

**TECHNICAL INFORMATION COMMITTEE WORKSHOP
ON MAYFLY TAXONOMY**

N.A.B.S. 1998

**UNIVERSITY OF PRINCE EDWARD ISLAND
CHARLOTTETOWN, P.E.I. CANADA**

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INTRODUCTION

Welcome to this special workshop on mayfly taxonomy. This workshop will focus on the taxonomy of Nearctic families, genera, and to some extent species. Depending on who shows up to assist with the workshop expertise may be available on Central and South American, Ethiopian, and Palearctic mayflies as well. The goals of this workshop are:

- 1.) To update you on the higher classification of Ephemeroptera and what this may mean to you in the future.
- 2.) To introduce you to basic laboratory techniques used to study mayflies, specifically those that involve microdissection and slide preparation.
- 3.) To give you some practical experience in the identification of families, genera, and perhaps species of mayflies.
- 4.) To provide you with some basic information on the development of reference collections, curation of specimens, and how and who to seek help from regarding systematic problems you may encounter.

Mayfly taxonomy has changed rapidly over the past 20 years and shows no real signs of slowing down. Recent changes in the primary literature are quickly exceeding the standard texts that many nonspecialists have come to rely on. Currently there is only one reasonably up-to-date key for North American families and genera (Merritt and Cummins 1996) and even this does not include some of the most recent generic changes for the Baetidae. Therefore, as with other groups of aquatic insects the days of using a single comprehensive book to reliably identify mayflies to the family and genus level are fast disappearing, if they are not already gone. If this state of affairs has caused you some anxiety, hopefully by the end of this workshop you will see that it may not be as bleak as you think.

Merritt, R.W. and K.W. Cummins (ed.) 1996. An Introduction to the Aquatic Insects of North America, 3rd ed. Kendall/Hunt Publishing Co., Dubuque, Iowa.

COMMENTS ON THE HIGHER CLASSIFICATION OF THE EPHEMEROPTERA WITH SPECIFIC REGARDS TO NEARCTIC FAMILIES

If you have tried to follow the higher classification of the Ephemeroptera since 1979 you have undoubtedly noticed many changes. The most sweeping changes were those proposed by McCafferty (1991). Instability seems to best describe the nature of many supraspecific categories (e.g., suborders, infraorders, and superfamilies). The attempt to develop a phylogenetic classification and the problems of interpreting plesiomorphic and apomorphic characters have been central to many of these changes. Fortunately, a level of stability does seem to have been achieved regarding Nearctic families. Currently, two (somewhat different) classifications for Nearctic families are available and both are from Pat McCafferty (1997, 1998). In 1997 the 4th volume of "Nomina Insecta Nearctica" was published and contained a synthesis by McCafferty of the higher classification of the Nearctic mayfly fauna. The classification had three suborders (one of which, the Carapacea was new), no infraorders (but instead 7 superfamilies were listed), and 21 families. In February of 1998 McCafferty updated the higher classification on the Mayfly Central web site and lists 4 suborders (one by a replacement name i.e., the Furcatergalia replaces the name Rectracheata in previous usage), 4 infraorders (but only 2 superfamilies), and 21 families. Despite the difference at the suprafamily level, the family structure is the same. The generic structure within these families, seems for the moment, also

to be somewhat stable. New studies will likely result in some genera being split up or some species being placed in different genera, but massive rearrangements do not seem to be in the wind. At this point you might be asking which if either of the higher classifications should we use? My best recommendation is that it doesn't matter which one you use if your mostly working at the family level or lower. There are no rules governing the categories above the family level and these higher levels above family may be fluid for some time to come. If you really have to use the higher categories a good recommendation would be to accept the most recently published version until some decision is made about new material "published" on the internet.

On a purely practical note, the higher category structure of the Ephemeroptera is not terribly important in the day to day activities of taxonomy in support of water quality and ecological studies until it begins to affect the placement of lower categories. Higher category structure is most relevant to the study of the evolutionary relationships among major groups of mayflies; their biogeography; and in the recognition of basal groups that have been shown to be of value in defining conservation priorities. Finally, from a purely systematic point of view, the names and category rank are not terribly important, its the relationships among groups that are important.

McCafferty, W.P. 1991. Toward a phylogenetic classification of the Ephemeroptera (Insecta): a commentary on systematics. *Ann. Entomol. Soc. Am.* 84: 343-360.

McCafferty, W.P. 1997. Ephemeroptera, p. 89-117. *In* Poole, R. and P. Gentilli (eds.). *Nomina Insecta Nearctica, A Check List of the Insects of North America, Vol. 4: Non-holometabolous Orders.* Entomological Information Services, Rockville, Maryland.

McCafferty, W.P. 1998. Higher Classification of the Ephemeroptera. *MAYFLY CENTRAL*, <http://www.entm.purdue.edu/entomology/mayfly/>

GENERAL TAXONOMIC REFERENCES

The general references listed here provide some of the most important taxonomic information for a number of different mayfly groups. Some references were written for a particular geo-political region, but often are useful beyond the limits of that area. Regardless of age many of these references still represent our current understanding of the status of many species and provide the only keys to some groups (however, many older keys must be used cautiously and only with a full knowledge of recent systematic changes).

Berner, L. and M.L. Pescador 1988. *The Mayflies of Florida, Revised Edition.* University Presses of Florida, Gainesville, FL. 415 pp.

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

Daggy, R.H. 1941. Taxonomic and biologic investigations on Minnesota mayflies (Ephemeroptera). Ph.D. dissertation, University of Minnesota, p. 331, plates 1-22.

Eaton, A.E. 1883-88. A revisional monograph of recent Ephemeridae on mayflies. *Trans. Linn. Soc. London, 2nd Ser. Zool.* 3[Part 1: 1-77, plts. 1-24 (1883); Part 2: 78-152, plts. 25-45 (1884); Part 3: 153-230, plts. 46-113 (April 1885); Part 4: 231-281 (Dec. 1885); Part 5: 281-319, plts. 114-115 (1887); Part 6: 320-352, indices and title page (Feb. 1888)]: 1-352.

- Edmunds, G.F., Jr., S.L. Jensen, and L. Berner 1976. The Mayflies of North and Central America. University Minnesota Press, Minneapolis. 330 pp.
- Hilsenhoff, W.L. 1982. Using A Biotic Index to Evaluate Water Quality in Streams. Wisconsin Dept. of Natural Resources Tech. Bull. No. 132.
- Jensen, S.L. 1966. The mayflies of Idaho (Ephemeroptera). M.S. Thesis, University of Utah, Salt Lake City, p. 365.
- Landa, V. and T. Soldan 1985. Phylogeny and the higher classification of the order Ephemeroptera: A discussion from the comparative anatomical point of view. Studie CSAV (Praha) 4-85. 121 pp.
- Leonard, J.W. and F.A. Leonard 1962. Mayflies of Michigan trout streams. Cranbrook Inst. Sci. Bull. No. 43. 139 pp.
- McCafferty, W.P. 1991. Toward a phylogenetic classification of the Ephemeroptera (Insecta): a commentary on systematics. Ann. Entomol. Soc. Am. 84: 343-360.
- McCafferty, W.P. 1996. The Ephemeroptera species of North America and index to their complete nomenclature. Trans. Am. Entomol. Soc. 122: 1-54.
- McCafferty, W.P. 1997. Ephemeroptera, p. 89-117. In Poole, R. and P. Gentili (eds.). Nomina Insecta Nearctica, A Check List of the Insects of North America, Vol. 4: Non-holometabolous Orders. Entomological Information Services, Rockville, Maryland.
- McCafferty, W.P. and G.F. Edmunds, Jr. 1979. The higher classification of the Ephemeroptera and its evolutionary basis. Ann. Entomol. Soc. Am. 72: 5-12.
- Merritt, R.W. and K.W. Cummins (ed.) 1996. An Introduction to the Aquatic Insects of North America, 3rd ed. Kendall/Hunt Publishing Co., Dubuque, Iowa.
- Peters, W.L. 1980. Phylogeny of the Leptophlebiidae: An introduction, p. 33-41. In Flannagan, J.F. and K.E. Marshall (eds.), Advances in Ephemeroptera Biology. Plenum Press, New York.
- Spieth, H.T. 1941. The North American ephemeropteran types of the Rev. A.E. Eaton. Ann. Entomol. Soc. Am. 34: 87-98.
- Traver, J.R. 1935. Part II. North American Mayflies: A systematic account of North American species in both adult and nymphal stages. In Needham, J.G., J.R. Traver, and Y. Hsu. The Biology of Mayflies. Comstock Publishing Co., Ithaca, New York.
- Traver, J.R. 1937. Notes on mayflies of the southeastern states. J. Elisha Mitchell Sci. Soc. 53: 27-86.
- Ward, J.V. and B.C. Kondratieff. 1992. An Illustrated Guide to the Mountain Stream Insects of Colorado. University of Colorado Press, Niwot, Colorado, p. 191.

LIST OF SELECTED SPECIFIC REFERENCES FOR MAYFLY TAXONOMY

The listing of taxa is according to McCafferty (1997). Differences in higher category names that appear in the higher classification of Ephemeroptera available on the Mayfly Central web site are presented in parentheses. The interpretation of how the category names from the web site equate to names from McCafferty (1997) is my own and not that of Pat McCafferty. So any errors are my fault, sorry. The references listed here provide taxonomic data primarily on species of the northeastern and southeastern parts of North America, thus it is far from complete. At best references listed here might address about half of the North American fauna.

SUBORDER PISCIFORMA

McCafferty, W.P. and T.-Q. Wang. 1994. Relationships of the genera *Acanthametropus*, *Analetris*, and *Siphuriscus*, and re-evaluation of their higher classification (Ephemeroptera: Pisciforma). *Great Lakes Entomol.* 27: 209-215.

Superfamily Siphonuroidea

Kluge, N.J., D. Studemann, P. Landolt, and T. Gonser. 1995. A reclassification of the Siphonuroidea (Ephemeroptera). *Bull. Soc. entomol. Suisse* 68: 103-132.

Family Acanthametropodidae

Edmunds, G.F., Jr. and R.W. Koss. 1972. A review of the Acanthametropodinae with a description of a new genus. *Pan-Pac. Entomol.* 48: 136-144.

Lehmkuhl, D.M. 1976. Additions to the taxonomy, zoogeography, and biology of *Analetris eximia* (Acanthametropodinae: Siphonuridae: Ephemeroptera). *Can. Entomol.* 108: 199-207.

Lillie, R.A. 1995. A Survey of Rare and Endangered Mayflies of Selected Rivers of Wisconsin. Wisconsin Dept. of Natural Resources Research Report No. 170.

McCafferty, W.P. 1991. Comparison of old and new world *Acanthametropus* (Ephemeroptera: Acanthametropodidae) and other psammophilous mayflies. *Entomol. News* 102: 205-214.

Family Ameletidae

Carle, F.L. 1978. A new species of *Ameletus* (Ephemeroptera: Siphonuridae) from West Virginia. *Ann. Entomol. Soc. Am.* 71: 581-584.

Clemens, W.A. 1922. A parthenogenetic mayfly (*Ameletus ludens* Needham). *Can. Entomol.* 54: 77-78.

McDunnough, J. 1928. The Ephemeroptera of Jasper Park, Alberta. *Can. Entomol.* 60: 8-10.

McDunnough, J. 1933. New Ephemeroptera from the Gaspé Peninsula. *Can. Entomol.* 65: 278-281.

McDunnough, J. 1938. New species of North American Ephemeroptera with critical notes. *Can. Entomol.* 70: 23-34.

Traver, J.R. 1932. Mayflies of North Carolina; Part I. *J. Elisa Mitchell Sci. Soc.* 47: 85-162, 163-236.

Zloty, J. 1996. A revision of the Nearctic *Ameletus* mayflies based on adult males with descriptions of seven new species (Ephemeroptera: Ameletidae). *Can. Entomol.* 128: 293-346.

Family Ametropodidae

Allen, R.K. and G.F. Edmunds, Jr. 1976. A revision of the genus *Ametropus* in North America (Ephemeroptera: Ametropodidae). *J. Kansas Entomol. Soc.* 49: 625-635.

McDunnough, J. 1928. The Ephemeroptera of Jasper Park, Alberta. *Can. Entomol.* 60: 8-10.

Family Baetidae

Allen, R.K. and E.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. 1900. New genera and species of Nearctic neuropteroid insects. *Trans. Am. Entomol. Soc.* 26: 244-259.

Banks, N. 1914. New neuropteroid insects, native and exotic. *Proc. Acad. Nat. Sci. Phila.* 66: 614-616.

Banks, N. 1924. New neuropteroid insects. *Bull. Mus. Comp. Zool.* 65: 424-425.

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

Check, G.R. 1982. A revision of the North American species of *Callibaetis* (Ephemeroptera: Baetidae). Ph.D. Dissertation, University of Minnesota, USA.

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.

Day, W.C. 1954a. New species and notes on California mayflies II. *Pan-Pac. Entomol.* 30: 15-29.

- Day, W.C. 1954b. New species of California mayflies in the genus *Baetis*. Pan-Pac. Entomol. 30: 29-34.
- Day, W.C. 1955. New genera of mayflies from California. Pan-Pac. Entomol. 31: 121-137.
- Dodds, G.S. 1923. Mayflies of Colorado. Trans. Am. Entomol. Soc. 49: 93-114.
- Durfee, R. and B. Kondratieff. 1993. Description of adults of *Baetis magnus*, (Ephemeroptera: Baetidae). Entomol. News 104: 227-232.
- Durfee, R. and B. Kondratieff. 1995. Description of adults of *Baetis notos* (Ephemeroptera: Baetidae). Entomol. News 106: 71-74.
- Durfee, R. and B. Kondratieff. 1997. Description of adults of *Labiobaetis apache* (Ephemeroptera: Baetidae) with additions and corrections to the inventory of Colorado mayflies. Entomol. News 108: 97-101.
- Flowers, R.W. 1987. The adult stage of three Central American *Baetodes* (Ephemeroptera: Baetidae) with notes on the genus. Aquatic Insects 9: 1-10.
- Hagen, H. 1861. Synopsis of the Neuroptera of North America, with a list of South American species. Smith. Misc. Coll. 38-55.
- Harper, F. and P.P. Harper 1981. Northern Canadian mayflies (Insecta; Ephemeroptera), records and descriptions. Can. J. Zool. 59: 1784-1789.
- Ide, F.P. 1930. Contribution to the biology of Ontario mayflies with descriptions of new species. Can. Entomol. 62: 204-213, 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. and A. Glazaczow. 1986. *Pseudocentropiloides*, a new baetid genus of Palearctic and Oriental distribution (Ephemeroptera). Aquatic Insects 8: 197-206.
- Jacob, U. 1990. Ephemeroptera: zur systematik der Europaischen Baetidae auf Gattungsebene. Verh. Westd. Entomol. Tag 1990, S. 271-290, Dusseldorf 1991.
- Jensen, S.L. 1969. A new species of *Pseudocloeon* from Idaho (Ephemeroptera: Baetidae). Pan-Pac. Entomol. 45: 14-15.
- Keffermuller, M. and R. Sowa. 1984. Survey of central European species of the genera *Centroptilum* Eaton and *Pseudocentropilum* Bogoescu (Ephemeroptera: Baetidae). Polsk. Pismo Entomol. 54: 309-340.
- Lowen, R.G. and J.F. Flannagan. 1990a. *Centroptilum infrequens* McDunnough (Ephemeroptera: Baetidae), a junior synonym of *Pseudocentropilum pennulatum* (Eaton). Can. Entomol. 122: 173-174.
- Lowen, R.G. and J.F. Flannagan. 1990b. The nymph and male of *Centroptilum infrequens* McDunnough (Baetidae). p. 311-321. In I.C. Campbell (ed.). Proc. 5th Inter. Ephemeroptera Conf. and 9th Inter. Plecoptera Conf. Kluwer Academic Publishers, Boston.

- Lowen, R.G. and J.F. Flannagan. 1991. Four Mantitoba species of *Centroptilum* Eaton (Ephemeroptera: Baetidae) with remarks on the genus. p. 189-205. In Alba-Tercedor, J. and A. Sanchez-Ortega (eds.). Overview and Strategies of Ephemeroptera and Plecoptera. Sandhill Crane Press, Gainesville, Florida.
- Lowen, R.G. and J.F. Flannagan. 1992. Nymphs and imagoes of four North American species of *Procloeon* Bengtsson with description of a new species (Ephemeroptera, Baetidae). Can. Entomol. 124: 97-108.
- Lugo-Ortiz, C.R., W.P. McCafferty, and R.D. Waltz. 1994. Contribution to the taxonomy of the Panamerican genus *Fallceon* (Ephemeroptera: Baetidae). J. New York Entomol. Soc. 102: 460-475.
- Lugo-Ortiz, C.R. and W.P. McCafferty. 1995. Taxonomy of the North and Central American species of *Camelobaetidius* (Ephemeroptera: Baetidae). Entomol. News 106: 178-192.
- Lugo-Ortiz, C.R. and W.P. McCafferty. 1996a. Contribution to the taxonomy of *Callibaetis* (Ephemeroptera: Baetidae) in southwestern North America and Middle America. Aquatic Insects 18: 1-9.
- Lugo-Ortiz, C.R. and W.P. McCafferty. 1996b. Phylogeny and classification of the *Baetodes* complex (Ephemeroptera: Baetidae), with description of a new genus. J. N. Am. Benthol. Soc. 15: 367-380.
- Lugo-Ortiz, C.R. and W.P. McCafferty. 1996c. Taxonomy of the Neotropical genus *Americabaetis*, new status (Insecta: Ephemeroptera: Baetidae). Studies on Neotropical Fauna and Environment 31: 156-169.
- McCafferty, W.P. 1997. Name adjustments and a new synonym for North American Ephemeroptera species. Entomol. News 108: 318 & 320.
- McCafferty, W.P. and T.H. Klubertanz. 1994. *Camelobaetidius* (Ephemeroptera: Baetidae) in Indiana and Iowa: new species and range extensions. Proc. Entomol. Soc. Wash. 96: 37-43.
- McCafferty, W.P. and C.R. Lugo-Ortiz. 1994. Taxonomic status of three species of *Fallceon* (Ephemeroptera: Baetidae). Entomol. News 105: 161-163.
- McCafferty, W.P. and D.K. Morihara 1979. The male of *Baetis macdunnoughi* and notes on parthenogenetic populations within *Baetis* sp. (Ephemeroptera: Baetidae). Entomol. News 90: 26-28.
- McCafferty, W.P. and A.V. Provonsha. 1975. Reinstatement and biosystematics of *Heterocloeon* McDunnough (Ephemeroptera: Baetidae). J. Georgia Entomol. Soc. 10: 110-122.
- 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. Wash. 89: 659.
- McCafferty, W.P. and R.D. Waltz. 1990a. Revisionary synopsis of the Baetidae (Ephemeroptera) of North and Middle America. Trans. Am. Entomol. Soc. 116: 769-799.

- McCafferty, W.P. and R.D. Waltz. 1990b. *Baetis jesmondensis* McDunnough, a new junior synonym of *Baetis tricaudatus* Dodds (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Wash. 92: 138.
- McCafferty, W.P. and R.D. Waltz. 1995. *Labiobaetis* (Ephemeroptera: Baetidae): new status, new North American species, and related new genera. Entomol. News 106: 19-28.
- McCafferty, W.P., M.J. Wagle, and R.D. Waltz. 1994. Systematics and biology of *Acentrella turbida* (McDunnough) (Ephemeroptera: Baetidae). Pan-Pac. Entomol. 70: 301-308.
- McDunnough, J. 1921. Two new Canadian may-flies (Ephemeroptera). Can. Entomol. 53: 117-120.
- McDunnough, J. 1923. New Canadian Ephemeridae with notes. Can. Entomol. 55: 39-50.
- McDunnough, J. 1924a. New Canadian Ephemeridae with notes, II. Can. Entomol. 56: 90-98.
- McDunnough, J. 1924b. New North American Ephemeridae. Can. Entomol. 56: 221-226.
- McDunnough, J. 1925. New Canadian Ephemeridae with notes, III. Can. Entomol. 57: 168-176, 185-192.
- McDunnough, J. 1926. Notes on North American Ephemeroptera with descriptions of new species. Can. Entomol. 58: 184-196.
- McDunnough, J. 1928. Ephemerid notes with description of a new species. Can. Entomol. 60: 238-240.
- McDunnough, J. 1931. New species of North American Ephemeroptera. Can. Entomol. 63: 82-93.
- Morihara, D.K. and W.P. McCafferty 1979a. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Trans. Am. Entomol. Soc. 105: 139-221.
- Morihara, D.K. and W.P. McCafferty 1979b. Systematics of the *propinquus* group *Baetis* species (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 72: 130-135.
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- Newkirk, M. 1981. The biology of *Cloeon cognatum* (Ephemeroptera: Baetidae). Ann. Entomol. Soc. Am. 74: 204-208.
- 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.
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- Sowa, R. 1975. What is *Cloeon dipterum* (Linnaeus, 1761)? The nomenclatural and morphological analysis of a group of European species of *Cloeon* Leach (Ephemeroidea: Baetidae). Entomol. Scand. 6: 215-223.
- Stephens, J.F. 1835. Illustrations of British Entomology. Mandibulata 4: 53-70.
- Traver, J.R. 1932. Mayflies of North Carolina; Part I. J. Elisa Mitchell Sci. Soc. 47: 85-162, 163-236.
- Walsh, B.D. 1862. List of pseudoneuroptera of Illinois, contained in the cabinet of the writer, with descriptions of over forty new species, and notes on the structural affinities. Proc. Acad. Nat. Sci. Phila. 13-14: 361-402.
- Walsh, B.D. 1863. Observations on certain North American Neuroptera, by H. Hagen, M.D. of Koenigsberg, Prussia; translated from original French manuscript and published by permission of author, with notes and descriptions of about 20 new North American species of pseudoneuroptera. Proc. Entomol. Soc. Philadelphia 2: 167-272.
- Waltz, R.D. 1993. *Cloeodes binocularis* (Ephemeroidea: Baetidae), a new combination for a Neotropical species of *pseudocloeon* S. Auctt. Entomol. News 104: 233-234.
- Waltz, R.D. 1994. Field recognition of adult *Acentrella* and *Heterocloeon* (Ephemeroidea: Baetidae). Great Lakes Entomol. 26: 321-323.
- Waltz, R.D. 1995. *Baetis ochris*, a new synonym of *Baetis flavistriga* (Ephemeroidea: Baetidae). Entomol. News 106: 75-76.
- Waltz, R.D., D.E. Baumgardner, and J.H. Kennedy. 1996. An atypical larval color form of *Baetis intercalaris* (Ephemeroidea: Baetidae) from Pennsylvania and the Kiamichi River Basin of southeastern Oklahoma. Entomol. News 107: 83-87.
- Waltz, R.D., W.P. McCafferty and J.H. Kennedy 1985. *Barbaetis*: A new genus of eastern nearctic mayflies (Ephemeroidea: Baetidae). Great Lakes Entomol. 18: 161-165.
- Waltz, R.D. and W.P. McCafferty 1987a. New genera of Baetidae for some Nearctic species previously included in *Baetis* Leach (Ephemeroidea). Ann. Entomol. Soc. Am. 80: 667-670.
- Waltz, R.D. and W.P. McCafferty 1987b. Systematics of *Pseudocloeon*, *Acentrella*, *Baetiella*, and *Liebebiella*, new genus (Ephemeroidea: Baetidae). J. New York Entomol. Soc. 95: 553-568.
- Waltz, R.D. and W.P. McCafferty. 1987c. Revision of the genus *Cloeodes* Traver (Ephemeroidea: Baetidae). Ann. Entomol. Soc. Am. 80: 191-207.
- Waltz, R.D. and W.P. McCafferty. 1989. New species, redescriptions, and cladistics of the genus *Pseudocentropiloides* (Ephemeroidea: Baetidae). J. New York Entomol. Soc. 97: 151-158.
- Waltz, R.D. and W.P. McCafferty. 1997. New generic synonymies in Baetidae (Ephemeroidea). Entomol. News 108: 134-140.
- Waltz, R.D. and J.B. Munro. 1996a. *Callibaetis pretiosus* (Ephemeroidea: Baetidae) from Pennsylvania: new distribution record. Great Lakes Entomol. 29: 37-38.

Waltz, R.D. and J.B. Munro. 1996b. *Procloeon viridocularis* (Ephemeroptera: Baetidae) from Michigan and Pennsylvania, new range extensions with comments on the species. Entomol. News 107: 166-168.

Wang, T.-Q. and W.P. McCafferty. 1996. New diagnostic characters for the mayfly family Baetidae (Ephemeroptera). Entomol. News 107: 207-212.

Wiersema, N.A. 1998. *Camelobaetidius variabilis* (Ephemeroptera: Baetidae), a new species from Texas, Oklahoma, and Mexico. Entomol. News 109: 21-26.

Wiersema, N.A. and W.P. McCafferty. 1998. A new species of *Pseudocentropiloides* (Ephemeroptera: Baetidae), with revisions to other previously unnamed baetid species from Texas. Entomol. News 109: 110-116.

Family Metretopodidae

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Subfamily Polymitarcyinae

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SUBORDER CARAPACEA

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FIELD AND LABORATORY METHODS

The following references provide most of the basic information necessary to collect, rear, and prepare larval and adult mayflies for study. Among these the text by Edmunds et al. (1976) is still the most complete. Platts et al. (1983) provides much useful information for making standardized measurements of stream habitats. Provonsha and McCafferty (1975) discuss some highly efficient methods for selective light trapping and rearing mayflies. Finally the chapter from Stehr's book provides a concise discussion of preserving soft bodied insects and recipes for mounting media.

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NOTES ON EQUIPMENT AND PROCEDURES FOR TAXONOMIC STUDY OF MAYFLIES

Microscopes:

It is important to have both a stereo dissecting microscope that has good resolution up to about 80 or 90X. Many scopes have zoom magnification changers. These are ok, but only the best allow for accurate measurements to be made using an ocular micrometer. If possible, get one with 4 or 5 fixed magnification levels. A compound microscope with a top magnification of at least 400X is also necessary. For some structures a compound scope with a phase contrast system that goes up to 1000X is helpful. Although there are many good brands of compound scopes around, there are still only two real choices for stereo scopes, Leica(formerly Wild) and Zeiss. In addition, a good fiber optics light source is recommended with double focusing light wands, but beware of the metal goose-neck type because these are often difficult to keep in position. The ones developed for cytogenetic work are the best. These have the wands encased in thick plastic, which are difficult to bend, but stay where you put them.

Microdissection Instruments:

For fine detailed dissection it is important to have good tools. Fortunately most probes and microscalpels can be improvised from common entomological materials. High quality fine point forceps can be purchased from jewelry supply companies and biological supply houses for between \$30.00 and \$100.00 a pair. If you have a steady hand and some skill it is possible to buy less expensive forceps (about \$10.00 a pair) and regrind them to ultra fine points. The only thing that you can't adjust is the spring tension affecting the "touch" of the forceps. The expensive forceps not only come in a variety of point types, but also in varying degrees of "touch." I have two good pairs of high quality forceps that I use only for the most delicate and minute work. Most of the time I work with less expensive forceps that have been reworked. As for microscalpels, I prefer to use about a number 3 stainless steel insect pin inserted into the end of an applicator stick. With the tip clipped off and sharpened. These microscalpels are capable of slicing the abdominal tergites off the smallest larvae or removing only the genitalia from the smallest adults. If you should need something sharper or smaller your best bet are ultra small glass knives that are made by drawing out glass rods over a Bunsen burner and breaking them. These were developed by developmental biologists for work on live embryos.

Rearing:

A complete larval/adult association provides the best chance of making an accurate determination. Usually, this can only be accomplished by rearing larvae through to the adult stage. Although rearing can be done in the field, I think that it can be done more successfully in the lab. This requires the space and equipment to accommodate different species from different habitat types and likely different temperature regimes. If you have a cold room individual dishes or multiple flow tanks can be run under similar thermal conditions. Various strategies exist for mass rearing and individual rearing. Regardless of your selection you must devote a lot of time to checking the rearing systems multiple times each day to ensure subimagos are removed before they drown and cast larval skins can be recovered intact. A close and frequent watch can detect problems with flow, temperature, or fungal contamination. Rapid detection can mean you won't lose everything. The best specimens to lab rear are black wing pad larvae because you don't have to feed them and because they should be within a few days to a few hours of emergence. Rearing early-mid instar larvae to adults is much more difficult and will not be discussed here.

Electron Microscopy and Molecular Analysis:

For most general taxonomic purposes it is usually not necessary to delve into the world of scanning electron microscopy (SEM) or molecular analytical methods, but it is important to know when these avenues need to be explored. Both SEM and molecular analysis have been used extensively in revisionary studies, studies of intraspecific variation, and in phylogenetic analysis. Often taxonomic problems involving polymorphic taxa, allopatric populations, or suspected sibling species can best be addressed by these means. Microanatomical characters or molecular characters, by themselves may not be terribly practical to most general taxonomists, but they usually point the way to other overlooked macroscopic characters that may provide more accurate keys or diagnoses. Finally, access to at least molecular analyses has improved tremendously over the past 5-7 years. Many universities have setup molecular "job-shops" that can provide a wide range of molecular services for reasonable fees. This combined with the increased number of molecular analyses that are being sold in "kit" form has helped to reduce the cost of obtaining molecular data.

SELECTED LIST OF NORTH AMERICAN MAYFLY SPECIALISTS

The following is a **short** list of mayfly taxonomists in North America that may be helpful in answering taxonomic questions or in the identification of specimens. A much more complete list can be obtained by accessing one or both of the internet web sites listed at the end of this section. People listed here include graduate students, university professors, independent researchers, and consultants. Most of the specialists listed below have specific requirements (and perhaps fees) for certain taxonomic tasks. When contacting a specialist it is best to ask about their requirements, fees, and turn-around time before any specimens are shipped. Mailing addresses for the specialists listed here can be obtained from the NABS directory.

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INTERNET SITES TO VISIT FOR MAYFLY INFORMATION:

MAYFLY CENTRAL

<http://www.entm.purdue.edu/entomology/mayfly/>

This is a good place to get recent changes in the current status of the higher classification of Nearctic taxa as well as nomenclatural changes affecting species names. The site also has a list of Central American taxa. Other useful information here includes the rationale for all systematic changes, directory of e-mail addresses of mayfly researchers, and some general information on faunal regions.

EPHEMEROPTERA GALACTICA

<http://www.famu.edu/mayfly/>

This a good place to catch up on international events in the world of mayflies. There is a similar list of mayfly specialists and their e-mail addresses and many links to other web sites that have useful information on mayflies. This web site is the official internet news vehicle of the International Conference on Ephemeroptera. This site will also link you to Mayfly Central, although I am not sure that Mayfly Central has a link for this site. Between these two sites you should be able to find most of the useful information on mayflies that exists on the web.

