

Scientific Note

Notes on the distribution of the mayfly *Caudatella edmundsi* (Allen, 1959) (Ephemeroptera: Ephemerellidae)

Caudatella edmundsi (Allen 1959) was described from a series of larvae collected from the Coast Ranges and Cascade Mountains of western Oregon (Allen 1959). Allen (1959) and Allen and Edmunds (1961) provided descriptions of these mature larvae and suggest that *C. edmundsi* is a boreal species found in fast-flowing, cold, mountain streams. Later, this mayfly was recorded from Washington and Idaho (Jensen 1966). More recently, this species has been collected in several watersheds in western Montana (Stagliano et al. 2007), a region from which Jacobus et al. (2006) described the adults and eggs. In addition, Meyer and McCafferty (2007) and McCafferty and Meyer (2007) recently summarized records for this species in Oregon and Washington respectively. We are aware of no published records of this species in California.

During the summers of 1988 and 1989 we made extensive collections of benthic invertebrates from 45 streams located throughout the Sierra Nevada, the Klamath Mountains, and the North Coast Range of California. We also quantified the physical and biological environments at these sites. We found larvae of *C. edmundsi* in 4 of these streams draining the western slope of the central and southern Sierra Nevada.

Our observations indicate that streams with *C. edmundsi* were deeper, steeper, lower in substrate diversity, and higher in cascade habitats than streams without this species. *Caudatella edmundsi* larvae were also more likely to be collected from streams sampled early in the summer than those sampled later. Streams with this mayfly also tended to have lower mean summer temperature, higher amounts of moss, and occurred at higher elevation (Hogue 2001). Furthermore, *C. edmundsi* larvae appear to be restricted to the aquatic moss *Fontinalis* Hedwig (Fontinalaceae). Hundreds of individuals have been observed crawling in mats of this moss (George Edmunds, personal communication), and larvae are invariably collected from moss (Hawkins 1984). We found larvae associated with moss covering bedrock or large boulder and cobble substrates in fast-water riffle and run habitats. These substrates are probably more stable over time than smaller particles and may permit the establishment of mats of moss. *Fontinalis* makes up a significant proportion of the diet of *C. edmundsi* in addition to diatoms and detritus ingested in association with this moss (Hawkins 1985). These microhabitat associations agree with recent observations in Montana (Jacobus et al. 2006). Other species of *Caudatella* occur in and consume moss, but do not appear to be restricted to this microhabitat.

In addition to our collections, we know of several other collections of this species in California. In an unpublished Master's thesis, Charles Doherty (1976) reported *C. edmundsi* from three streams in Alpine and El Dorado Counties, Roy Haile recorded the species in an unpublished list of taxa he collected in the Upper Sacramento River in Siskiyou County near Dunsmuir, and Michael D. Meyer (personal communication) collected this species in Tehama County. Mark R. Vinson of the Utah State University National Aquatic Monitoring Center (USU-NAMC) provided us with

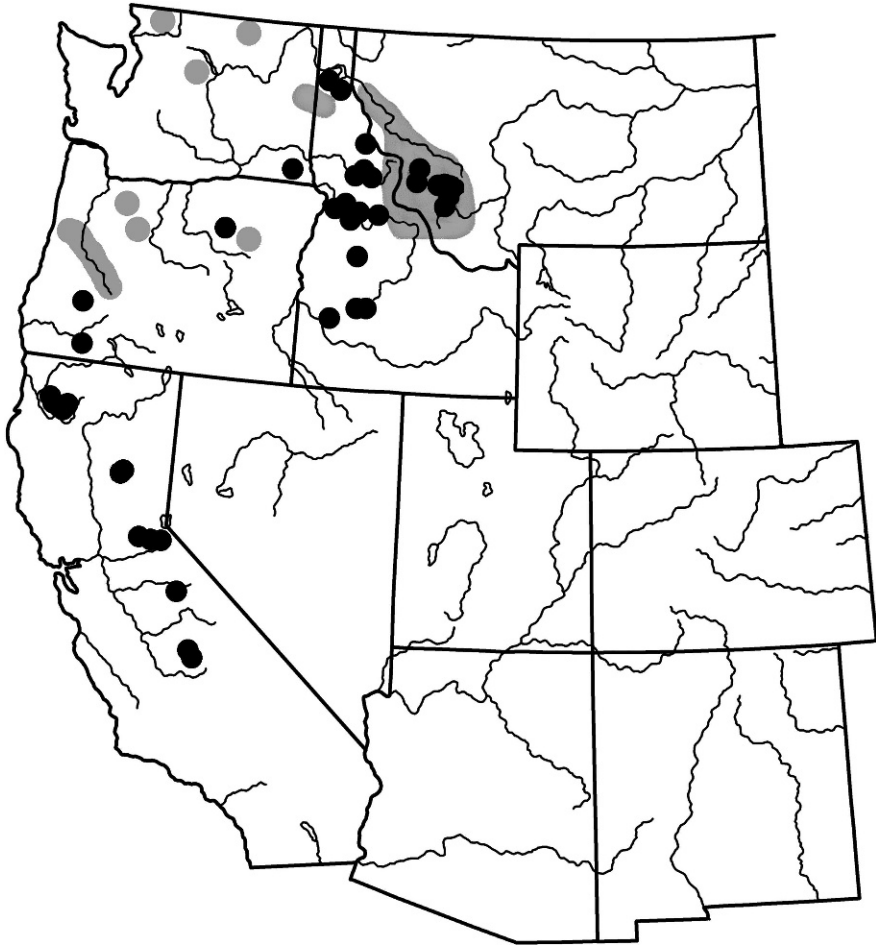


Figure 1. Map of western United States showing distribution of *Caudatella edmundsi* based on published records (gray shading) and records reported in this paper (black circles).

additional California records as well as numerous records from Washington, Oregon, Idaho, and Montana from collections in his care made by biologists with the U. S. Forest Service and identified by the USU-NAMC (see details below and Fig. 1). Although we have not examined these specimens, we assume the identifications are correct because they were done by competent production taxonomists, and it is unlikely this species could be confused with other species of *Caudatella*. *Caudatella edmundsi* larvae are easily recognized by having paired submedian tubercles on abdominal segments 1–10, a double row of denticles on the tarsal claws, no ventral abdominal color pattern, and by the distinctively vestigial maxillary palpus. Our specimens are deposited in the collection of the Natural History Museum of Los Angeles County (LACM), those identified by the USU-NAMC are in the USU-NAMC collection, and that of M. D. Meyer is at the Purdue Entomological Research Collection (PERC) in West Lafayette, Indiana.

Inspection of all known collection records indicates that, as in most western North American mayfly species, *C. edmundsi* occurs at progressively lower elevations with

increasing proximity to the Pacific coast, but there is no apparent relationship between elevation and latitude. Furthermore, the distribution of this species now best matches the Northwest and Coast Ranges Distribution Pattern of the Western North American Subdivision of mayfly distributions that is comprised of the mountainous regions of northern Baja California, California, Oregon, Washington, Idaho, western Montana and Wyoming, and southern British Columbia and Alberta (Allen 1990). We suspect this mayfly will be found in other high-gradient, cold, mountainous streams throughout this region in microhabitats dominated by aquatic moss.

Collection Records. USA: CALIFORNIA. *ALPINE Co.*: Caples Creek, 38.708_N 120.050_W, elev. 2350 m, April–June 1976, C. B. Doherty [1 larva]. *EL DORADO Co.*: Alder Creek, 38.755_N 120.371_W, elev. 1170 m, April–June 1976, C. B. Doherty [1 larva]; South Fork American River, 38.773_N 120.701_W, elev. 490 m, April–June 1976, C. B. Doherty [1 larva]. *FRESNO Co.*: Kaiser Creek, 37.35_N 119.20_W, elev. 1900 m, 24–29 June 1989, B. Wells and J. P. Haehnel [12 larvae, LACM]. *SISKIYOU Co.*: Cecil Creek, 41.124_N 123.132_W, elev. 850 m, 28 July 2004, [89 larvae, USU-NAMC]; Irving Creek, 41.470_N 123.431_W, elev. 975 m, 23 June 2004, [8 larvae, USU-NAMC]; Irving Creek, 41.470_N 123.431_W, elev. 975 m, 11 July 2006, [4 larvae, USU-NAMC]; Irving Creek, 41.464_N 123.427_W, elev. 915 m, 12 July 2007, [4 larvae, USU-NAMC]; Plummer Creek, 41.150_N 123.212_W, elev. 670 m, 10 August 2004, [2 larvae, USU-NAMC]. Upper Sacramento River near Dunsmuir, 21 February 1977 [larvae], R. Haile. *TEHAMA Co.*: Deer Creek at Highway 32, 14 May 2002, M. D. Meyer [1 larva, PERC]; Deer Creek Meadows Creek, 13 June 2005, [2 larvae, USU-NAMC]. *TRINITY Co.*: Mule Creek, 40.880_N 122.822_W, elev. 875 m, 18 July 2004, [1 larva, USU-NAMC]. *TULARE Co.*: Freeman Creek, 36.12_N 118.45_W, elev. 1450 m, 11–14 June 1989, K. L. Bartz & J. N. Hogue [4 larvae, LACM]; Peppermint Creek, 36.05_N 118.47_W, elev. 1350 m, 15 June 1989, M. T. Larkin [4 larvae, LACM]. *TUOLUMNE Co.*: Deadman Creek, 38.32_N 119.73_W, elev. 2200 m, 8 July 1989, J. N. Hogue [1 larva, LACM]. *IDAHO.* *BOISE Co.*: Granite Creek, 43.943_N 115.975_W, elev. 1345 m, 18 July 2004, [1 larva, USU-NAMC]. *BONNER Co.*: Lamb Creek, 48.531_N 116.980_W, elev. 790 m, 29 June 2004, [1 larva, USU-NAMC]. *CLEARWATER Co.*: Elk Creek, 46.883_N 116.162_W, elev. 1070 m, 12 July 2000, [1 larva, USU-NAMC]; Elk Creek, 46.882_N 116.163_W, elev. 1070 m, 2 July 2004, [5 larvae, USU-NAMC]; Johnny Creek, 46.611_N 115.432_W, elev. 760 m, 31 July 2004, [1 larva, USU-NAMC]. *ELMORE Co.*: Shake Creek, 43.616_N 115.157_W, elev. 1495 m, 2 July 2003, [2 larvae, USU-NAMC]; Trinity Creek, 43.607_N 115.278_W, elev. 1400 m, 5 July 2003, [4 larvae, USU-NAMC]. *IDAHO Co.*: Bargamin Creek, 45.707_N 115.050_W, elev. 1525 m, 2 August 2003, [5 larvae, USU-NAMC]; Big River, 45.622_N 115.513_W, elev. 1950 m, 18 June 2000, [1 larva, USU-NAMC]; Meadow River, 45.901_N 115.920_W, elev. 975 m, 17–18 June 2000, [9 larvae, USU-NAMC]; South Fork White Bird Creek, 45.766_N 116.069_W, elev. 1465 m, 29 June 2004, [2 larvae, USU-NAMC]; Twentymile Creek, 45.761_N 115.749_W, elev. 1310 m, 30 July 2003, [15 larvae, USU-NAMC]; Twentymile Creek, 45.761_N 115.749_W, elev. 1310 m, 2 August 2004, [1 larva, USU-NAMC]. *SHOSHONE Co.*: Bird Creek, 47.272_N 115.609_W, elev. 975 m, 4 July 2004, [1 larva, USU-NAMC]; Emerson Creek, 47.910_N 116.231_W, elev. 915 m, 21 June 2003, [1 larva, USU-NAMC]. *VALLEY Co.*: Trapper Creek, 44.802_N 115.491_W, elev. 1980 m, 21 July 2002, [3 larvae, USU-

NAMC]. MONTANA. *DEER LODGE Co.*: Lemarche Creek, 45.877_N 113.198_W, elev. 1770 m, 7 July 2005, [15 larvae, USU-NAMC]; Warm Springs Creek, 46.175_N 113.156_W, elev. 1860 m, 30 June 2004, [1 larva, USU-NAMC]. *GRANITE Co.*: Ranch Creek, 46.526_N 113.623_W, elev. 1400 m, 17 August 2002, [3 larvae, USU-NAMC]; Stony Creek, 46.338_N 113.628_W, elev. 1525 m, 21 June 2004, [1 larva, USU-NAMC]. *POWELL Co.*: Dempsey Creek, 46.310_N 112.939_W, elev. 2045 m, 19 August 2003, [2 larvae, USU-NAMC]; Racetrack Creek, 46.276_N 112.913_W, elev. 1630 m, 18 August 2003, [2 larvae, USU-NAMC]; Rock Creek, 46.408_N 112.968_W, elev. 1875 m, 20 July 2003, [1 larva, USU-NAMC]; Rock Creek, 46.408_N 112.968_W, elev. 1875 m, 15 July 2004, [3 larvae, USU-NAMC]. OREGON. *DOUGLAS Co.*: Little River, 43.225_N 122.713_W, elev. 945 m, 5 August 2003, [1 larva, USU-NAMC]. *GRANT Co.*: South Fork Desolation Creek, 44.812_N 118.683_W, elev. 1615 m, 29 June 2004, [1 larva, USU-NAMC]. *JACKSON Co.*: Ashland Creek, 42.108_N 122.746_W, elev. 1430 m, 5 July 2003, [1 larva, USU-NAMC]. WASHINGTON. *COLUMBIA Co.*: Tucannon River, 46.188_N 117.618_W, elev. 1065 m, 7 July 2004, [2 larvae, USU-NAMC].

ACKNOWLEDGMENTS

We thank Roy Haile (deceased), Mark R. Vinson (Utah State University), and Michael D. Meyer (Christopher Newport University, Virginia) for use of their unpublished records. We dedicate this note to George Edmunds Jr., this species' honoree, eminent student of mayflies, and contributor to much knowledge on these fascinating insects. George contributed to early drafts of this paper and died in Salt Lake City on 4 March 2006 at the age of 85.

James N. Hogue* and Charles P. Hawkins, *Department of Watershed Sciences, Utah State University, Logan, UT 84322-5210*. *Present address: *Department of Biology, California State University Northridge, 18111 Nordhoff St., Northridge, CA 91330-8303*.

LITERATURE CITED

- Allen, R. K. 1959. A new species of *Ephemerella* from Oregon (Ephemeroptera: Ephemerellidae). *Journal of the Kansas Entomological Society* 32:59–60.
- Allen, R. K. 1990. Distribution patterns of north and central American mayflies (Ephemeroptera), pp. 155–167. *In*: I. C. Campbell (Ed.). *Mayflies and stoneflies*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Allen, R. K. & G. F. Edmunds, Jr. 1961. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae) II. The subgenus *Caudatella*. *Annals of the Entomological Society of America* 54:603–612.
- Doherty, C. B. 1976. Environmental conditions and species assemblages of northern California stream insects. M. S. Thesis, University of California, Davis.
- Hawkins, C. P. 1984. Substrate associations and longitudinal distributions in species of Ephemerellidae (Ephemeroptera: Insecta) from western Oregon. *Freshwater Invertebrate Biology* 3(4):181–188.
- Hawkins, C. P. 1985. Food habits of species of ephemerellid mayflies (Ephemeroptera: Insecta) in streams of Oregon. *American Midland Naturalist* 113:343–352.
- Hogue, J. N. 2001. Benthic invertebrate assemblage structure in mountain streams: the influence of spatial scale of observation and organism size on relationships with environmental factors. Ph.D. Dissertation, Utah State University, Logan, Utah.
- Jacobus, L. M., R. L. Newell & W. P. McCafferty. 2006. First adult and egg descriptions of *Caudatella edmundsi* (Ephemeroptera: Ephemerellidae) from Montana (U.S.A.), with habitat observations. *Entomological News* 117:175–180.

- Jensen, S. L. 1966. The mayflies of Idaho (Ephemeroptera). M. S. thesis. University of Utah, Salt Lake City, Utah.
- McCafferty, W. P. & M. D. Meyer. 2007. Confirmation data for three species of mayflies in the state of Washington, U.S.A. (Ephemeroptera: Ephemerellidae, Ephemeridae, Heptageniidae). *Entomological News* 118:523–524.
- Meyer, M. D. & W. P. McCafferty. 2007. Mayflies (Ephemeroptera) of the far western United States. Part 2: Oregon. *Transactions of the American Entomological Society* 133:65–114.
- Stagliano, D. M., G. M. Stephens & W. R. Bosworth. 2007. Aquatic invertebrate species of concern on USFS northern region lands. Report to USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana and Idaho Conservation Data Center, Boise, Idaho. 95 pp, plus appendices.

Received 5 October 2007; Accepted 22 July 2008; Publication date 4 Dec 2008.