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NOTE ON THE OCCURRENCE OF *SIPHLONURUS AUTUMNALIS* (EPHEMEROPTERA: SIPHLONURIDAE) IN A MONTANA SPRING BROOK

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ABSTRACT.—The little-known mayfly *Siphlonurus autumnalis* McDunnough (Ephemeroptera: Siphlonuridae) was collected from several locations in its floodplain habitats along the Middle Fork of the Flathead River in western Montana. To confirm identification, nymphs were reared along with an associated species, *S. occidentalis* Eaton (Ephemeroptera: Siphlonuridae). Adults emerged from 6 September until 16 October. Habitats are described and the first photos of the 2 sexes are provided.

Key words: mayfly, Siphlonurus autumnalis, *emergence, habitats, Montana, spring brook.*

The biology of the mayfly *Siphlonurus autumnalis* McDunnough is so poorly known that the nymphs were only recently described (Jacobus and McCafferty 2002). *Siphlonurus autumnalis* has been recorded in Montana (Newell 1970, Randolph 2002, McCafferty and Newell 2007), Washington (Jensen 1966, Jacobus and McCafferty 2002, Randolph 2002), and the Canadian provinces of Alberta and British Columbia (McDunnough 1931, Randolph 2002). Jacobus and McCafferty (2002) suggested that this species is seldom collected because of the difficulty in accessing larvae habitat, which includes the rocky edgewaters of large rivers (Edmunds et al. 1976). We suggest there may be other reasons why *S. autumnalis* is rarely collected: notably, the immature nymphs are nearly impossible to identify, the species is often associated with other species of *Siphlonurus,* and the published habitat is incomplete.

Opportunities to collect large numbers of *Siphlonurus* from a variety of habitats was afforded through a long-term ecological study of aquatic habitats associated with the Nyack Floodplain of the Middle Fork of the Flathead River in western Montana. The study area was located in Flathead County, Montana, approximately 16 km northeast of West Glacier along the southern boundary of Glacier National Park. *Siphlonurus occidentalis* and *S. autumnalis* were particularly abundant in a small spring brook, locally called Crazy Beaver Spring Brook (48°28′16.77″N, 113°49′21.11″W). This spring brook arises from groundwater seeps at about 1009 m elevation and flows westward, eventually into a side channel of the Middle Fork of the Flathead River. During the annual peak in the river hydrograph (June–July), the spring channel contains a portion of the Flathead River discharge. This flow of surface water from the main channel into the spring brook is cut off when the river discharge declines by late July. The sampling location was approximately 100 m from the spring source in an area 4 m wide and a maximum of 30 cm deep with a substrate of cobble, gravel, sand, and silt. Flow was barely perceptible at <1 cms.

Anderson (2008) and Chilcote (2004) collected at this location on numerous occasions during 2002–2005. Their summer sampling revealed mature nymphs of *S. occidentalis* and a smaller unidentifiable *Siphlonurus.* Late summer collections (12 September 2003) revealed subimagoes of *S. autumnalis.* It was concluded the small previously collected nymphs were probably *S. autumnalis.* The presence of these 2 *Siphlonurus* species in this small spring brook provided an opportunity to learn more about the biology of these species through further sampling. Our goals were to determine population composition of the 2 species, determine emergence timing, and provide photos of the 2 sexes of *S. autumnalis.*

Crazy Beaver Spring Brook was visited on 31 August 2007, 15 September 2007, and 5 October 2007 for the purpose of obtaining

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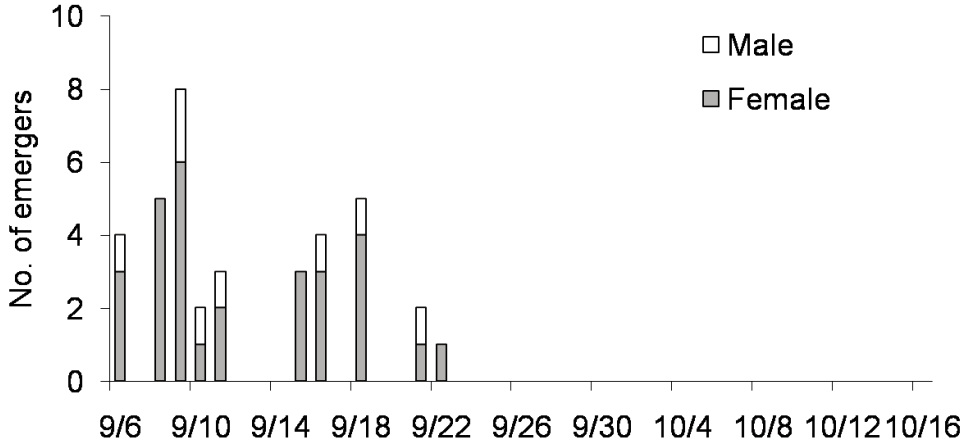

Fig. 1. Emergence sequence of laboratory-reared *Siphlonurus occidentalis.*

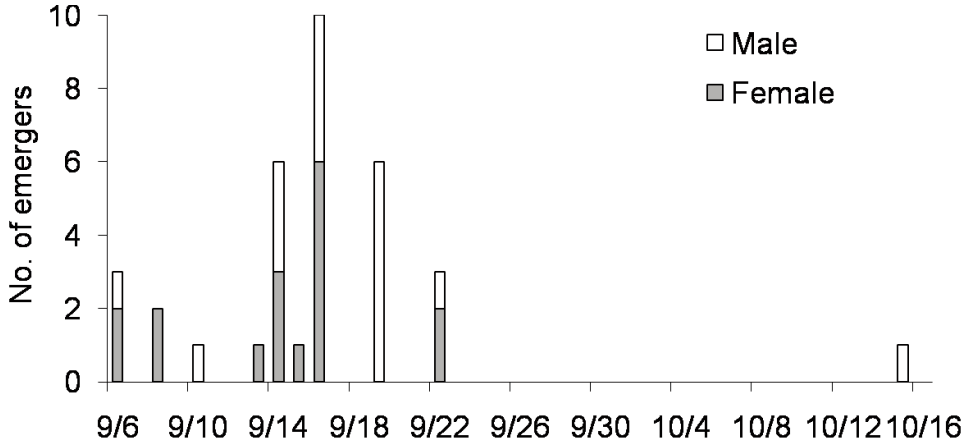

Fig. 2. Emergence sequence of laboratory-reared *Siphlonurus autumnalis.*

specimens of *Siphlonurus* for identification and rearing. Nymphs were collected using a kicknet (125-micron mesh). Part of the sample was preserved in 80% ethyl alcohol and returned to the laboratory where nymphs were identified and counted. The remainder of the sample was placed into aerated chambers with spring water, refrigerated, and transported to the University of Montana's Flathead Lake Biological Station (FLBS). In the laboratory, the live nymphs were placed into flow-through, aerated emergence chambers at a temperature of 11°C. Screening was placed over the emergence chambers to retain adults. The light cycle was 12 hours of light and 12 hours of dark. The chambers were checked daily for adults. Adults and nymphal skins were collected, identified, and preserved. Digital photos were taken of nymphs, subimagoes, and imagoes. Nymphs of some associated mayfly species were also retained, allowed to emerge, and identified to species.

On 31 August 2007, we collected 35 *S. occidentalis* nymphs, most of which had black wing pads. We also collected 20 *Siphlonurus* nymphs that were unidentifiable to species but were presumably *S. autumnalis.* Water temperature in the spring brook was 10 °C. On 15 September 2007 we collected 7 *S. occidentalis* nymphs with black pads, 20 *S. autumnalis* nymphs with black pads, and 10 *Siphlonurus* nymphs without black pads that were unidentifiable to species. Water temperature in the spring brook was again 10 °C. On 5 October 2007, no *Siphlonurus* nymphs were present and water temperature

Fig. 3. Ventral abdomen of *Siphlonurus occidentalis* subimago.

in the spring brook was 8 °C. Additional mayfly taxa present during the collection dates were *Timpanoga hecuba* (Eaton) (Ephemeroptera: Ephemerellidae), *Paraleptophlebia bicornuta* (McDunnough) (Ephemeroptera: Leptophlebiidae), *Ameletus validus* McDunnough (Ephemeroptera: Ameletidae), *Ameletus similior* McDunnough (Ephemeroptera: Ameletidae), and *Centroptilum conturbatum* McDunnough (Ephemeroptera: Baetidae).

A total of 37 *S. occidentalis* and 34 *S. autumnalis* adults emerged from the emergence chambers. The rearing chamber results may not reflect the true emergence patterns of these species, but coupled with the results of previous field collections (Chilcote 2004, Anderson 2008), the results do offer an index of relative abundance and a possible range of dates for emergence (Figs. 1, 2). Our results support the previously reported emergence timing for *S. occidentalis* as summer–fall: Oregon—March–August (Meyer and McCafferty 2007a); Alaska—July (Harper and Harper 1981); Idaho—July, September (Jensen 1966); Arizona—June (Allen and Chao 1981); Alberta and British Columbia—August, September (McDunnough 1931); Utah—May–October (Edmunds 1952); Washington—July and August (Meyer and McCafferty 2007b); and Montana—July–September (Newell unpublished data). We also found evidence to support the observation that *S. autumnalis* is a fall emerger (McDunnough 1931, Jacobus and McCafferty 2002).

Siphlonurus occidentalis and *S. autumnalis* clearly coexist in Crazy Beaver spring brook. Both species were nearly equal in abundance in our fall 2007 samples (Figs. 1, 2). Subimagoes were collected in the field on 12 September 2007, but it is questionable if emergence to maturity occurred in the field during late September and early October in the study area. Freezing air temperatures are common after mid-September, and ice formed in shallow reaches of the spring in early October, although the spring typically retains some ice-free reaches throughout the winter.

In the process of identifying *Siphlonurus* specimens to species, we found that mature nymphs and subimagoes of *S. occidentalis* were easily identified by the U-shaped pattern on each sternite (Fig. 3). This pattern appears some time before the nymphs mature, just prior to

Fig. 4. Ventral surface of male (left) and female (right) *Siphlonurus autumnalis* nymphs.

development of black wing pads, thus increasing the chance of identifying nymphs to species using abdominal coloration. Male *S. autumnalis* nymphs can be identified by the dorsal touching of the eyes, a character not observed in *S. occidentalis* or any other species of *Siphlonurus.* Jacobus and McCafferty (2002) noted that female nymphs can be identified using morphology of the pronotum. We have not found this character to be a useful species separator when large numbers of *S. occidentalis* and *S. autumnalis* coexist in samples, due to overlapping variability in the shape of the pronotum in both species.

We found color pattern to be the easiest species identifier for *S. autumnalis*, but it is only available for a short time prior to emergence. *Siphlonurus autumnalis* does not develop an abdominal sternite color pattern (Fig. 4) until very late in nymphal maturity when black wing pads are also present. The color appears a few days before emergence and is primarily a uniform brown in males, while females have an unusual mottled pattern of brown and pale yellow to grayish white on the last 2 sternites (Fig. 5). This color pattern is actually the color of the subimago adult showing through the nymphal skin, similar to *S. occidentalis* (Edmunds 1952). The late summer emergence of *S. autumnalis* and the lack of a distinctive color pattern throughout much of the nymphal life may have reduced the probability of proper identification of this species in other studies.

Based on the differences we observed in the *S. occidentalis* and *S. autumnalis* nymphs collected from Crazy Beaver Spring Brook, *Siphlonurus* nymphs collected from past ecological studies done on this floodplain were reexamined. Additional *S. autumnalis* nymphs were identified from collections made in the main river, 2 spring brooks, and numerous floodplain ponds (Newell unpublished data). McCafferty and Newell (2007) also reported this species from several small lakes in Glacier National Park, Montana, illustrating the wide habitat preferences of this species. These locations expand the previously recorded habitat of *S. autumnalis* (Edmunds et al. 1976).

Specimens of *S. autumnalis* and *S. occidentalis* have been archived at the University of

Fig. 5. Ventral surface of female *Siphlonurus autumnalis* subimago (left) and imago (right).

Montana, Flathead Lake Biological Station invertebrate reference collection. Thanks to Marie Kohler and Don Schenck for their help with editing the text and figures in this paper. Thanks to Dave Ruiter for his review of this manuscript. This work was supported in part by the National Science Foundation Biocomplexity in the Environment Grant #EAR-0120523.

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