1990) would place it in a separate subfamily Callibaetinae, and Landa and Soldan (1985) considered the genus in a subfamily Cloeoninae. We prefer not to follow any subfamilial classification until more cladistic data on major baetid lineages become available.

### **Camelobaetidius** Demoulin

*Species identification.*— Larvae (as *Dactylobaetis*): Traver and Edmunds (1968), Allen and Chao (1978). Adults (as *Dactylobaetis*): Traver and Edmunds (1968).

*Remarks.*— The definitive work on this genus was given by Traver and Edmunds (1968) under their generic name, *Dactylobaetis*. Demoulin (1966), however, while being aware of the comprehensive study being conducted by Traver and Edmunds, proposed the name *Camelobaetidius* for a single South American species(*C. leentvaari* Demoulin). We have examined the types of both *Camelobaetidius* and *Dactylobaetis* and must conclude that not only is there insufficient characterization for maintaining the two names, but also they represent an unnatural classification in that *Dactylobaetis* would be paraphyletic. Therefore, we recognize *Camelobaetidius* Demoulin [Type species: *Camelobaetidius leentvaari* Demoulin 1966:9, by original designation] as the senior subjective synonym of *Dactylobaetis* Traver and Edmunds [Type species: *Dactylobaetis warreni* Traver and Edmunds 1968:630, by original designation] and have formally transferred all North and Middle American species in the checklist above. South American species are formally transferred as follows: *Camelobaetidius anubis* (Traver and Edmunds) **n. comb.**, *C. cayumba* (Traver and Edmunds) **n. comb.**, *C. penai* (Traver and Edmunds) **n. comb.**, *C. phaedrus* (Traver and Edmunds) **n. comb.**, and *C. serapis* (Traver and Edmunds) **n. comb.**

While larvae of this genus are easily distinguished from all other known baetid genera by the uniquely spatulate form of the claws, our preliminary studies of larval and adult characterization within the genus suggest that several specific synonyms will be required. The Northeast Region distribution indicated in the checklist as part of the range of *C. mexicanus* may appear to be an anamoly based on the otherwise entirely western distribution of the genus. Actually, however, *C. mexicanus* is known only from western Kansas in the Northeast Region (Liechti, 1982).

## **Centroptilum** Eaton

*Species identification.*— Larvae: No reliable key to the larvae of Nearctic species is available, see instead descriptions of Traver (1935) (including*Neocloeon*), Burks (1953), Bergman and Hilsenhoff (1978b), and Lowen and Flannagan (1990a,b,c). Adults (including*Neocloeon*): Traver (1935).

*Remarks.*— As newly defined herein, species of *Centroptilum* may possess hindwings (hindwing pads present in the larval stage) or may completely lack hindwings (hindwing pads absent in the larval stage). The genus *Centroptilum* is restricted to include those species with adult males possessing a prominent medial spine between the forceps bases and an elongated terminal segment of the forceps. Lowen and Flannagan (1990c) have also recognized some such characteristics for *Centroptilum.* The world distribution of true *Centroptilum* cannot be ascertained until further studies of materials from other regions, are conducted. *Centroptilum* of the Afrotropics, which is essentially equivalent to Gillies recent *Afroptilum* (Gillies, 199a) appears to be polyphyletic

Larvae of *Centroptilum* s. str., as pointed out by several earlier authors (Kazlauskas, 1972; Jacob, 1973; Keffermuller and Sowa, 1984), are unique among the more broadly included species of *Centroptilum* s. l. because of the presence of strongly expanded, apically truncated (slightly excavate medially) terminal segments of the labial palps. Several Nearctic larvae possess lateral spines on abdominal segments 8-9, which are not present in all species of the genus. We do not regard the presence or absence of such lateral spines as generic criteria. A more detailed discussion of the basis for the revision of *Centroptilum* will be published elsewhere (Waltz and McCafferty, in manuscript).

We have designated *Neocloeon* Traver [Type species: *Neocloeon alamance* Traver, by original designation] as a junior subjective synonym of *Centroptilum* Eaton. Comparisons of *Neocloeon* with *C. luteolum* clearly indicate the synonymy. The previous inclusion of *Neocloeon* as a junior synonym of *Cloeon* (Edmunds et al., 1976) is apparently based on the absence of hindwings. *Neocloeon*, however, is very distinct from the type species of *Cloeon*, *C. dipterum.*

We are aware that some larvae that we have assigned to *Procloeon* Bengtsson come close to our definition of *Centroptilum* larvae. Nevertheless, these larvae are associated with adults lacking the distinctive medial spine between the forceps bases of the male genitalia. Critical review of more larval-adult associations, such as that being provided by the rearings of Lowen and Flannagan (1990c), may result in refinements of the basic generic scheme that we propose. Our restriction of the concept of *Centroptilum* is based on the examination of types and comparisons with the Nearctic species and related world genera (see also discussions of *Cloeon* and *Procloeon*).

*Centroptilum* larvae, as here restricted, are typically found in slow or quiet waters (e.g., Sweeney and Vannote, 1984) often with silty or sandy bottoms. The small, cold-water, meandering brooks found in beaver pond meadows in the Upper Peninsula of Michigan represent a common type of habitat for *Centroptilum* (McCafferty, unpublished).

## **Cloeodes** Traver

*Species identification.*— Larvae: Waltz and McCafferty (1987a). Adults: Waltz and McCafferty (1987b).

*Remarks.*— As larvae, species of *Cloeodes* may be distinguished in the field by a *Centroptilum*-like appearance, and on closer inspection, by their short edentate claws, simple gills, distinct bands of setae on the tibiae, and ventral abdominal setal tufts (high magnification may be required). Species of *Cloeodes* may possess hindwings, or hindwings may be absent. Waltz and McCafferty (1987b) gave a generic description of the adult stage; however, several species remain to be described as adults.

This dominantly Western Hemisphere genus is undoubtedly Neotropical in origin, with its most northern known distribution being Oak Creek Canyon in northern Arizona (Waltz and McCafferty, 1987a). Apparently some new species of *Cloeodes* have recently been discovered in Cuba by N. Kluge of Leningrad (Kluge, pers. comm.).

### **Cloeon** Leach

*Species identification.*— Larvae and adults: Sowa (1975).

*Remarks.*— Only one species of *Cloeon* is present in North and Middle America. Previous keys written for Nearctic *Cloeon* actually are applicable to species of *Procloeon* and *Centroptilum* (see Guide below). The first verifiable records of *Cloeon* s. str. in the Nearctic were reported by Burks (1953) and Traver (1962). Flowers (1978) updated the Nearctic nomenclature based upon Sowa (1975). Our own review of several collections of *C. cognatum* compared with European material confirmed the uniqueness of this species in the Nearctic fauna.

Although our restriction of the genus *Cloeon* in the Nearctic may be regarded by some as severe, it is the only defensible conclusion we can make based on our examination of extensive collections of adults and larvae of pertinent species in North America and comparisons with the adults and larvae of the type species of *Cloeon*, *C. dipterum* from Europe (Waltz and McCafferty, unpublished). We concur with Edmunds et al. (1976) that in the Nearctic *Cloeon* s. auctt. and *Centroptilum* s. auctt. make up a cohesive unit. The majority of these species, however, belong neither to *Cloeon* s. str. nor to *Centroptilum* s. str. but rather are assignable to *Procloeon* Bengtsson (see Guide below).

### **Diphetor** Waltz and McCafferty

*Species identification.*— Larvae (as *Baetis*): Morihara and McCafferty (1979a). Adults (as *Baetis*): Traver (1935), considering synonymies in Morihara and McCafferty (1979a).

*Remarks.*— This genus, which may eventually prove to be Holarctic, is distinguished in the larval stage by the loss of gills 1 and in the adults by unique wing venation. *Diphetor* is not a member of the *Baetis* complex because it lacks the larval femoral villopore. Because of this and on the basis of other characteristics, its species were removed from *Baetis* by Waltz and McCafferty (1987c). Waltz and McCafferty (unpublished) have studied the undescribed larva of *D. devinctus*, which presently keys to *D. hageni* in Morihara and McCafferty (1979a).

Bergman and Hilsenhoff (1978c) experimentally showed *D. hageni* to be obligate parthenogenetic, as had been suggested by the field observations of Ide (1930, 1937). At least California populations of *D. devinctus* are sexually reproductive (Traver, 1935).

### **Fallceon** Waltz and McCafferty

*Species identification.*— Larvae (as *Baetis*): Morihara and McCafferty (1979a). Adults

(as *Baetis*): Traver (1935), considering synonymies in Morihara and McCafferty (1979a).

*Remarks.*— The Western Hemiphere genus *Fallceon* is distinguishable in the larval stage by numerous characteristics, including the absence of a femoral villopore; adults are easily told from other Western Hemisphere genera by the their characteristic hindwings (Waltz and McCafferty, 1987c). A review of large series of Nearctic *Fallceon* larvae has indicated the presence of some consistant patterns of morphological variation. Some of these variants may ultimately require recognition as distinct species, but this cannot be determined definitively without larval-adult reared associations becoming available.

To avoid confusion that might arise in the future in trivial name formation when combining with *Fallceon*, it should be noted that the generic nomen was an arbitrary combination of letters designated as masculine in gender. Thus, the genus is not neuter as might be construed when referring to some other netuer names in Baetidae, such as *Choeon* or *Heterocloeon*, which hava s similar three-letter ending.

### **Guajirolus** Flowers

*Species identification.*— Larvae and adults: Flowers (1985).

*Remarks.*— Larvae of this Neotropical genus are easily recognized on the basis of the distinctive mouthparts. Although this genus is noted as a new taxon since 1976 in the following Guide, it acually has been known since Roback (1966) referred to a Peruvian population of it as Genus 3 nr *Pseudocloeon*. Flowers (1985) lter found it in Panama and gave it a formal name. Additional species of this genus are pending description (Waltz and McCafferty, in manuscript).

### **Heterocloeon** McDunnough

*Species identification.*— Larvae: Morihara and McCafferty (1979c); (as *Rheobaetis*): Muller-Liebenau (1974). Adults (as *Rheobaetis*): Muller-Liebenau (1974).

*Remarks.*— McCafferty and Provonsha (1975) revalidated this Nearctic genus, affirmed its distinctiveness, and showed that the name *Rheobaetis* was synonymous with *Heterocloeon*.. Larvae of the genus are typically found in medium sized, clean-water streams with heterogeneous substrates.

### **Moribaetis** Waltz and McCafferty

*Species identification.*— Larvae and Adults: Waltz and McCafferty (1985b).

*Remarks.*— This genus appears to be restricted to tropical areas in the Western Hemisphere. The large size of the larvae, unusual claw structure (similar only to *Baetodes*), and unique mouthpart structure provide useful identification characters for this genus. Among other places, larvae have been collected out of the water in the splash zone along the edge of small waterfalls of some high elevation streams in Costa Rica (Waltz and McCafferty. 1985b, McCafferty, unpublished).

### **Paracloeodes** Day

*Species identification.*— Larvae and adults: Day (1955).

*Remarks.*— The placement of *Paracloeodes abditus* Day as a junior subjective synonym of *P. minutus* (Daggy) is based on an examination and comparison of the type series asociated with the two names as well as comparisons with other available collections of *Paracloeodes*

larvae and adults from North America.

The genus is apparently indigenous to the Western Hemisphere. Kondratieff and Harris (1986) provided the only data-verified record of *Paracloeodes* for the Southeast Region, although those workers were unable to assign a species name. In the Northeast Region, we have found it as far east as Lafayette, Indiana, where we have collected large populations of *P. minutus* larvae along the edges of the Wabash River in summer.

**Procloeon** Bengtsson

*Species identification.*— Larvae: No reliable keys to species are presently available, see instead descriptions under *Centroptilum* and *Cloeon* of Traver (1935) and Burks (1953). Adults (as *Centroptilum* or *Cloeon*): Traver (1935).

*Remarks.*— The genus *Procloeon* is widespread in the Palearctic, Afrotropical, and Oriental realms, and is herein reported as well represented in the Nearctic realm. It is distinct from both *Cloeon* and *Centroptilum* in the larval and adult stage. We have found that the majority of species previously placed in *Centroptilum* and *Cloeon* in the Nearctic to be congeneric with the type of *Procloeon*, *P. bifidum* (see Guide below). Furthermore, these species are not assignable to *Pseudocentroptilum* Bogoescu, as would be suggested by the recent work of Keffermüller and Sowa (1984). In fact, the genus *Pseudocentroptilum* is doubtfully distinct from *Procloeon*, although several world species have recently been assigned to it, primarily to recognize their distinct separation from the type of *Centroptilum*, *C. luteolum* and its cognates. The comprehensive morphological bases for our revision will be published elsewhere (Waltz and McCafferty, in manuscript).

There may be some problems in clearly diagnosing certain western North American larvae to either *Centroptilum* or *Procloeon*. As more larvae are associated with their respective adults, as being provided by Lowen and Flannagan (1990c), we anticipate this problem will be rectified and probably require a refinement of the presently relatively strict definition of the *Procloeon*.

**Pseudocentroptiloides** Jacob

*Species identification.*— Larvae and adults: Waltz and McCafferty (1989).

*Remarks.*— As larvae, this genus is relatively easy to identify in field samples by the extremely elongated claws, *Centroptilum*-like external morphology, and distinctive labium. The genus demonstrates a Laurasian type of distribution pattern, being known from the Holarctic and Oriental realms (Waltz and McCafferty, 1989). We suspect that it may eventually be found to be represented by more than one species in the Western Hemisphere.

A GUIDE TO NAME CHANGES AND ADDED TAXA (*) SINCE 1976

*Baetis* Leach, 1815

= *Acentrella* Bengtsson, 1912, in part (Waltz and McCafferty, 1987d); = *Acerpenna* Waltz and McCafferty, 1987, in part (Waltz and McCafferty, 1987c); =*Baetis* Leach, 1815, in part, (herein); =*Diphetor* Waltz and McCafferty, 1987, in part (Waltz and McCafferty, 1987c); = *Fallceon* Waltz and McCafferty, 1987, in part (Waltz and McCafferty, 1987c); = *Heterocloeon* McDunnough, 1925, in part (Morihara and McCafferty, 1979c); = *Moribaetis* Waltz and McCafferty, 1985, in part (Waltz and McCaf-

ferty, 1985b)

*Baetis akataleptos* McDunnough, 1926
= *Acerpenna akataleptos* (McDunnough) (herein)

*Baetis amplus* (Traver), 1932
= *Acentrella ampla* Traver (Waltz and McCafferty, 1987d, as originally described)

*Baetis anachris* Burks, 1953
= *Baetis brunneicolor* McDunnough, 1925 (Morihara and McCafferty, 1979a)

*Baetis australis* Traver, 1932
= *Baetis frondalis* McDunnough, 1925 (Morihara and McCafferty, 1979a)

*Baetis baeticatus* Burks, 1953
= *Baetis frondalis* McDunnough, 1925 (Bergman and Hilsenhoff, 1978a)

**Baetis buenoi* Allen, 1985
= *Fallceon buenoi* (Allen) (Waltz and McCafferty, 1987c)
= *Fallceon quilleri* (Dodds), 1923 (herein)

*Baetis bundyae* Lehmkuhl, 1973
= *Baetis macani bundyae* Lehmkuhl (Morihara and McCafferty, 1979d)

**Baetis byblis* Allen and Murvosh, 1983
= *Fallceon byblis* (Allen and Murvosh) (Waltz and McCafferty, 1987c)
= *Fallceon quilleri* (Dodds), 1923 (herein)

**Baetis caelestis* Allen and Murvosh (1983)

*Baetis cleptis* Burks, 1953
= *Baetis quilleri* Dodds, 1923 (Morihara and McCafferty, 1979a)
= *Fallceon quilleri* (Dodds) (Waltz and McCafferty, 1987c)

*Baetis dardanus* McDunnough, 1923 (revalidation by Morihara and McCafferty, 1979b)

*Baetis devinctus* Traver, 1935
= *Diphetor devinctus* (Traver) (Waltz and McCafferty, 1979c)

*Baetis eatoni* Kimmins, 1934
= *Fallceon eatoni* (Kimmins) (Waltz and McCafferty, 1987c)
= *Fallceon quilleri* (Dodds), 1923 (herein)

*Baetis elachistis* Burks, 1953
= *Baetis dardanus* McDunnough, 1923 (Morihara and McCafferty, 1979b)

*Baetis endymion* Traver, 1935
= *Baetis quilleri* Dodds, 1923 (Morihara and McCafferty, 1979a)
= *Fallceon quilleri* (Dodds) (Waltz and McCafferty, 1987c)

*Baetis erebus* Traver, 1935
= *Baetis quilleri* Dodds, 1923 (Morihara and McCafferty, 1979a)
= *Fallceon quilleri* (Dodds) (Waltz and McCafferty, 1987c)

*Baetis frivolus* McDunnough, 1925
= *Heterocloeon frivolum* (McDunnough) (Morihara and McCafferty, 1979c)

**Baetis garcianus* (Traver), 1938 (geographic addition herein)
= *Fallceon garcianus* (Traver) (herein).

*Baetis hageni* Eaton, 1885
= *Diphetor hageni* (Eaton) (Waltz and McCafferty, 1987c)

*Baetis harti* McDunnough, 1924
= *Acerpenna harti* (McDunnough) (herein)

*Baetis hiemalis* Leonard, 1950

= *Baetis brunneicolor* McDunnough, 1925 (Morihara and McCafferty, 1979a)
*Baetis incertans* McDunnough, 1925
= *Baetis vagans* McDunnough, 1925 (Bergman and Hilsenhoff, 1978a)
= *Baetis tricaudatus* Dodds, 1923 (Morihara and McCafferty, 1979a)
*Baetis insignificans* McDunnough, 1926
= *Acentrella insignificans* (McDunnough)(Waltz and McCafferty 1982d)
*Baetis intermedius* Dodds, 1923
= *Baetis tricaudatus* Dodds, 1923 (Morihara and McCafferty, 1979a)
*Baetis jesmondensis* McDunnough, 1938
= *Baetis tricaudatus* Dodds, 1923 (Waltz and McCafferty, 1990)
*Baetis lapponicus* (Bengtsson), 1912
= *Acentrella lapponica* Bengtsson (Muller-Liebenau, 1981, as originally described)
*Baetis leechi* Day, 1954
= *Baetis quilleri* Dodds, 1923 (Morihara and McCafferty, 1979a)
= *Fallceon quilleri* (Dodds) (Waltz and McCafferty, 1987c)
*Baetis levitans* McDunnough, 1925
= *Baetis flavistraga* McDunnough, 1921 (Morihara and McCafferty, 1979a)
**Baetis libos* Allen and Murvosh 1987
= *Baetis magnus* McCafferty and Waltz, 1986 (herein)
**Baetis longipalpus* Morihara and McCafferty 1979b
*Baetis macdunnoughi* Ide, 1937
= *Acerpenna macdunnoughi* (Ide) (Waltz and McCafferty, 1987c)
**Baetis maculipennis* Flowers, 1979
= *Moribaetis maculipennis* (Flowers) (Waltz and McCafferty, 1985b)
**Baetis magnus* McCafferty and Waltz, 1986
*Baetis nanus* McDunnough, 1923
= *Baetis flavistriga* McDunnough, 1921 (Morihara and McCafferty, 1979a)
**Baetis notos* Allen and Murvosh 1987
*Baetis pallidulus* McDunnough, 1924
= *Baetis flavistregia* McDunnough, 1921 (Morihara and McCafferty, 1979a)
*Baetis parvus* Dodds, 1923
= *Baetis hageni* Eaton, 1885 (Morihara and McCafferty, 1979a)
= *Diphetor hageni* (Eaton) (Waltz and McCafferty, 1987c)
*Baetis phoebus* McDunnough, 1923
= *Baetis pallidulus* McDunnough, 1924 (Bergman and Hilsenhoff, 1978a)
= *Baetis flavistriga* McDunnough, 1921 (Morihara and McCafferty, 1979a)
*Baetis phyllis* Burks, 1953
= *Baetis brunneicolor* McDunnough, 1925 (Morihara and McCafferty, 1979a)
**Baetis poyei* (Eaton), 1885
*Baetis pygmaeus* (Hagen), 1861
= *Acerpenna pygmaea* (Hagen) (Waltz and McCafferty, 1987c)
*Baetis quebecensis* McDunnough [sic]
= *Baetis phoebus* McDunnough, 1923 (Bergman and Hilsenhoff, 1978a)
= *Baetis quebecensis* Hubbard, 1974 (new name for *Baetis cingulatus* McDunnough, 1925) (incorrectly ascribed to McDunnough by Edmunds et al., 1976) (Morihara and McCafferty, 1979a)

= *Baetis flavistriga* McDunnough, 1921 (Morihara and McCafferty, 1979a)
*Baetis quilleri* Dodds, 1923
= *Fallceon quilleri* (Dodds) (Waltz and McCafferty, 1987c)
*Baetis salvini* Eaton, 1885
= *Moribaetis salvini* (Eaton) (Waltz and McCafferty, 1985b)
**Baetis sonora* Allen and Murvosh, 1987 (Allen and Murvosh, 1987)
= *Baetis tricaudatus* Dodds, 1923 (herein)
**Baetis* sp. A Morihara and McCafferty, 1979a
= *Baetis caelestis* Allen and Murvosh, 1983 (McCafferty and Waltz, 1987)
**Baetis* sp. B Morihara and McCafferty, 1979a
= *Baetis magnus* McCafferty and Waltz, 1986 (McCafferty and Waltz, 1986)
**Baetis* sp. C Morihara and McCafferty, 1979a
= *Baetis notos* Allen and Murvosh, 1987 (Allen and Murvosh, 1987)
*Baetis spiethi* Berner, 1940
= *Baetis pygmaeus* (Hagen), 1861 (Morihara and McCafferty, 1979a)
= *Acerpenna pygmaea* (Hagen) (Waltz and McCafferty, 1987c)
*Baetis spinosus* McDunnough, 1925
= *Baetis propinquus* (Walsh), 1863) (Bergman and Hilsenhoff, 1978a)
*Baetis vagans* McDunnough, 1925
= *Baetis tricaudatus* Dodds, 1923 (Morihara and McCafferty, 1979a)

*Baetodes bellus* Mayo, 1972
= *Baetodes deficiens* Cohen and Allen, 1972 (Cohen and Allen, 1978)
*Baetodes furvus* Mayo, 1973
= *Baetodes fuscipes* Cohen and Allen, 1972 (Cohen and Allen, 1978)
**Baetodes velmae* Cohen and Allen 1978 (Cohen and Allen, 1978)
*Baetodes veracrusensis* Mayo, 1972
= *Baetodes caritus* Cohen and Allen, 1972 (Cohen and Allen, 1978)
**Barbaetis* Waltz and McCafferty, 1985 in Waltz et al. (1985)
**Barbaetis benfieldi* Kennedy, 1985 in Waltz et al. (1985)
**Barbaetis cestus* (Provonsha and McCafferty), 1982 (Provonsha and McCafferty, 1982)(as *Pseudocloeon*)

*Callibaetis brevicostatus* Daggy, 1945
= *Callibaetis skokianus* Needham, 1903 (herein)
*Callibaetis carolus* Traver, 1935
= *Callibaetis americanus* Banks, 1900 (herein)
*Callibaetis Coloradensis* Banks, 1900
= *Callibaetis americanus* Banks, 1900 (herein)
**Callibaetis completa* Banks, 1924 (geographic addition herein)
*Callibaetis doddsi* Traver, 1935
= *Callibaetis pictus* (Eaton), 1871 (herein)
*Callibaetis evergreenensis* Thew, 1959
= *Callibaetis americanus* Banks, 1900 (herein)
*Callibaetis hebes* Upholt, 1936
= *Callibaetis americanus* Banks, 1900 (herein)
*Callibaetis pacificus* Seemann, 1927

= *Callibaetis pictus* (Eaton), 1871 (herein)
*Callibaetis semicostatus* Banks, 1914
= *Callibaetis pallidus* Banks, 1900 (herein)
*Callibaetis signatus* Banks, 1918
= *Callibaetis pictus* (Eaton), 1871 (herein)
*Callibaetis traverae* Upholt, 1937
= *Callibaetis fluctuans* (Walsh), 1862 (herein)

*Centroptilum* Eaton, 1869
= *Centroptilum* Eaton, 1869, in part (herein); = *Procloeon* Bengtsson, 1915, in part (herein)
*Centroptilum album* McDunnough, 1926
= *Procloeon album* (McDunnough) (herein)
*Centroptilum asperatum* Traver, 1935
= *Procloeon asperatum* (Traver) (herein)
*Centroptilum bellum* McDunnough, 1924
= *Procloeon bellum* (McDunnough) (herein)
*Centroptilum caliginosum* McDunnough, 1925
= *Procloeon caliginosum* (McDunnough) (herein)
*Centroptilum conturbatum* McDunnough, 1929
= *Procloeon conturbatum* (McDunnough) (herein)
*Centroptilum convexum* Ide, 1930
= *Procloeon convexum* (Ide) (herein)
*Centroptilum elsa* Traver, 1935
= *Procloeon elsa* (Traver) (herein)
*Centroptilum fragile* McDunnough, 1923
= *Procloeon fragile* (McDunnough) (herein)
*Centroptilum hobbsi* Berner, 1946
= *Procloeon hobbsi* (Berner) (herein)
*Centroptilum infrequens* McDunnough, 1924
= *Pseudocentroptilum pennulatum* (Eaton), 1885 (Lowen and Flannagan 1990b)
= *Procloeon pennulatum* (Eaton) (herein)
*Centroptilum intermediale* McDunnough, 1931
= *Procloeon intermediale* (McDunnough) (herein)
*Centroptilum oreophilum* Edmunds, 1954
= *Procloeon oreophilum* (Edmunds) (herein)
*Centroptilum ozburni* McDunnough, 1924
= *Procloeon ozburni* (McDunnough) (herein)
*Centroptilum quaesitum* McDunnough, 1931
= *Procloeon quaesitum* (McDunnough) (herein)
*Centroptilum rivulare* Traver, 1935
= *Procloeon rivulare* (Traver) (herein)
*Centroptilum rufostrigatum* McDunnough, 1924
= *Procloeon rufostrigatum* (McDunnough) (herein)
*Centroptilum similie* McDunnough, 1924 [sic] in Edmunds et al. (1976)
= *Procloeon simile* (McDunnough) (herein)
*Centroptilum venosum* Traver, 1935

= *Procloeon venosum* (Traver) (herein)
*Centroptilum viridocularis* Berner, 1940
= *Procloeon viridocularis* (Berner) (herein)
*Centroptilum walshi* McDunnough, 1929
= *Procloeon walshi* (McDunnough) (herein)

**Cloeodes* Traver, 1938 (Waltz and McCafferty, 1987a)
**Cloeodes consignatus* Traver, 1938 (geographic addition herein)
**Cloeodes excogitatus* Waltz and McCafferty 1987 (Waltz and McCafferty, 1987a)
**Cloeodes macrolamellus* Waltz and McCafferty 1987 (Waltz and McCafferty, 1987a)
**Cloeodes maculipes* Traver, 1938 (geographic addition herein)
**Cloeodes peninsulus* Waltz and McCafferty 1987 (Waltz and McCafferty, 1987a)

*Cloeon* Leach, 1815
= *Centroptilum* Eaton, 1869, in part (herein); = *Cloeon* Leach, 1815, in part (herein);
= *Procloeon* Bengtsson, 1915, in part (herein)
*Cloeon alamance* (Traver), 1932
= *Centroptilum alamance* (Traver) (herein)
*Cloeon dipterum* (Linnaeus), 1761
= *Cloeon cognatum* Stephens, 1835 (in North America) (Flowers, 1978)
*Cloeon implicatum* McDunnough, 1924
= *Procloeon implicatum* (McDunnough) (herein)
*Cloeon inanum* McDunnough, 1924
= *Procloeon inanum* (McDunnough) (herein)
*Cloeon ingens* McDunnough, 1923
= *Procloeon ingens* (McDunnough) (herein)
*Cloeon insignificans* McDunnough, 1925
= *Procloeon insignificans* (McDunnough) (herein)
*Cloeon mendax* (Walsh), 1862
= *Procloeon mendax* (Walsh) (herein)
*Cloeon minor* McDunnough, 1925
= *Procloeon minor* (McDunnough) (herein)
*Cloeon rubropictum* McDunnough, 1923
= *Procloeon rubropictum* (McDunnough) (herein)
*Cloeon simplex* McDunnough, 1925
= *Procloeon simplex* (McDunnough) (herein)
*Cloeon triangulifer* McDunnough
= *Centroptilum triangulifer* (McDunnough) (herein)
*Cloeon vincinum* (Hagen), 1861
= *Procloeon vincinum* (Hagen) (herein)

*Dactylobaetis* Traver and Edmunds, 1968
= *Camelobaetidius* Demoulin, 1966 (herein)
*Dactylobaetis arriga* Traver and Edmunds, 1968
= *Camelobaetidius arriaga* (Traver and Edmunds) (herein)
*Dactylobaetis cepheus* Traver and Edmunds, 1968
= *Camelobaetidius cepheus* (Traver and Edmunds) (herein)

*Dactylobaetis chiapus* Traver and Edmunds, 1968
= *Camelobaetidius chiapus* (Traver and Edmunds) (herein)
*Dactylobaetis jenseni* Traver and Edmunds, 1968
= *Camelobaetidius jenseni* (Traver and Edmunds) (herein)
*Dactylobaetis mexicanus* Traver and Edmunds, 1968
= *Camelobaetidius mexicanus* (Traver and Edmunds) (herein)
*Dactylobaetis musseri* Traver and Edmunds, 1968
= *Camelobaetidius musseri* (Traver and Edmunds) (herein)
**Dactylobaetis navis* Allen and Chao, 1978
= *Camelobaetidius navis* (Allen and Chao) (herein)
**Dactylobaetis salinus* Allen and Chao, 1978
= *Camelobaetidius salinus* (Allen and Chao) (herein)
**Dactylobaetis sinaloa* Allen and Chao, 1978
= *Camelobaetidius sinaloa* (Allen and Chao) (herein)
**Dactylobaetis trivialis* Allen and Chao, 1978
= *Camelobaetidius trivialis* (Allen and Chao) (herein)
*Dactylobaetis warreni* Traver and Edmunds, 1968
= *Camelobaetidius warreni* (Traver and Edmunds) (herein)
*Dactylobaetis zenobia* Traver and Edmunds, 1968
= *Camelobaetidius zenobia* (Traver and Edmunds) (herein)

*Fallceon buenoi* (Allen), 1985 (Waltz and McCafferty, 1987c)
= *Fallceon quilleri* (Dodds), 1923 (herein)
*Fallceon byblis* (Allen and Murvosh), 1983 (Waltz and McCafferty, 1987c)
= *Fallceon quilleri* (Dodds), 1923 (herein)
**Fallceon garcianus* (Traver), 1938 (geographic addition herein)
**Fallceon poeyi* (Eaton), 1885 (geographic addition herein)

*Genus Incertae Allen and Murvosh, 1983
= *Cloeodes peninsulus* Waltz and McCafferty, 1987 (Waltz and McCafferty, 1987a)

**Guajirolis* Flowers, 1985
**Guajirolis ektrapeloglossa* Flowers, 1985

**Moribaetis* Waltz and McCafferty, 1985
**Moribaetis macaferti* Waltz, 1985 in Waltz and McCafferty (1985b)
**Moribaetis maculipennis* (Flowers), 1979 (Waltz and McCafferty, 1985b)

*Neocloeon* Traver, 1932
= *Centroptilum* Eaton, 1869, s. str. (herein)

**Paracloeodes portoricensis* Traver, 1938 (geographic addition herein)
*Paracloeodes abditus* Day, 1955
= *Paracloeodes minutus* (Daggy), 1945 (herein)

*Pseudocloeon* Klapalek, 1905
= *Acentrella* Bengtsson, 1912, in part (Waltz and McCafferty, 1987d); = *Apobaetis* Day,

1955, in part (Waltz and McCafferty, 1986); = *Baetis* Leach, 1815, in part (herein); = *Barbaetis* Waltz and McCafferty, 1985, in part (herein)

*Pseudocloeon alachua* Berner, 1940
= *Baetis alachua* (Berner) (herein)
*Pseudocloeon anoka* Daggy, 1945
= *Baetis punctiventris* (McDunnough), 1923 (herein)
*Pseudocloeon bimaculatum* Berner, 1946
= *Baetis bimaculatus* (Berner) (herein)
*Pseudocloeon carolina* (Banks), 1924
= *Acentrella carolina*(Banks)(Waltz and McCafferty, 1987d)
**Pseudocloeon cestum* Provonsha and McCafferty, 1982
= *Barbaetis cestus* (Provonsha and McCafferty) (herein)
*Pseudocloeon chlorops* (McDunnough), 1923
= *Baetis dubius* (Walsh), 1862 (herein)
*Pseudocloeon cingulatum* McDunnough, 1931
= *Baetis cinctutus* McCafferty and Waltz (herein)
*Pseudocloeon edmundsi* Jensen, 1969
= *Baetis* punctiventris (McDunnough), 1923 (herein)
*Pseudocloeon ellioti* Daggy, 1945
= *Baetis ellioti* (Daggy) (herein)
*Pseudocloeon etowah* Traver, 1935
= *Apobaetis etowah* (Traver) (Waltz and McCafferty, 1986)
*Pseudocloeon futile* McDunnough, 1931
= *Baetis futile* (McDunnough) (herein)
*Pseudocloeon ida* Daggy, 1945
= *Baetis ellioti* (Daggy), 1945 (herein)
*Pseudocloeon myrsum* Burks, 1953
= *Baetis punctiventris* (McDunnough), 1923 (herein)
*Pseudocloeon parvulum* McDunnough, 1932
= *Baetis armillatus* Waltz and McCafferty (herein)
*Pseudocloeon punctiventris* McDunnough, 1923
= *Baetis punctiventris* (McDunnough) (herein)
*Pseudocloeon rubrolaterale* McDunnough, 1931
= *Baetis rubrolaterale* (McDunnough) (herein)
*Pseudocloeon turbidum* McDunnough, 1924
= *Acentrella turbida* (McDunnough) (Waltz and McCafferty, 1987d)
*Pseudocloeon veteris* McDunnough, 1924
= *Baetis veteris* (McDunnough) (herein)
*Pseudocloeon virile* McDunnough, 1923
= *Baetis virile* (McDunnough) (herein)

**Pseudocentroptiloides* Jacob, 1986 (Waltz and McCafferty, 1989)
**Pseudocentroptiloides usa* Waltz and McCafferty ,1989

*Pseudocentroptilum pennulatum* (Eaton), 1885 (Lowen and Flannagan, 1990b)
= *Procloeon pennulatum* (Eaton) (herein)

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LITERATURE CITED

Allen, R.K. 1985. Mexican mayflies: new species, descriptions and records (Ephemeroptera). Pan-Pacific Entomol. 61:332-333.

Allen, R.K. and S.M. Chao. 1978. Mayflies of the Southwest: new species and records of *Dactylobaetis* (Ephemeroptera: Baetidae). Pan-Pac. Entomol. 54:300-304.

Allen, R.K. and C. M. Murvosh. 1983. Taxonomy and zoogeography of the mayflies (Ephemeroptera: Insecta) of Baja California. Ann. Entomol. Soc. Am. 76:425-433.

Allen, R. K. and C. M. Murvosh. 1987. New Baetidae from the southwestern United States and northern Mexico (Ephemeroptera: Insecta), with notes. Can. Entomol. 119:1095-1099.

Banks, N. 1924. Descriptions of new neuropteroid insects. Bull. Harvard Univ. Mus. Comp. Zool. 65: 421-455.

Bergman, E. A. and W. L. Hilsenhoff. 1978a. *Baetis* (Ephemeroptera: Baetidae) of Wisconsin. Great Lakes Entomol. 11:125-135.

Bergman, E. A. and W. L. Hilsenhoff. 1978b. Description of the nymph of *Centroptilum walshi* (Ephemeroptera: Baetidae), with biological notes. Great Lakes Entomol. 11: 81-84.

Bergman, E. A. and W. L. Hilsenhoff. 1978c. Parthenogenesis in the mayfly genus *Baetis* (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 71: 167-168.

Berner, L. and M. L. Pescador. 1988. The Mayflies of Florida (Revised Edition). University Presses of Florida, Gainesville.

Burks, B. D. 1953. The mayflies, or Ephemeroptera, of Illinois. Bull. Ill. Nat. Hist Surv. 26: 1-216.

Cohen, S. D. and R. K. Allen. 1978. Generic revisions of mayfly nymphs III. *Baetodes* in North and Central America (Baetidae). J. Kansas Entomol. Soc. 51: 253-269.

Crass, R. S. 1947. The May-flies (Ephemeroptera) of Natal and the Eastern Cape. Ann. Natal Mus. 11: 37-110.

Daggy, R. H. 1945. New species and previously undescribed naiads of some Minnesota mayflies (Ephemeroptera). Ann. Entomol. Soc. Am. 38: 373-396.

Day, W. C. 1955. New genera of mayflies from California (Ephemeroptera). Pan-Pacific Entomol. 31: 121-137.

Demoulin, G. 1966. Contribution A L'etude des Ephemeropteres du Surinam. Bull. Inst. R. Sci. Nat. Belg. 42(37): 1-22.

Eaton, A. E. 1885 (1883-1888). A revisional monograph of recent Ephemeridae or mayflies. trans. Linn. Soc. Lond. 2nd ser. Zool. 3: 1-352.

Edmunds, G. F., Jr. 1974. Some taxonomic changes in Baetidae (Ephemeroptera). Proc. Entomol. Soc. Washington 76: 289.

Edmunds, G. F., Jr., S. L. Jensen, and L. Berner. 1976. Mayflies of North and Central America. University of Minnesota Press, Minneapolis.

Flannagan, P. M. and J. F. Flannagan. 1982. Present distribution and the post-glacial origin of the Ephemeroptera, Plecoptera, and Trichoptera of Manitoba. Manitoba Dept. Nat. Res. Tech. Rep. No. 82-1: 1-79.

Flowers, R. W. 1978. Occurrence of *Cloeon cognatum* Stephens in the United States (Ephemeroptera, Baetidae). Entomol. News 89: 79-80.

Flowers, R. W. 1979. A new species of *Baetis* from Panama (Ephemeroptera: Baetidae). Pan-Pacific Entomol. 55: 187-191.

Flowers, R. W. 1985. *Guajirolis*, a new genus of Neotropical Baetidae (Ephemeroptera). Stud. Neotrop. Fauna and Environ. 20: 27-31.

Flowers, R. W. 1987. The adult stage of three Central American *Baetodes* (Ephemeroptera: Baetidae) with notes on the genus. Aquat. Insects 9: 1-10.

Gillies, M. T. 1990a. A refvision of the African species of Centroptilum Eaton (Baetidae, Ephemeroptera). Aquatic Insects 12: 97-128.

Gillies, M. T. 1990b. Convergence of two monophyletic lines of Baetidae occurring in east Africa stony streams. In J. Alba-Tercedor and A. Sanchez-Ortega [eds.], Proceedings of the sixth international conference on Ephemeroptera and tenth international symposium on Plecoptera. Sandhill Crane Press, Gainesville, in press.

Hennig, W. 1966. Phylogenetic systematics. Univ. Ilinois Press, Urbana.

Ide, F. P. 1930. Contributions to the biology of Ontario mayflies with descriptions of new species. Can. Entomol. 62: 204-312, 218-231.

Ide, F. P. 1937. Descriptions of eastern North American species of baetine mayflies with particular reference to the nymphal stages. Can. Entomol. 69: 219-231, 235-243.

Jacob, U. 1973. Ein *Centroptilum* des *Stenopteryx*-komplexes aus dem Mitteleuropäischen Flachland (Baetidae, Ephemeroptera). Reichenbachia 14(21): 163-170.

Jacob, U. and A. Glazaczow. 1986. *Pseudocentroptiloides*, a new baetid genus of Palearctic and Oriental distribution (Ephemeroptera). Aquat. Insects 8: 197-206.

Kazlauskas, R. S. 1972. Neues uber das system der Eintagsfliegen der familie Baetidae (Ephemeroptera). XIII Internat. Congr. Entomol. 3(1968): 337-338.

Keffermüller, M. 1980. Un changement dans la taxonomie de la famille Baetidae, pp. 115-121 In J. F. Flannagan and K. E. Marshall [eds.], Advances in Ephemeroptera biology. Plenum, New York.

Keffermüller, M. and R. Sowa. 1984. Survey of central European species of the genera

*Centroptilum* Eaton and *Pseudocentroptilum* Bogoescu (Ephemeroptera: Baetidae). Polsk. Pismo Entomol. 54: 309-340.

Kondratieff, B. C. and S. C. Harris. 1986. Preliminary checklist of the mayflies (Ephemeroptera) of Alabama. Entomol. News 97: 230-236.

Kondratieff, B. C. and J. R. Voshell, Jr. 1984. The North and Central American species of *Isonychia* (Ephemeroptera: Oligoneuriidae). Trans. Am. Entomol. Soc. 110: 129-244.

Landa, V. and T. Soldán. 1985. Phylogeny and higher classification of the order Ephemeroptera: a discussion from the comparative anatomical point of view. Academia, Prague.

Liechti, P. M. 1982. Five additonal Ephemeroptera genera from Kansas. Tech. Publ. St. Biol. Surv. Kansas 12: 13-16.

Lowen, R. G. and J. F. Flannagan. 1990a. The nymph and male of *Centroptilum infrequens* McD (Baetidae), pp. 311-321 In: I.C. Campbell [ed.], Mayflies and stoneflies: life histories and biology. Kluwer Academic Publishers, Dorcrecht, The Netherlands.

Lowen, R. G. and J. F. Flannagan. 1990b. *Centroptilum infrequens* McDunnough (Ephemeroptera: Baetidae), a junior synonym of *Pseudocentroptilum pennulatum* (Eaton). Can. Entomol. 122: 173-174.

Lowen, R. G. and J. F. Flannagan. 1990c. Four Maintoba species of *Centroptilum* Eaton (Baetidae) with remarks on the genus, In J. Alba-Tercedor and A. Sanchez-Ortega [eds.], Proceedings of the sixth international conference on Ephemeroptera and tenth international conference on Plecoptera. Sandhill Crane Press, Gainesville, in press.

McCafferty, W. P. 1990. Biogeographic affinities of the Ephemeroptera of the Black Hills, South Dakota. Entomol. News 101: 193-199.

McCafferty, W. P. and D. K. Morihara. 1979. The male of *Baetis macdunnoughi* and notes on parthenogenetic populations within *Baetis* (Ephemeroptera: Baetidae). Entomol. News 90: 26-28.

McCafferty, W. P. and C. Pereira. 1984. Effects of developmental thermal regimes on two mayfly species and their taxonomic implications. Ann. Entomol. Soc. Am. 77: 69-87.

McCafferty, W. P. and A. V. Provonsha. 1975. Reinstatement and biosystematics of *Heterocloeon* McDunnough (Ephemeroptera: Baetidae). J. Georgia Entomol. Soc. 10: 123-127.

McCafferty, W. P. and A. V. Provonsha. 1978. The Ephemeroptera of mountainous Arkansas. J. Kansas Entomol. Soc. 51: 360-379.

McCafferty, W. P., B. Stark and A. V. Provonsha. 1990. Ephemeroptera, Plecoptera, and Odonata, pp. 43-58 In M. Kosztarab and C. W. Schaefer [eds.], Systematics of the North American insects and arachnids: status and needs. Virginia Agr. Exp. Stat. Informat. Ser. 90-1, Virginia Poytech. Inst. St. Univ., Blacksburg.

McCafferty, W. P. and R. D. Waltz. 1986. *Baetis magnus*, new species, formal new name for *Baetis* sp. B of Morihara and McCafferty (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 88: 604.

McCafferty, W. P. and R. D. Waltz. 1987. *Baetis caelestis* Allen and Murvosh, an available name for *Baetis* sp. A of Morihara and McCafferty (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 89: 659.

Morihara, D. K. and W. P. McCafferty. 1979a. The *Baetis* larvae of North America. Trans. Am. Entomol. Soc. 105: 139-221.

Morihara, D. K. and W. P. McCafferty. 1979b. Systematics of the *propinquus* group of *Baetis* Species (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 72: 130-135.

Morihara, D. K. and W. P. McCafferty. 1979c. The evolution of *Heterocloeon* with the first

larval description of *Heterocloeon frivolus* comb. n. (Ephemeroptera: Baetidae). Aquat. Insects 1: 225-231.

Morihara, D. K. and W. P. McCafferty. 1979d. Subspecies of the transatlantic species, *Baetis macani* Kimmins (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 81: 34-37.

Müller-Liebenau, I. 1970. Revision der Europaischen arten der gattung *Baetis* Leach, 1815 (Insecta, Baetidae). Gewasser und Abwasser 48/49: 1-214.

Müller-Liebenau, I. 1974. *Rheobaetis*: A new genus from Georgia (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 67: 555-567.

Müller-Liebenau, I. 1981. Review of the original material of the baetid genera *Baetis* and *Pseudocloeon* from the Sunda Islands and the Phillipines described by G. Ulmer, with some general remarks (Insecta: Ephemeroptera). Mitt. Hamburg Zool. Mus. Inst. 78: 197-208.

Muller-Liebenau, I. 1982. Five new species of *Pseudocloeon* Klapalek, 1905 (fam. Baetidae) from the Oriental region (Insecta, Ephemeroptera) with some general remarks on *Pseudocloeon*. Arch. Hydrobiol. 95: 282-298.

Novikova, E. A. and N. Kluge. 1987. Systematics of the genus *Baetis* (Ephemeroptera: Baetidae) with description of a new species from middle Asia. Vestn. Zool. 1987(4): 8-19. [in Russian]

Provonsha, A. V. and W. P. McCafferty. 1982. New species and previously undescribed larvae of North American Ephemeroptera. J. Kansas Entomol. Soc. 55: 23-33.

Riek, E. f. 1973. The classification of the Ephemeroptera, pp. 160-178. In: W. L. and J.G. Peters [eds], Proceedgins of the first international conference of Ephemoeroptera. E. J. Brill. Leiden.

Roback, S. S. 1966. The Catherwood Foundation Peruvian-Amazon Expedition. VI - Ephemeroptera Nymphs. Monogr. Acad. Nat. Sci. Philad. 14: 129-199.

Ross, H. H. 1974. Biological systematics. Addison-Wesley, Reading, Massachusetts.

Soluk, D. A. 1981. The larva of *Baetis dardanus* McDunnough (Ephemeroptera: Baetidae). Entomol. News 92: 147-151.

Sowa, R. 1975. What is *Cloeon dipterum* (Linnaeus, 1761)? The nomenclatural and morphological analysis of a group of the European species of *Cloeon* Leach (Ephemeroptera: Baetidae). Entomol. Scand. 6: 215-233.

Spieth, H.T. 1933. The phylogeny of some mayfly genera. J. New York Entomol. Soc. 41: 55-86, 327-390.

Sweeney, B. W. and R. L. Vannote. 1984. Influence of food quality and temperature on life history characteristics of the parthenogenetic mayfly, *Cloeon triangulifer*. Freshwat. Biol. 14: 621-630.

Traver, J. R. 1935. Part II, Systematic. pp. 239-739 In: J. G. Needham, J. R. Traver and Y. C. Hsu [eds.], The biology of mayflies with a systematic account of North American species. Comstock Publ. Co., Ithaca, New York.

Traver, J. R. 1937. Notes on mayflies of the southeastern states (Ephemeroptera). J. Elisha Mitchell Sci. Soc. 53: 27-86.

Traver, J. R. 1938. Mayflies of Puerto Rico. J. Agric. Univ. Puerto Rico. 22: 5-42.

Traver, J. R. 1962. *Cloeon dipterum* (L.) in Ohio (Ephemeroptera: Baetidae). Bull. Brooklyn Entomol. Soc. 57: 47-50.

Traver, J. R. and G. F. Edmunds, Jr. 1968. A revision of the Baetidae with spatulate-clawed nymphs (Ephemeroptera). Pacif. Insects 10: 629-677.

Waltz, R. D. and W. P. McCafferty. 1985a. Redescription and new lectotype designation for

the type species of *Pseudocloeon*, *P. kraepelini* Klapalek (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 87: 800-804.

Waltz, R. D. and W. P. McCafferty. 1985b. *Moribaetis*: A new genus of Neotropical Baetidae (Ephemeroptera). Proc. Entomol. Soc. Washington 87: 239-251.

Waltz, R. D. and W. P. McCafferty. 1986. *Apobaetis etowah* (Traver), a new combination in Nearctic Baetidae (Ephemeroptera). Proc. Entomol. Soc. Washington 88: 191.

Waltz, R. D. and W. P. McCafferty. 1987a. Revision of the genus *Cloeodes* Traver (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 80: 191-207.

Waltz, R. D. and W. P. McCafferty. 1987b. Generic revision of *Cloeodes* and description of two new genera (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 89: 177-184.

Waltz, R. D. and W. P. McCafferty. 1987c. New genera of Baetidae for some Nearctic species previously included in *Baetis* Leach (Ephemeroptera). Ann. Entomol. Soc. Am. 80: 667-670.

Waltz, R. D. and W. P. McCafferty. 1987d. Systematics of *Pseudocloeon*, *Acentrella*, *Baetiella*, and *Liebebiella*, new genus (Ephemeroptera: Baetidae). J. New York Entomol. Soc. 95: 553-568.

Waltz, R. D. and W. P. McCafferty. 1987e. New genera of Baetidae (Ephemeroptera) from Africa. Proc. Entomol. Soc. Washington 89: 95-99.

Waltz, R. D. and W. P. McCafferty. 1989. New species, redescriptions, and cladistics of the genus *Pseudocentroptiloides* (Ephemeroptera: Baetidae). J. New York Entomol. Soc. 97: 151-158.

Waltz, R. D. and W. P. McCafferty. 1990. *Baetis jesmodensis* McDunnough, a new junior synonym of *Baetis tricaudatus* Dodds (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Washington 92: 138.

Waltz, R. D., W. P. McCafferty and J. H. Kennedy. 1985. *Barbaetis*: a new genus of eastern Nearctic mayflies (Ephemeroptera: Baetidae). Great Lakes Entomol. 18: 161-165.

Wiley, E. O. 1981. Phylogenetics, the theory and practice of phylogenetic systematics. John Wiley & Sons, New York.