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116 THE GREAT LAKES ENTOMOLOGIST Vol. 46, Nos. 1 - 2

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Abstract

Using scanning electron microscopy, epizooic diatoms were observed growing on the cerci of *Caenis amica* Hagen naiads (Ephemeroptera, Caenidae). *Meridion circulare* (Greville) C. Agardh was the most abundant, followed by *Synedra rumpens* Kützing, then *Cocconeis pediculus* Ehrenberg. Other diatom species observed from substrates in Cedar Creek, Isabella County, Michigan were not observed on the cerci. No diatoms were observed on Ephemerellidae naiads.

Epizoic algae are not infrequent on the surfaces of most active animals. The association between sloths and epizooic algae was one of the first to be described showing this unusual and interesting association since such relationships were described (Kuhn, in Welcher 1864). Freshwater epizootic algae have been described from a variety of hosts. These include protistans (Wiley et al. 1970, Pérez-Martinez et al. 2001); invertebrate animals such as Cladocera (Gaiser and Bachmann 1993, Barea-Arco et al. 2001), Rotifera (Wujek 2006); insects including Trichoptera (Bergey and Resh 1994, Sheath et al. 1995), Diptera (Sheath et al. 1996), and Odonata (Wujek personal observation); Crustacea together with Copepods (Russell and Norris 1971) and crayfish (Fuelling et al. 2010). The vertebrate hosts for epizootic algae include amphibians (Tumlison and Trauth 2006), reptiles including lizards and turtles (Gradstein and Equihua 1995, Garbary et al. 2007), fish (Shin et al. 2004), and captive polar bears (Lewin and Robinson 1979, Lewin et al. 1981).

Materials and Methods

Spring collections containing naiad Ephemeroptera of the families Caenidae (N = 22) and Ephemerellidae (N = 43) were taken from a heavily shaded 200 m section of Cedar Creek, Isabella County, Michigan (34ºN33´794´´, 84ºW54´043´´) located between Wing and Deerfield Roads. The insects used for SEM observations, collected weekly from February through March 1988, were picked from substrates and immediately placed in buffered 7.2 pH 2% glutaraldehyde. Insects used for light microscopy were fixed in 5% formalin. Insects which had been affixed to aluminum stubs were dehydrated, critical point dried, and sputter-coated with gold. Observations were done using an AMR 1200 scanning electron microscope. Diatom slides for light microscopic observations were prepared on both naiad families and material taken from various substrates associated with Cedar Creek where the mayflies were collected. These slides were observed using a Zeiss Photoscope II.

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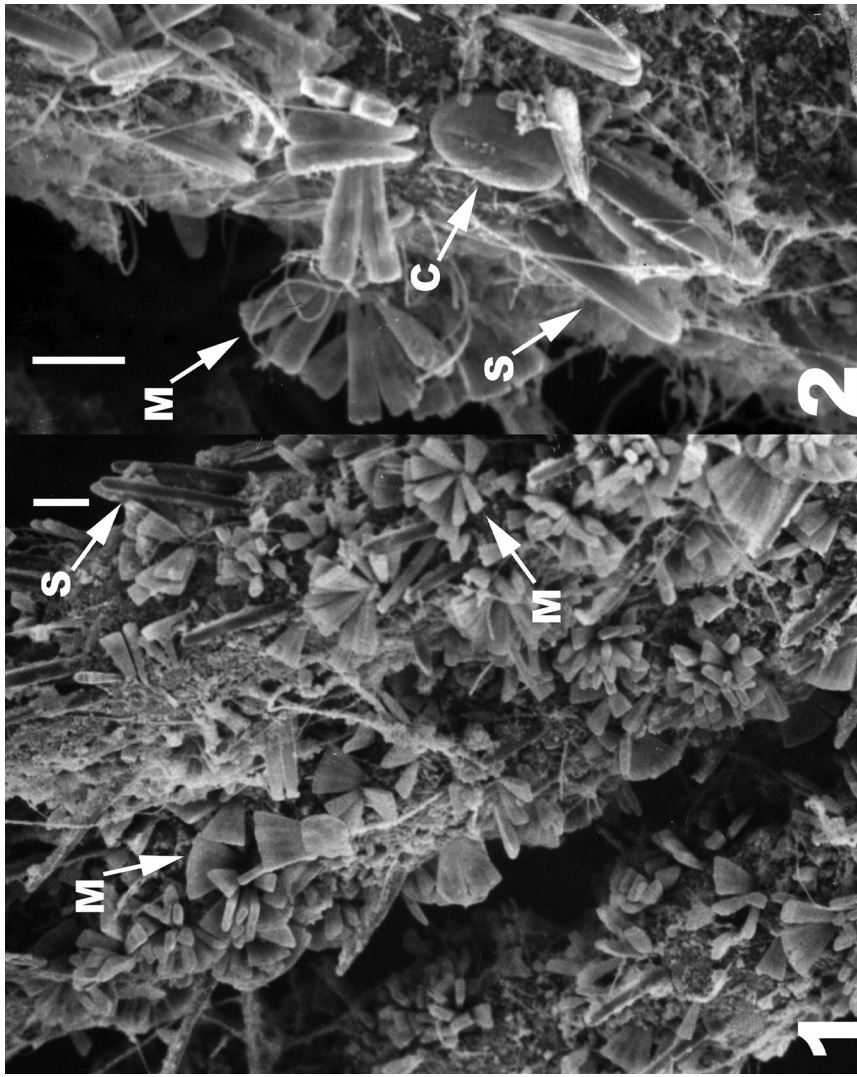

Figure 1. Overview of diatoms on *Caenis amica* naiad cerci showing the epizootic community. Scale bar = 20 µm.

Figure 2. A higher magnification of a *Caenis* naiad cercus with epizooic diatom genera including *Cocconeis pediculus* (C), *Meridion circulare* (M), and *Synedra rumpens* (S). Scale bar = 20 µm.

Results and Discussion

Three species of epizooic diatoms were observed growing abundantly only on the external surfaces of naiad mayfly cerci of *Caenis amica* Hagen, family Caenidae. They included *Cocconeis pediculus* Ehrenberg, *Meridion circulare* (Greville) C. Agardh, and *Synedra rumpens* Kützing (Figs. 1 and 2). By far the most numerous were cells of *M. circulare*. No diatoms were observed on the cerci of members of the family Ephemerellidae.

The genus *Meridion* is instantly recognizable by most phycologists. It is an araphid, pinnate diatom found in both lentic and lotic habitats. Frustules are heteropolar in both valve and girdle views. In valve view, frustules appear clavate with a subcapitate footpole. Size ranges have been reported from 7-80 µm in length and 4-21 µm wide at the widest point. Costae are well developed. The species *M. circulare* has been described as a cosmopolitan taxon, although relatively rare in the tropics. It generally achieves maximal abundance in the spring, the season when the naiads for this study were collected. The species is considered to be alkaliphilous. It was also the most abundant species observed taken from natural substrates samples.

Like *M. circulare*, *Synedra rumpens* is a cosmopolitan tychoplankton-benthic species. It is reported from many freshwater lakes or ponds or slow-moving streams (Patrick and Reimer 1986), most often from waters having a pH above 7.0. It was observed infrequently from the natural substrate samples.

Cocconeis pediculus, like *M. circulare*, is very common and often is quite abundant in lowland streams and rivers. It also occurs in large numbers as an epiphyte in samples scraped from stones or woody debris. Its presence in such samples is probably related to the abundance of filamentous algae such as *Cladophora* at such sites. It favors circumneutral to alkaline water, often with high nutrient concentrations and also is able to tolerate moderate levels of organic pollution. A summary of its autecology can be found in Jahn et al. (2009).

Other diatoms including *Achnanthes lanceolata* (Brébisson) Grunov *A. minutissima* Kützing, *Fragilaria pinnata* Ehr., *Gomphonema olivaceum* (Hornemann) Brébisson, *Staurosirella leptostauron*, var. *dubia* (Grun.) Edlund, and *Planothidium hauckianum* (Grun.) Round and Bakhiyarova were observed as periphyton or epilithon on substrates in the creek. They were not observed as part of the naiad's epizooic flora. All are representatives of oligotrophic to mesotrophic conditions and, as the three species observed on the cerci, considered alkaliphilous (Lowe 1974).

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