

# Insecta, Ephemeroptera, Ephemerellidae, *Attenella margarita* (Needham, 1927): Southeastern range extension to North Carolina, USA

Luke M. Jacobus<sup>1\*</sup> and Eric D. Fleek<sup>2</sup>

<sup>1</sup> Indiana University, Department of Biology, 1001 East Third Street, Bloomington, IN, 47405, USA.

<sup>2</sup> Environmental Sciences Section, North Carolina Division of Water Quality, 4401 Reedy Creek Road, Raleigh, NC, 27606, USA.

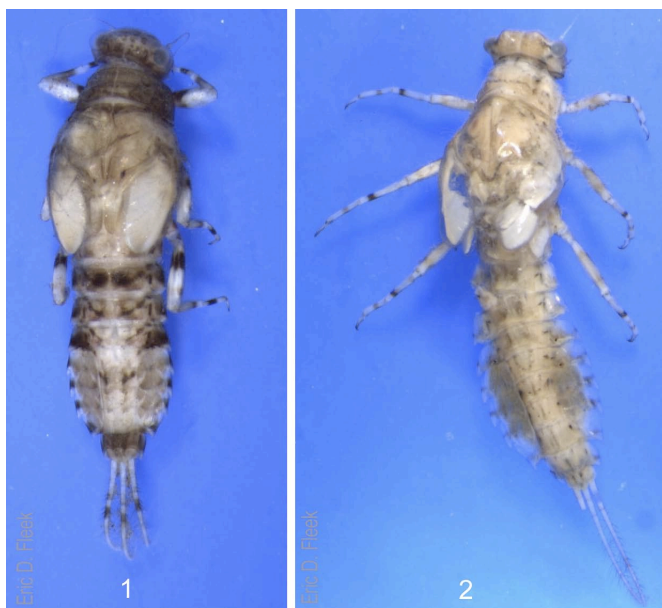
\* Corresponding author. E-mail: [lukemjacobus@alumni.purdue.edu](mailto:lukemjacobus@alumni.purdue.edu)

**ABSTRACT:** New data from the Great Smoky Mountains, in Swain County, North Carolina, USA, extend the geographic range of *Attenella margarita* (Needham, 1927) (Insecta, Ephemeroptera, Ephemerellidae) southeast by approximately 1,300 km. We confirm that *A. margarita* has a disjunct east-west distribution in North America, which is rare among mayflies. Head, thoracic and abdominal characters for distinguishing larvae of *A. margarita* from the sympatric species, *A. attenuata* (McDunnough, 1925), are illustrated and discussed.

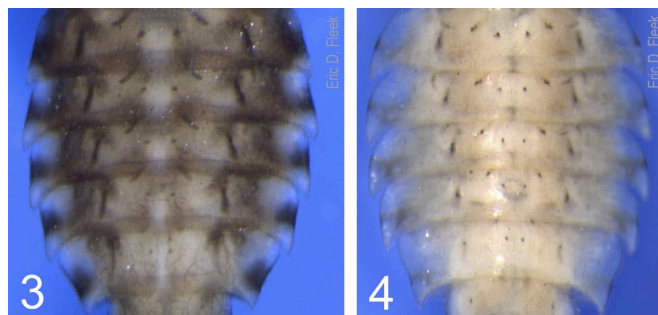
Needham (1927) described *Ephemerella margarita* Needham, 1927, (Ephemeroptera: Ephemerellidae) based on larvae from Utah, USA (Traver 1935). Allen (1980) established the present binomial combination, *Attenella margarita*, by elevating subgenera of *Ephemerella* Walsh to genus status. *Attenella margarita* larvae (Figure 1) are distinguishable from other *Attenella* Edmunds species by having the following combination of characteristics: abdominal terga four through eight with short and blunt, paired spines; most abdominal sterna with brown transverse bands on their lateral margins (Figure 3); prothorax with paired spines small (Figure 5); and occiput without paired spines (Figure 5) (Allen and Edmunds 1961). We have seen the sternal coloration pattern variably expressed on some other *Attenella* species, such as the sympatric *A. attenuata* (McDunnough, 1925), (*e.g.*

Figure 4), so its diagnostic utility is limited. Adults were associated with Needham's (1927) larvae tentatively by McDunnough (1931) and Allen and Edmunds (1961).

Jacobus and McCafferty (2008) recently reviewed the systematics of *Attenella*. The genus is restricted to North America and solely comprises the tribe Attenellini McCafferty of the subfamily Timpanoginae Allen. McCafferty and Wang (1994) hypothesized cladistic relationships within the genus, and McCafferty (1977; 2000), McCafferty and Wang (2000), McCafferty *et al.* (2003), Kluge (2004) and Jacobus and McCafferty (2006) have discussed its relationships to other ephemerellid genera, primarily those considered part of the subfamily Timpanoginae. Ogden *et al.* (2009) provided molecular data for *A. margarita* and discussed alternative phylogenetic placements of the genus within Ephemerellidae based on these data, introducing the possibility that *Attenella* might be an aberrant member of the group that currently is considered as the subfamily Ephemerellinae.



**FIGURES 1 and 2.** *Attenella margarita* (1) and *Attenella attenuata* (2), dorsal habitus.

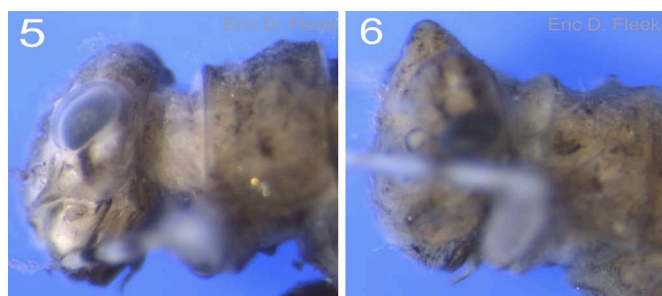


**FIGURES 3 and 4.** *Attenella margarita* (3) and *Attenella attenuata* (4), abdominal sterna.

*Attenella margarita* is relatively widespread in western North America, and it has a range that extends from British Columbia and Alberta, in Canada, south to California and New Mexico, in the USA (Allen and Edmunds 1961; McCafferty *et al.* 1997; McCafferty and Randolph 1998; Meyer and McCafferty 2008). McDunnough (1931) was

the first to report individuals attributable to *A. margarita* from an apparently disjunct eastern North American population. Since then, *A. margarita* has been recorded from an eastern range that extends from Nova Scotia and New Brunswick, in Canada, south to the USA states of Minnesota in the west and Connecticut in the east (Allen and Edmunds 1961; Lager *et al.* 1982; Burian and Bednarik 1994; McCafferty and Randolph 1998).

McCafferty and Meyer (2007a) listed *A. attenuata*, rather than *A. margarita*, as an example of a North American mayfly species with disjunct eastern and western populations. This must represent an inadvertent error, because *A. attenuata* is not known to occur any further west than Missouri and Arkansas, and the species has a somewhat continuous distribution within its range (Allen and Edmunds 1961; Berner 1977; McCafferty and Provonsha 1978; Sarver and Kondratieff 1997; Randolph and McCafferty 1998; Ferro and Sites 2007). An old misidentification of *A. attenuata* from British Columbia (Walley 1927) probably is the source of confusion. McCafferty and Randolph (1998: 58) indicated that these data (Walley 1927) were based on misidentified *A. margarita*, and they provided additional corroborating data for the latter species from British Columbia.



FIGURES 5 and 6. *Attenella margarita* (5) and *Attenella attenuata* (6), dorsal habitus.

Allen and Edmunds (1961) noted inconsistent coloration differences between the eastern and western populations of *A. margarita*, but these populations are otherwise morphologically inseparable. Allen and Edmunds (1961), Hawkins (1985) and Chandler *et al.* (2006) have discussed aspects of the biology of *A. margarita*.

We provide data that extend the recorded eastern range of *A. margarita* south by approximately 1300 km and that establish a North Carolina record for the species. These data are as follows: USA, North Carolina, Swain County, Great Smoky Mountains National Park, Eagle Creek, near mouth, 35°29'8" N, 83°46'27" W; elevation 528.2 m; 3-VIII-2005; Eric D. Fleek, Trish MacPherson, Cathy Tyndall, collectors; sample number 9679. This location is in the Little Tennessee drainage basin and the southern metasedimentary mountains ecoregion (Griffith *et al.* 2002). These record data (McCafferty 2001) substantiate Parker *et al.* (2007) inclusion of *A. margarita* in a list of species from Great Smoky Mountains National Park, USA.

Our material of *A. margarita* (Figures 1, 3, 5) was collected together with some of our *A. attenuata* comparative material (Figures 2, 4, 6) and demonstrates discreet morphological differences from the latter species, as discussed above. Additional comparative

material of *A. attenuata* was examined from the Level IV Sandhills ecoregion (Griffith *et al.* 2002) of North Carolina: Richmond County, Lumber River Basin, Naked Creek, 35°4'55" N, 79°35'25" W, 10-VII-2006, sample number 9966. All material examined is deposited with the North Carolina Division of Water Quality, Raleigh, North Carolina, USA.

Randolph and McCafferty (1998) cited McCafferty *et al.* (1993) when discussing the distribution pattern of *A. margarita*, noting "a north boreal band continuing to the extreme Northeast" from the West. McCafferty *et al.* (1993) did not document such a boreal band, and we have found no data that indicate such a continuous distribution, although it is possible. To date, *A. margarita* has not been reported from areas of central and far northern Canada and USA, and we have seen no specimens from these areas. Furthermore, McCafferty and Meyer (2007b) did not include *A. margarita* in their list of species with more or less continuous transcontinental distribution patterns. Thus, based on present record data and our observations, we conclude that *A. margarita* is a bonafide example of a mayfly species with a disjunct east-west distribution in North America, being essentially absent from the Far North and the central Great Plains.

Such disjunct east-west distributions are rare among species of North American mayflies, with only two others being documented: *Anthopotamus verticis* (Say, 1839) (Potamanthidae) and *Cinygmula subaequalis* (Banks, 1914) (Heptageniidae) (McCafferty and Meyer 2007a). Based on current taxonomy, *Ephemerella dorothea* Needham, 1908, (Ephemerellidae) could prove to be another species with a similar, disjunct east-west distribution (Jacobus and McCafferty 2003), but further study of *Ephemerella* species systematics is needed (Alexander *et al.* 2009) before this can be concluded with certainty.

**ACKNOWLEDGMENTS:** We thank Trish Finn MacPherson (Apex, North Carolina, USA) for drawing our attention to *A. margarita* in North Carolina through her initial identification of specimens. Comments from an anonymous reviewer helped us to improve this paper.

#### LITERATURE CITED

- Alexander, L.C., M. Delion, D.J. Hawthorne, W.O. Lamp and D.H. Funk. 2009. Mitochondrial lineages and DNA barcoding of closely related species in the mayfly genus *Ephemerella* (Ephemeroptera:Ephemerellidae). *Journal of the North American Benthological Society* 28(3): 584-595.
- Allen, R.K. 1980. Geographic distribution and reclassification of the subfamily Ephemerellinae (Ephemeroptera: Ephemerellidae); p. 71-91 In: J.F. Flannagan and K. E. Marshall (eds.). *Advances in Ephemeroptera Biology*. New York: Plenum.
- Allen, R.K. and G.F.Jr. Edmunds. 1961. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae) III. The subgenus *Attenuatella*. *Journal of the Kansas Entomological Society* 34(4): 161-173.
- Berner, L. 1977. Distributional patterns of southeastern mayflies (Ephemeroptera). *Bulletin of the Florida State Museum, Biological Sciences* 22(1): 1-56.
- Burian, S.K. and A.F. Bednarik. 1994. The mayflies (Ephemeroptera) of Connecticut: an initial faunal survey. *Entomological News* 105(4): 204-216.
- Chandler, D.S., G.D. Whitmore, S.K. Burian and J.F. Burger. 2006. The mayflies (Ephemeroptera) of New Hampshire: Seasonality and diversity of the stream fauna. *Transactions of the American Entomological Society* 132(1+2): 25-73.
- Ferro, M.L. and R.W. Sites. 2007. The Ephemeroptera, Plecoptera, and Trichoptera of Missouri State Parks, with notes on biomonitoring, mesohabitat associations, and distribution. *Journal of the Kansas Entomological Society* 80(2): 105-129.
- Griffith, G.E., J.M. Omernik, J.A. Comstock, M.P. Schafale, W.H. McNab, D.R. Lenat, T.F. MacPherson, J.B. Glover and V.B. Shelburne. 2002. *Ecoregions of North Carolina and South Carolina*. (Color poster with

- map, descriptive text, summary tables and photographs). Reston: United States Geological Survey (map scale 1:1,500,000).
- Hawkins, C.P. 1985. Food-habits of species of ephemerellid mayflies (Ephemeroptera, Insecta) in streams of Oregon. *American Midland Naturalist* 113(2): 343-352.
- Jacobus, L.M. and W.P. McCafferty. 2003. Revisionary contributions to North American *Ephemerella* and *Serratella* (Ephemeroptera: Ephemerellidae). *Journal of the New York Entomological Society* 111(4): 174-193.
- Jacobus, L.M. and W.P. McCafferty. 2006. Reevaluation of the phylogeny of the Ephemeroptera Infraorder Pannota (Furcatergalia), with adjustments to higher classification. *Transactions of the American Entomological Society* 132(3+4): 81-90, 429-430.
- Jacobus, L. M. and W. P. McCafferty. 2008. Revision of Ephemerellidae genera (Ephemeroptera). *Transactions of the American Entomological Society* 134(1+2): 185-274.
- Kluge, N. 2004. *The phylogenetic system of Ephemeroptera*. Dordrecht: Kluwer. 456 pp.
- Lager, T.M., M.D. Johnson and W.P. McCafferty. 1982. The mayflies of northeastern Minnesota (Ephemeroptera). *Proceedings of the Entomological Society of Washington* 84(4): 729-741.
- McCafferty, W.P. 1977. Biosystematics of *Dannella* and related subgenera of *Ephemerella* (Ephemeroptera: Ephemerellidae). *Annals of the Entomological Society of America* 70(6): 881-889.
- McCafferty, W.P. 2000. A hierarchical classification of the Timpanoginae (Ephemeroptera: Ephemerellidae) and description of a new species from Quebec. *Annales de Limnologie* 36(3): 157-161.
- McCafferty, W.P. 2001. Reporting species record data. *Entomological News* 111(4): 311-312.
- McCafferty, W.P. and M.D. Meyer. 2007a. An extreme range extension and disjunction for the Ephemeroptera family Potamanthidae in North America. *Proceedings of the Entomological Society of Washington* 109(3): 737-738.
- McCafferty, W.P. and M.D. Meyer. 2007b. Insecta, Ephemeroptera: Transcontinental range extensions in western North America. *Check List* 3(1): 51-54.
- McCafferty, W.P. and R.P. Randolph. 1998. Canada mayflies: A faunistic compendium. *Proceedings of the Entomological Society of Ontario* 129: 47-97.
- McCafferty, W.P. and A.V. Provonsha. 1978. The Ephemeroptera of mountainous Arkansas. *Journal of the Kansas Entomological Society* 51(3): 360-379.
- McCafferty, W.P. and T.Q. Wang. 1994. Phylogenetics and the classification of the *Timpanoga* complex (Ephemeroptera: Ephemerellidae). *Journal of the North American Benthological Society* 13(4): 569-579.
- McCafferty, W.P. and T.Q. Wang. 2000. Phylogenetic systematics of the major lineages of pannote mayflies (Ephemeroptera: Pannota). *Transactions of the American Entomological Society* 126(1): 9-101.
- McCafferty, W.P., R.S. Durfee and B.C. Kondratieff. 1993. Colorado mayflies (Ephemeroptera): an annotated inventory. *Southwestern Naturalist* 38(3): 252-274.
- McCafferty, W.P., L.M. Jacobus and T.Q. Wang. 2003. Phylogenetics and the reconfirmation of *Dentatella* Allen (Ephemeroptera: Ephemerellidae). *Proceedings of the Entomological Society of Washington* 105(3): 786-788.
- McCafferty, W.P., C.R. Lugo-Ortiz and G.Z. Jacobi. 1997. Mayfly fauna of New Mexico. *Great Basin Naturalist* 57(4): 283-314.
- Meyer, M.D. and W.P. McCafferty. 2008. Mayflies (Ephemeroptera) of the far western United States. Part 3: California. *Transactions of the American Entomological Society* 134(3+4): 337-430.
- McDunnough, J. 1931. The eastern North American species of the genus *Ephemerella* and their nymphs (Ephemeroptera). *Canadian Entomologist* 63: 187-197, 201-216.
- Needham, J.G. 1927. The Rocky Mountain species of the mayfly genus *Ephemerella*. *Annals of the Entomological Society of America* 20: 107-117.
- Ogden, T.H., J.T. Osborne, L.M. Jacobus and M.F. Whiting, 2009. Combined molecular and morphological phylogeny of Ephemerellinae (Ephemeroptera: Ephemerellidae), with remarks about classification. *Zootaxa* 1991: 28-42.
- Parker, C.R., O.S. Jr. Flint, L.M. Jacobus, B.C. Kondratieff, W.P. McCafferty and J.C. Morse. 2007. Ephemeroptera, Plecoptera, Megaloptera, and Trichoptera of Great Smoky Mountains National Park. *Southeastern Naturalist, Special Issue 1*: 159-174.
- Traver, J.R. 1935. Part II: Systematic. North American mayflies order Ephemeroptera; p. 237-739 In: J.G. Needham, J.R. Traver, and Y.C. Hsu (eds.). *The biology of mayflies*. Ithaca: Comstock.
- Randolph, R.P. and W.P. McCafferty. 1998. The diversity and distribution of the mayflies of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin. *Ohio Biological Survey Bulletin, New Series* 13: 1-188.
- Sarver, R. and B.C. Kondratieff. 1997. Survey of Missouri mayflies with the first description of adults of *Stenonema bednariki* (Ephemeroptera: Heptageniidae). *Journal of the Kansas Entomological Society* 70(2): 132-140.
- Walley, G.S. 1927. Ephemeroptera; p. 59-61 In Criddle, N. (ed). The entomological record, 1926. *Annual Report of the Entomological Society of Ontario* 57: 47-62.

RECEIVED: December 2009

REVISED: May 2010

ACCEPTED: May 2010

PUBLISHED ONLINE: June 2010

EDITORIAL RESPONSIBILITY: André V. L. Freitas