

Parthenogenesis in the Mayfly Genus *Baetis* (Ephemeroptera: Baetidae)¹EDWARD A. BERGMAN AND WILLIAM L. HILSENHOFF²

ABSTRACT

Parthenogenesis has been confirmed for 4 species of *Baetis* mayflies by hatching larvae from eggs taken from reared unmated female imagoes. *Baetis macdunnoughi* Ide and *B. hageni* Eaton were thelytokous and obli-

gatory while *B. frondalis* McDunnough and *B. spinosus* McDunnough were deuterotokous and facultative. This represents the 1st demonstrated case of parthenogenesis in North America for the genus *Baetis*.

Parthenogenesis in mayflies from North America was reviewed by McCafferty and Huff (1974) in conjunction with confirmation of parthenogenesis in *Stenonema femoratum* (Say) (Heptageniidae). The most extensive study of parthenogenesis in Ephemeroptera was carried out by Degrange (1960), who demonstrated parthenogenesis in several genera including 4 species of European *Baetis*. In North America, Ide (1930, 1937) reported collecting only females of *Baetis hageni* Eaton (as *parvus* Dodds) and *Baetis macdunnoughi* Ide. McDunnough (1936) suspected parthenogenesis in *Baetis foemina* McDunnough when he could find only females among mature nymphs and imagoes. However, neither Ide nor McDunnough checked for parthenogenesis in the laboratory.

Preliminary parthenogenetic studies on selected species were initiated in 1975 after field collections of *B. macdunnoughi* consistently contained only female nymphs. Female nymphs were brought into the laboratory and placed in rearing pans. Subimagoes were transferred to jars to molt, and ca. 12–24 h following the imaginal molt individual females were held beneath distilled water in a crystallizing dish to voluntarily discharge eggs. Eggs were removed by dissection from individuals that would not oviposit voluntarily. Each dish containing eggs was maintained under continuous light and aerated by a single air stone. Water temperature was recorded daily and distilled water added to replace water lost through evaporation. Newly hatched nymphs were removed daily and counted, and unhatched eggs were counted at the end of the test period. Tests were terminated when hatching ceased for 4 consecutive days.

Results are summarized in Table 1, and represent the 1st confirmed parthenogenesis for *Baetis* in North America. Of 6 species of *Baetis* tested, 4 were parthenogenetic, while 2, *B. vagans* McDunnough and *B. brunneicolor* McDunnough, were not. Attempts to rear nymphs to maturity, principally *B. macdunnoughi*, were unsuccessful, probably due to our inability to provide newly hatched nymphs with a suitable diet.

The incubation period varied with temperature and species (Table 1). At 19°–23°C the mean in-

cupation period was 8.5 days for *B. hageni*, 8.8 for *B. macdunnoughi*, 15.5 for *B. frondalis* and 19.3 for *B. spinosus*, and, in a single test at 13°–15°C, it was 15 days for *B. macdunnoughi*, 19 for *B. hageni*, 31 for *B. frondalis*, and 32 for *B. spinosus*.

Eggs of the 2 nonparthenogenetic species were more adhesive than those of parthenogenetic species, indicating possible differences in oviposition behavior. *Baetis* that exhibited parthenogenesis usually oviposited voluntarily when submerged in water while the 2 nonparthenogenetic species did not. Although voluntary oviposition by virgin females seemed strongly indicative of parthenogenesis, Degrange (1960) found several species of mayflies, including a species of *Baetis*, in which virgin females with parthenogenetic eggs would not oviposit in captivity.

Since nymphs died or were preserved shortly after hatching, the type of parthenogenesis was estimated from field data. Female *B. macdunnoughi* nymphs were collected from several consecutive, exclusively female generations indicating that parthenogenesis is thelytokous and obligatory. Similarly, only female *B. hageni* are known from Wisconsin, with 26 nymphs having been collected from one locality in the spring of 1976. All 50 nymphs of *B. hageni* (as *parvus*) collected by Ide (1930) from Ontario were females. Northern populations of *B. hageni* appear to be thelytokous and obligatory, but male *B. hageni* are known from Illinois and Indiana (Burks 1953) and the eastern United States (Edmunds 1962). The *B. hageni* females from Wisconsin had the distinctive hind wing venation that is characteristic of the species, and nymphs from which they were reared fit the brief description by Burks (1953) of a suspected female nymph. However, the nymphs had a rounded 7th gill, rather than the pointed gill described by Burks for male nymphs of *B. hageni* (as *herodes*) and it is possible that the parthenogenetic northern species is not *B. hageni* but a sibling species. *Baetis spinosus* McDunnough and *B. frondalis* McDunnough in field collections had approximate male to female sex ratios of 1:2 and 1:1, respectively. For these 2 species, parthenogenesis is probably facultative and deuterotokous. Parthenogenesis of these 4 species of *Baetis* is probably not the rudimentary type mentioned by McCafferty and Huff (1974) due to the high percentages of eggs of each species that hatched in the laboratory.

Further study on such questions as genetic mech-

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Table 1.—Collection of mature nymphs of parthenogenetic *Baetis* mayflies for rearing to the imago and results of rearing eggs obtained from imagoes.

| Species | Collection* site | Months collected | No. of females incubated | No. of eggs | % hatched | Temp. (°C) | Incubation period (days) |
|------------------------|---------------------|---------------------------|--------------------------------|----------------|--------------|---------------|--------------------------------|
| <i>B. macdunnoughi</i> | Lawrence Cr. | Apr., May, Aug., Sept. | 9 | 3897 | 95 (87-100) | 19-22 | 8-10 |
| <i>B. macdunnoughi</i> | Lawrence Cr. | May | 1 | 725 | 97 | 13-15 | 15 |
| <i>B. macdunnoughi</i> | Carter Cr. | May, Aug. | 4 | 1988 | 66 (57-98) | 19-21 | 9-10 |
| <i>B. hageni</i> | Jericho Cr. | May | 2 | 1796 | 97 (97-98) | 20-22 | 8-9 |
| <i>B. hageni</i> | Jericho Cr. | May | 1 | 872 | 97 | 13-15 | 19 |
| <i>B. frondalis</i> | Dunlap Cr. | June, Aug. | 4 | 1574 | 36 (18-60) | 19-23 | 14-18 |
| <i>B. frondalis</i> | Dunlap Cr. | June | 1 | 392 | 10 | 13-15 | 31 |
| <i>B. spinosus</i> | Mecan R. | June, Aug. | 4 | 1503 | 41 (12-63) | 19-23 | 19-20 |
| <i>B. spinosus</i> | Mecan R. | June | 1 | 258 | 38 | 13-15 | 32 |

* Lawrence Cr., Marquette Co., Wisconsin T-17-N, R-8-E, S31 at Adams Co. line; Carter Cr., Adams Co., Wisconsin T-19-N, R-7-E, S26 at Highway G; Jericho Cr., Waukesha Co., Wisconsin T-5-N, R-17-E, S25 at Highway 99; Dunlap Cr., Dane Co., Wisconsin 7-9-N, R-6-E, S33 at Highway Y; Mecan R., Marquette Co., Wisconsin T-17-N, R-10-E, S28 at Highway 22.

anisms of parthenogenesis and the effect of parthenogenesis on phenotypic character distribution might best be carried out using *Baetis* due to their high percentage of hatching. *Baetis macdunnoughi* was reared through several instars, and with the proper diet it should be possible to colonize this and other species.

REFERENCES CITED

- Burks, B. D. 1953. The mayflies or Ephemeroptera of Illinois. Bull. Ill. Nat. Hist. Surv. 26: 1-216.
- Degrange, C. 1960. Recherches sur la reproduction des Ephéméroptères. Trav. Lab. Hydrobiol. Piscic. Univ. Grenoble 51: 7-193.
- Edmunds, G. F., Jr. 1962. The type localities of the Ephemeroptera of North America north of Mexico. Univ. Utah Biol. Ser. 2: 1-45.
- Ide, F. P. 1930. Contribution to the biology of Ontario mayflies with descriptions of new species. Can. Entomol. 62: 204-13, 218-31.
1937. Descriptions of eastern North American species of baetine mayflies with particular reference to the nymphal stages. Ibid. 69: 219-31, 235-43.
- McCafferty, W. P., and B. L. Huff. 1974. Parthenogenesis in the mayfly *Stenonema fermoratum* (Say) (Ephemeroptera: Heptageniidae). Entomol. News 85: 76-80.
- McDunnough, J. 1936. A new Arctic baetid (Ephemeroptera). Can. Entomol. 68: 32-34.

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