THE BAETIS LARVAE OF NORTH AMERICA (EPHEMEROPTERA:BAETIDAE)[1]

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INTRODUCTION

The genus *Baetis* Leach, 1815 is one of the largest and most widespread genera of Ephemeroptera. The larvae are generally found in a wide variety of running water habitats throughout the world (excluding oceanic islands and New Zealand). In North America (N.A.), species range from the most extreme southern limits, north into the tundra of Canada where they may be found in ponds or lakes. *Baetis* is often the only mayfly genus represented in marginal habitats of high altitude cold mountain streams (to 13,000 feet).

Baetis larvae are distinguished by the presence of hind wing pads, tarsal claws with a single row of denticles (Fig. 6), and lamellate abdominal gills on segments one or two to seven. Adults are distinguished by fore wings with paired marginal intercalaries and the presence of hind wings.

A dearth of larval studies (including rearings), the use of unreliable characters, and regionally restricted analyses of geographically widespread species have led to serious problems in the species taxonomy of this genus. In general, many species descriptions and redescriptions have been too restrictive, and knowledge of individual and population variability has been incomplete. Early species accounts were based almost exclusively on adults. McDunnough (1921, 1923, 1924, 1925a and b, 1926, 1936, 1938, 1939) described 24 species of which only one was known as larvae. Traver (1935) summarized the known larvae (9 out of 41

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nominal species) in a key to the N.A. species. Previous to our study, the single, most important, larval treatment (Ide, 1937) involved the descriptions of 12 species. Finally, some taxonomy of *Baetis* species have been published as parts of local faunal studies of mayflies, e.g., Traver (1932) for North Carolina, Berner (1950) for Florida, Burks (1953) for Illinois, Leonard and Leonard (1962) for Michigan, and Day (1963) for California. Dodds (1923) described a number of species from Colorado and included larvae, McDunnough (1925b) described a number of species from Quebec, and Bergman and Hilsenhoff (1978b) treated the species of Wisconsin.

Prior to Ide's (1937) work, the most important characters used had been tail ratios, gill shapes and tracheal pigmentation, and color patterns. Ide introduced the labial palpi as a character and noted variation in color patterns. The discovery of more reliable taxonomic characters and methods for studying these were developed by Müller-Liebenau and formed the basis of her revision of the European *Baetis* fauna (Müller-Liebenau, 1969). Our adaptations of Müller-Liebenau's methodology as applied to widespread geographic populations in N.A., has revealed intraspecific variation and provided means for identifying larvae.

Table 1 summarizes the presently known species composition of the genus *Baetis* in N.A. north of Mexico as revised herein. Of the 39 nominal species listed, 21 are known as larvae (L). The ♂ and ♀ symbols pertain to the adult stage.

Distributional abbreviations are as follows: C = central, E = eastern, N = northern, Pan = pandemic, S = southern, and W = western. Most of the group names listed in the last column of the table were originally proposed by Müller-Liebenau (1969) as they applied to the European *Baetis* fauna. The bases of these groupings will be discussed below.

All species known as larvae are treated in the species accounts. Two nominally associated larvae are described for the first time. Also, three species designated as A, B, and C are newly described but remain unnamed since they are not associated with adults. In time, these distinctive larvae may prove to represent new species or other species which are still unknown as larvae.

The material upon which this study is based was provided by the

following institutions (abbreviations are given as they are referred to hereafter): ANSP — Academy of Natural Sciences of Philadelphia. CAS — California Academy of Sciences. CNC — Canadian National Collection. CSU — California State University at Los Angeles. CU — Cornell University. FAM — Florida A and M University. INHS — Illinois Natural History Survey. MCZ — Harvard Museum of Comparative Zoology. MPIL — Max-Planck-Institut für Limnologie. PU — Purdue University. ROM — Royal Ontario Museum. UF — University of Florida. UM — University of Michigan. US — University of Saskatchewan. USNM — U.S. National Museum. UU — University of Utah. UW — University of Wisconsin. VPI — Virginia Polytechnic Institute and State University.

In the material examined, states are given U.S. Postal Zip Code abbreviations and Canadian provinces are abbreviated as follows: ALTA = Alberta, BC = British Columbia, MAN = Manitoba, NS = Nova Scotia, NWT = Northwest Territories, ONT = Ontario, QUE = Quebec, and SAS = Saskatchewan.

Larval Characters

Body Length. — This is a measurement from the front of the head to the apex of the abdomen proper (excluding antennae and caudal filaments). Since intraspecific variation in size occurs between generations and geographically widespread populations, differences in this character, especially minor ones, are of limited diagnostic value.

Coloration. — Some of the most obvious and recurrent color pattern variations are related to the placement of apodemes (muscle insertions) along the dorsum of the body and are especially apparent in the disproportionate expansions of lines and points along the anterior margins of abdominal terga (Müller-Liebenau, 1969 and 1973). Caudal filaments may be uniformly shaded (Fig. 35a, b), or may possess a thick dark band at about their midlength (Figs. 24e, 25e, 27e, 30f, 31b, 32g).

Color may vary greatly within populations, and more than one species may express a single pattern. On the other hand, color pattern may be the only reliable character for separating larvae of a few closely related species (Figs. 24e, 25e).

ARMATURE. — Setae, scales, and spines are important in the comparative morphology of *Baetis*. Three types of setae are distinguished. *Fine setae* (Figs. 16a and f, 22d) are hairlike or bristlelike in appearance, and are scattered over the entire exoskeleton. Under light microscopy these setae appear to be simple and apically acute or blunt. S.E.M. examinations reveal some of these setae to be distinctly clubbed apically (Fig. 7), and these differences may eventually prove to be phyletically important. *Robust setae* (Fig. 3, 15d) vary greatly in placement and numbers, especially on the legs. Their occurrence on other parts of the body is diagnostic for some species (e.g., Figs. 19g, 20f, 37a). *Specialized setae* (e.g., Figs. 14b and d, 23a) may vary in number intraspecifically, but are diagnostic with respect to form and placement on body parts. They will be discussed in detail below. *Scales* (Fig. 18f) are flattened, triangular projections, often found on the abdominal surfaces and less frequently on the thorax, legs, head, and antennae. Their presence (or absence) (Fig. 15e) is diagnostic of species groups. Scale bases are frequently seen without scales (Figs. 8, 19e). They are either crescent-shaped (Fig. 19e) or angulate (Fig. 8), and are characteristic of species groups. *Spines* (Figs. 12, 19f, 33h) are unsocketed outgrowths. Their general shape and location are only sometimes diagnostic of species groups.

ANTENNAE. — Both the occurrence of robust setae on the pedicels and a distal lobe on the scapes are useful in characterizing species groups. The presence or absence of spines on the pedicel (Fig. 2), although indicative of species relationships, are difficult to observe.

LABRUM. — Differences in the numbers of specialized dorsal setae often provide specific characters and are denoted in the descriptions by the labral formula (1 + a); where 1 = submedial seta (Fig. 20a), and a = submarginal setae (Fig. 23a). This formula refers only to the right or left half of the labrum and all figures are of the right dorsal half. A range in the number of setae is indicated by a hyphen.

MANDIBLES. — The incisors are described by the mandibular formulae (a + b) or (a + 1 + b); where a = number of denticles present in the distal group of denticles (usually 3 or 4) and may in-

clude an additional, distal, much shortened denticle (Fig. 24b) [indicated as a(1)], and b = the number of denticles present in the basal set of denticles (usually 3 or 4). A "1" appearing between a and b indicates the presence of a small denticle between the basal and distal sets (Fig. 17a). Although useful for distinguishing species groups, problems sometimes arise in determining the number of denticles since they may be worn down. The prosthecae are the appendages (Fig. 34b) arising near the base of the incisors. The unusual condition of the right prostheca of *B. hageni* is diagnostic of this species.

MAXILLARY PALPI. — These are either simple and extend as far distally as the fused galea-lacinia (Fig. 16b), or are subapically excavated and relatively lengthened (Fig. 27b). These character states distinguish species groups.

LABIAL PALPI. — The numbers of dorsal setae of segment two are given in each species description. Figures (e.g., 27c, 30d, 34d) are of the second and third segments. Fine setae, pores, and robust setae are of little comparative use. Palpal shape is important in the delineation of species groups and sometimes species.

PARAGLOSSAE. — The shapes of the paraglossae are useful and range from small and slender (Fig. 25d) to large and broad (Fig. 30e). Previously, only three rows of subapical paraglossal setae had been recognized (Müller-Liebenau, 1973); however, we have found additional rows in our species A and B (Figs. 19b, 20c). Only subapical rows of setal bases are drawn in the figures of the apical third of the right paraglossa. S.E.M. examinations indicated that most of the glossal and paraglossal setae are pectinate (Fig. 4), and the degree of pectination may vary between species.

LEGS. — The occurrence of large setae (fine setae are generally excluded in our descriptions) on the dorsal margins of the femora (e.g., Figs. 13d, 15c), tibia (e.g., Figs. 14d, 16f), and tarsus can be diagnostic for both species groups and species.

TERGAL SURFACES. — Figures (e.g., 15e, 18f) are of the mid-posterior margin of a middle abdominal tergum. The occurrence of scales and scale bases (Fig. 19e) and the shape of the posterior spines (Fig. 33h) are only occasionally characteristic of some species groups. Numbers of scales and shapes of spines on terga are highly variable even from different terga of the same in-

dividual. Under light microscopy the posterior spines appear socketed; however, S.E.M. examinations have indicated that they are not socketed.

PARAPROCTS. — These paired sternites are situated directly posterior to the ninth sternum (Figs. 9, 10, 11) and generally reflect the condition of the tergal surfaces.

GILLS. — Some taxonomic treatments (Ide, 1937 and Burks, 1953) have relied heavily on the degree of pigmentation of the gill tracheae. We have found this to vary intraspecifically in all cases. The absence of gill 1; general gill shape, and marginal armature are sometimes species specific.

CAUDAL FILAMENTS. — The length of the median terminal filament relative to the cerci (Figs. 17f) appears to be diagnostic for some species. We have found this character to be variable in *B. tricaudatus*, and this may eventually prove to be the case for other species as well.

NORTH AMERICAN SPECIES GROUPS

Many N.A. species of *Baetis* can be placed within clusters of interrelated species. Since some of these clusters correspond to the species groups proposed by Müller-Liebenau (1969) for European *Baetis*, we have adopted her names when applicable. In all cases the study of N.A. species has allowed us to expand or elaborate on the concept of these groups. We regard these names as a convenience for discussing relationships, and do not necessarily regard them as having any nomenclatural status. Many species cannot be placed with any group (see Table 1) because their relationships are unclear or they are relatively unique. Species unknown as larvae are grouped tentatively on the basis of hind wing and genitalic similarities (see Müller-Liebenau, 1969).

The *B. lapponicus* group is distinguished as larvae by reduced labial palpi (Figs. 13b, 14b, 15a), two tails, an absence of scales and scale bases on the abdomen, and poorly developed marginal spines of the abdominal terga (Fig. 15e). We include the N.A. species, *B. amplus, frivolus, insignificans,* and *lapponicus* in this group. We have also found this group to be closely related to at least some N.A. species of the genus *Pseudocloeon* and to the genus

TABLE 1. — Summary of *Baetis* of North America north of Mexico (see text for further explanation).

Species	Known Life Stages	General Distribution	Related Species or Group
adonis Traver	♂,♀	W	*rhodani* grp.
akataleptos McDunnough	♂	NW	*pygmaeus*
alius Day	♂, L	W	?
amplus (Traver)	♂,♀,L	E	*lapponicus* grp.
bicaudatus Dodds	♀,L	W	*rhodani* grp.
brunneicolor McDunnough	♂,♀,L	E	*vernus* grp.
caurinus Edmunds and Allen	♂	NW	*fuscatus* grp.
dardanus McDunnough	♂	W	*propinquus* grp.
devinctus Traver	♂,♀	CW	?
diablus Day	♂	W	?
ephippiatus Traver	♂,L	SE	*propinquus* grp.
flavistriga McDunnough	♂,♀,L	E	*fuscatus* grp.
foemina McDunnough	♀,L	N	*rhodani* grp.
frivolus McDunnough	♂,♀	E	*lapponicus* grp.
frondalis McDunnough	♂,L	E	*propinquus* grp.
hageni Eaton	♂,♀,L	Pan	*muticus* grp.
harti McDunnough	♂	E	*pygmaeus*
hudsonicus Ide	L	N	*vernus* grp.
insignificans McDunnough	♂,♀,L*	W	*lapponicus* grp.
intercalaris McDunnough	♂,♀,L	E	*fuscatus* grp.
lapponicus Bengtsson	♂,♀,L	N	*lapponicus* grp.
longipalpus Morihara and McCafferty	♂,♀,L	C	*propinquus* grp.
macani bundyae Lehmkuhl	♂,L	N	*vernus* grp.
macdunnoughi Ide	♀,L	CE	*pygmaeus*
moffati Dodds	♂,♀	SW	*rhodani* grp.
ochris Burks	♂	C	*fuscatus* grp.
palisadi Mayo	♂,♀	SW	*rhodani* grp.
parallelus Banks	♂	SW	*rhodani* grp.
persecutus McDunnough	♂,♀	NW	*rhodani* grp.
piscatoris Traver	♂,♀	NW	*rhodani* grp.
pluto McDunnough	♂,♀,L	E	?
posticatus (Say)	♂	E	?
propinquus (Walsh)	♂,♀,L	E	*propinquus* grp.
pygmaeus (Hagen)	♂,♀,L	E	*macdunnoughi*
quilleri Dodds	♂,♀,L*	W	?
rusticans McDunnough	♂,♀	NE	*fuscatus* grp.
sulfurosus Day	♂	W	*thermophilos*
thermophilos McDunnough	♂	SW	*sulfurosus*
tricaudatus Dodds	♂,♀,L	Pan	*rhodani* grp.
sp. A	L*	SW	*rhodani* grp.
sp. B.	L*	SW	*rhodani* grp.
sp. C.	L*	SW	*fuscatus* grp.

* Larvae previously unknown

Heterocloeon.

The *B. rhodani* group is distinguished as larvae by the presence of robust setae on the antennal scapes and pedicels (Figs. 3, 18a) and on the paraprocts (Figs. 11, 19f). The N.A. species, *B. adonis, bicaudatus, foemina, moffati, palisadi, parallelus, persecutus, piscatoris, tricaudatus,* species A, and species B fall within this group.

The *B. vernus* group is distinguished as larvae by relatively uniform setal arrangements on the legs (Figs. 21d, 22c, 23d), similarly shaped labial palpi (Figs. 21b, 22a, 23b), and the absence of robust setae on the antennal scapes and pedicels, and paraprocts. We include the N.A. species, *B. brunneicolor, hudsonicus,* and *macani* in this group.

The *B. fuscatus* group is distinguished as larvae by short, broad labial palpi (Figs. 24c, 25c, 26c), reduced paraglossae (Fig. 25d), and similar pronotal color patterns (Figs. 24e, 25e, 26d). We include the N.A. species, *B. caurinus, flavistriga, intercalaris, ochris, rusticans,* and species C in this group.

The *B. propinquus* group (after Morihara and McCafferty, 1979b) is distinguished as larvae by a distal lobe on the antennal pedicels (Figs. 27a, 29a, 30a) and an indentation on the maxillary palpi (Figs. 27b, 30c). The N.A. species, *B. dardanus, ephippiatus, frondalis, longipalpus,* and *propinquus* are included in this group (Morihara and McCafferty, 1979b).

The N.A. species, *B. hageni,* is tentatively placed in the *muticus* group of Müller-Liebenau (1974) on the basis of its right prostheca which is reduced to two slender pectinate appendages (Fig. 34b). It also may be related to other species in which gills are absent on the first abdominal segment.

Key To The Baetis Larvae of N.A.

The following key is most reliable in identifying mature and recently collected individuals. Slide preparation of body parts (cast exuviae are recommended) may be required. Identification should be confirmed by reference to the discussions under individual species accounts.

1 Gills on abdominal segments 2-7; (Figs. 34 and 35) ..... *B. hageni*
Gills on abdominal segments 1-7 2

2(1) Median terminal filament reduced to stub of 5 segments or less, often barely visible and inconspicuous, less than 0.1 length of cerci (Fig. 17f) 3
Median terminal filament with more than 5 segments, usually 0.2-0.9 length of cerci, (Figs. 24e, 25e, 27e, 30f, 31b, 32g) 7

3(2) Dorsum of femora, tibiae, and tarsi with dense row of long fine setae (Fig. 14d) ..... *B. insignificans*
Dorsum of femora, tibiae, and tarsi without dense row of long fine setae, tibiae and tarsi nearly bare dorsally (Figs. 13c, 15b, 17d, 19c, 20d, 21d, 23d, 36e, 37d) 4

4(3) Labial palpi with median lobe of segment 2 poorly developed (Fig. 13b); gill margins smooth; tergal surfaces without scales and scale bases (Fig. 15e) 5
Labial palpi with median lobe of segment 2 moderately developed (Figs. 17b, 18b); gill margins serrate (Fig. 12); tergal surfaces with scales and scale bases (Fig. 18f) 6

5(4) Labial palpi (Fig. 15a) with segments 1 and 2 nearly parallel sided (from dorsoventral perspective), inner margin of segment 2 almost straight (Fig. 15a); eastern U.S. ..... *B. amplus*
Labial palpi (Fig. 13b) with inner margins of segments 1 and 2 forming broadly rounded lobes (from dorsoventral perspective), inner margin of segment 2 decurved; Canadian tundra ..... *B. lapponicus*

6(4) Gills not elongate, less than twice as long as wide (Fig. 17g); widespread western N.A. ..... *B. bicaudatus*
Gills elongate, more than twice as long as wide (Fig. 18e); Canadian tundra ..... *B. foemina*

7(2) Gills on abdominal segment 7 slender, apically acute (Figs. 31f, 32g); segment 2 of labial palpi with median lobe thumblike, projecting anteriorly (Figs. 31a, 32c) 8
Gills on abdominal segment 7 apically rounded (Fig. 16g) or at most broadly pointed (Fig. 21g); segment 2 of labial palpi variously produced but not forming thumblike projection (Figs. 16c, 21b, 28b) 9

8(7) Gills on abdominal segment 7 asymmetrically teardrop shaped (Fig. 32g), anterior margin smooth, posterior margin serrate ..... *B. pygmaeus*
Gills on abdominal segment 7 symmetrical (Fig. 31f), both anterior and posterior margins serrate ..... *B. macdunnoughi*

9(7) Antennal scapes with distal lobe (Figs. 27a, 29a, 30a); maxillary palpi with subapical excavation (Figs. 27b, 30c) 10
Antennal scapes simple, without distal lobe (Fig. 26a); maxillary palpi without subapical excavation (Fig. 16b) 13

10(9) Labial palpi with median lobe of segment 2 poorly developed (Fig. 27c); labrum dorsally covered with setae, more numerous near anterior margin (Fig. 27b) ..... *B. longipalpus*

Labial palpi with median lobe of segment 2 well developed, subequal in size to segment 3 (Figs. 28b, 29c, 30d); labrum with dorsal submarginal setae distinct in form and arrangement from other setae (Figs. 28a, 29b, 30b) 11

11(10) Labrum with submarginal setae slender and unbranched, reduced in number, often paired (Fig. 30b) ..... *B. propinquus*

Labrum with submarginal setae either branched or somewhat spatulate 12

12(11) Labrum with submarginal setae branched (Fig. 28a) ..... *B. ephippiatus*

Labrum with submarginal setae spatulate, often fringed apically (Fig. 29b) ..... *B. frondalis*

13(10) Gills elongate (Figs. 22e, 23f), more than twice as long as wide; Canadian tundra only 14

Gills not elongate (Figs. 16g, 17g) equal to or less than twice as long as wide; not restricted to tundra 15

14(13) Median terminal filament almost equal in length to cerci ..... *B. hudsonicus*

Median terminal filament 0.5-0.8 length of cerci ..... *B. macani bundyae*

15(13) Mandibles with tuft of setae between prosthecae and molars (as in Fig. 32b) ..... *B. quilleri*

Mandibles without tuft of setae between prosthecae and molars 16

16(15) Gill margins with large robust setae (Figs. 19g, 20g) 23

Gill margins serrate, without large robust setae (Fig. 12) 17

17(16) Caudal filaments with dark band near middle (Figs. 24e, 25e) 18

Caudal filaments uniformly shaded or at most only gradually changing (Figs. 35a and b) 20

18(17) Labial palpi slender, segment 2 more than twice as long as width of base of segment 3 (Fig. 36c) ..... *B. pluto*

Labial palpi broad, segment 2 less than twice as long as width of base of segment 3 (Figs. 24c, 25c) 19

19(18) Darker well marked abdominal terga with 2 large submedian pale areas often kidney shaped (Fig. 25e) ..... *B. flavistriga*

Darker well marked abdominal terga with 3 posterior round pale areas, middle spot often smaller than laterals (Fig. 24e) ..... *B. intercalaris*

20(17) Labial palpi with inner margin of segment 2 convex (Fig. 33c) ..... *B. alius*

Labial palpi with inner margin of segment 2 concave (Figs. 16c, 21b, 26c) 21

21(20) Pronotum with 2 submedian dark bilobed marks (Fig. 16d); abdominal sterna with robust setae ..... *B. tricaudatus*

Pronotum without dark bilobed marks; abdominal sterna without robust setae 22

22(21) Labial palpi slender, moderately developed median lobe of segment 2 (Fig. 21b); pronotum almost uniformly shaded ..... *B. brunneicolor*

Labial palpi broad, median lobe of segment 2 poorly developed (Fig. 26c); pronotum with submedian dark inverted "U" shaped marks (as in Fig. 24e) ..... *B.* sp. C

23(16) Posterior margins of terga with robust setae (Fig. 20f); paraglossae with 5 rows of subapical setae (Fig. 20c); gill margins smooth (Fig. 20g) ..... *B.* sp. A

Posterior margins of terga without robust setae (Fig. 19e); paraglossae with 3-4 rows of subapical setae (Fig. 19b); gill margins serrate (Fig. 19g) ..... *B.* sp. B

Species Accounts

Baetis lapponicus (Bengtsson) (Fig. 13)

Acentrella lapponica Bengtsson, 1912:110.
Baetis lapponicus (Bengtsson): Müller-Liebenau, 1969:81.

Body Length. — 4-6 mm.

Head. — Antennae: scape and pedicel with scattered fine setae. Labrum (Fig. 13a): 1 + 4-6 setae. Right Mandible: 3 + 4 denticles; innermost denticle divided basally. Left Mandible: 3 + 4 denticles; innermost denticle divided basally. Maxillary Palpi: short and robust, extending almost as far as galea-lacinia. Labial Palpi (Fig. 13b): compact; segment 2 with median lobe weakly developed and 3-5 dorsal setae. Paraglossae: innermost setal row with approximately 9 setae.

Thorax. — Legs (Fig. 13c): strong dorsal setae on femur (Fig. 13d) and tibia; short sharp setae on venter of femur and tibia, longer on tarsus; claws with 10-15 denticles and subapical pair of fine setae.

Abdomen. — Dorsal color pattern indistinct with submedian dark dots on most terga. Tergal surfaces: with fine setae and pores; posterior margins with fine setae, and with spines irregular in shape and spacing. Paraprocts (Fig. 13e): surface with pores, fine setae, and small spines; posteromedial margins with spines poorly developed. Gills: rounded posteriorly, nearly symmetrical (Fig. 13f); margins smooth with occasional fine setae. Caudal Filaments: unbanded; medium terminal filament minute, reduced to about 3 segments.

Discussions. — In addition to the *lapponicus* group characteristics, *B. lapponicus* in N.A. may be distinguished by the robust dorsal setae (relative to the dorsal setae in other *lapponicus* group larvae) of the femora and tibiae. This species was originally described by Bengtsson (1912) from specimens collected from northern Sweden (approximately 68°N). The N.A. material is represented by a single series collected from the Canadian tundra

on the south coast of Baffin Island (approximately 63°N). Although the identification of these N.A. specimens (McDunnough, 1936:33) was confirmed by Bengtsson, we regard the status of *B. lapponicus* in N.A. as tentative because of slight differences in larval morphological structure. In N.A. the large dorsal setae of the femora and tibiae are more robust and shorter than those in the European forms [see Müller-Liebenau (1969) for a detailed account of *B. lapponicus* in Europe].

B. lapponicus in northern Swedish Lapland was reported to occur on a wide variety of substrates. However, it was frequently abundant on unstable, almost bare stones. Its rather flattened body form is similar to that of the sprawling mayflies and may be an adaptation to this kind of environment (Ulfstrand et al., 1971).

Material Examined. — 30 L in alcohol and 1 slide mount: NWT: Lake Harbour, Baffin Island, VIII-5-1935 (CNC). 2 L on slides: Swed., Lapland (MPIL).

Baetis insignificans McDunnough
(Fig. 14)

Baetis insignificans McDunnough, 1926:300; Traver, 1935:692.

Body Length. — 4-6 mm.

Head. — Antennae: scape and pedicel with few scattered fine setae. Labrum: 1 + 5-7 setae. Right Mandible:3(1) + 4 denticles; incisors with basal spines. Left Mandible: 3(1) + 1 + 3 denticles; incisors with basal spines; primary denticle of molars elongate, almost parallel sided (Fig. 14a). Maxillary Palpi: extending approximately as far as galea-lacinia. Labial Palpi (Fig. 14b): compact; segment 2 with 2-5 dorsal setae. Paraglossae (Fig. 14c): innermost setal row with 7-9 pectinate setae.

Thorax. — Legs (Fig. 14d): dorsum of femur, tibia, and tarsus with dense row of long fine setae; venter of femur, tibia, and tarsus with shorter setae; claws with 8-10 denticles and no subapical setae.

Abdomen. — Dorsal color patterns distinct (Fig. 14e), similar on most terga. Tergal Surfaces: with fine setae; posterior margins with blunt triangular spines (irregular in shape and spacing) or with spines partially absent. Paraprocts: surfaces with numerous pores and fine setae. Gills: rounded posteriorly; margins smooth, with fine setae. Caudal Filaments: cerci unbanded; median terminal filament minute, 1 segmented.

Discussion. — The above represents the first larval description of *B. insignificans*. The distinct dorsal abdominal color pattern

(Fig. 14e) of this two-tailed species simplifies identification. This pattern is similar to the unrelated *B.* sp. C, but the latter is three-tailed. *B. insignificans* appears to be most closely related to *B. lapponicus;* these two allopatric species can be morphologically distinguished on the basis of the dorsal setae of the legs which are more slender in *B. insignificans.*

B. insignificans is probably the most common of the *lapponicus* group in N.A. It is known throughout the West as far north as British Columbia and Alberta and south into Arizona and New Mexico. The easternmost populations we have examined are from southwestern South Dakota.

This species appears to be bivoltine at least in the northern portion of its range with adults emerging in June-July and September.

Material Examined. — PARATYPES: 2 ♂♂, *Baetis insignificans* McDunnough, genitalia on slide No. 2349 (Seton Lake Cr, Lillooet, B.C., June 27, 28, J. McDunnough)(CNC).

Slide Mounts: AZ: 1 L, Coconino Co, 2 mi N Sedona, Edmumds, Edmunds (UU); 3 L, Fort Apache Co, White R, VII-6-1969, Koss, et al (PU); 3 L, Maricopa Co, Verde R, V-7-1969, Koss, Provonsha (PU); 5 L, Yavapai Co, Verde R, V-6-1969, Koss, Provonsha (PU); 1 L ♂ reared, Yavapai Co, Verde R above Clarksdale off Hwy 89a, V-10-1969, Koss, Provonsha (PU); CA: 4 L, Los Angeles Co, San Gabriel R, VIII-30-1965, Vann (CSU); 1 L, Tuolumne R, V-8-1955, Day (CAS); NM: 1 L, San Juan Co, San Juan R downstream from Shiprock, VII-5-1969, Koss et al (PU); 1 L, Mora Co, Mora R, VII-1-1964, Allen (CSU).

Specimens in Alcohol: 316 L, 25 ♂♂: ALTA (CNC); AZ (PU, UT); CA (CAS, CSU, PU); CO (PU); ID (PU); NM (CSU, PU); OR (CSU); SD (PU); UT (PU, UU); WA (PU, CAS).

S.E.M. Preparation: NM: 1 L, Grant Co, 1 mi S of Cliff trib of Gila R, VII-14-1967, Koss, Koss (PU).

Baetis amplus (Traver)
(Fig. 15)

Acentrella ampla Traver, 1932:233.
Baetis amplus (Traver): Traver, 1935:681.

Body Length. — 6-9 mm.

Head. — Antennae: scape and pedicel with scattered fine setae. Labrum: evenly rounded laterally, 1 + 5-10 setae. Right Mandible: 3(1) + 4 denticles; spines at base of incisors. Left Mandible: 3 + 3 denticles; basal denticle of incisors sometimes divided. Maxillary Palpi: robust; extending as far as galea-lacinia. Labial Palpi (Fig. 15a): compact; 3-5 dorsal setae on segment 2. Paraglossae: innermost setal row with 4-8 setae.

Thorax. — Pronotal color patterns sometimes distinct with 3-4 diagonal dark streaks. Legs (Fig. 15b): dorsum of femur with long sharp setae (Fig. 15c) often blunted due to breakage; venter of femur with blunt robust setae and numerous minute conical scale-like structures; tibia and tarsus almost bare dorsally except for fine setae and very small robust setae (Fig. 15d), venter of both segments with similar, short robust setae; claws with 9-14 denticles and no subapical setae.

Abdomen. — Dorsal color pattern indistinct, with terga 1-9 each usually with 2 pairs of dark submedial dots; tergum 10 paler. Tergal surfaces: with fine setae only; posterior margins with blunt spines (Fig. 15e). Paraprocts: surface with numerous pores and fine setae. Gills: posteriorly rounded; margins smooth with fine setae. Caudal Filaments: unbanded; median terminal filament reduced to 3-5 segmented stub.

Discussion. — *B. amplus* may be confused with the two-tailed larvae of *B. bicaudatus* or the other two-tailed larvae of the *lapponicus* group. It can be separated from *B. bicaudatus* by the shape of the labial palpi (Fig. 15a), the pronotal color pattern in well marked individuals, and the absence of scales. *B. amplus* belongs to the *lapponicus* group and can be distinguished by the long dorsal setae on the legs which are less dense than those occurring on other members of this group (Figs. 14d, 15b).

The unique form of the labial palpi of *B. amplus* and *Heterocloeon* (McCafferty and Provonsha, 1975) suggests a common ancestor which only recently diverged from the *lapponicus* group. The second and third segments of the *amplus-Heterocloeon* species' labial palpi are parallel sided from a dorsoventral perspective. The relatively restricted N.A. distributions of *B. amplus* and *Heterocloeon* would seem to corroborate this hypothesis of recent divergence and subsequent speciation of this group. In fact, the combined records of these species yield a distribution confined to eastern N.A. from Tennessee to Georgia north to Ontario and Quebec. *B. amplus* is widespread in the southern half of this area.

Material Examined. — Slide Mounts: GA: 1 L, Tallulah Falls at Tallulah Power House, IV-21-1931, Fattig (CU); IN: 1 L, Monroe

Co, Bryant Cr above Bryant Lake, Monroe-Morgan St Forest, III-12-1975, Provonsha, Harris (PU); 1 L ♂reared, same locale as preceding, IV-11-1975, Provonsha, Dersch (PU); 5 L (2 ♂♂ reared), Morgan Co, Bryant Cr above Bryant Lake, Monroe-Morgan St Forest, IV-11-1975, Provonsha, Dersch (PU); NC: 1 L, Big Alamance Cr, II-20-1930 (CU); OH: 4 L, Clermont Co, stream off Rt 133, 1/2 mi N Rt 52, III-27-1974, Flint (USNM); TN; 3 L, Cumberland Co, UF Cat. No. 4-1756-2, L. Berner No. 3792.1 (UF); VA: 1 L, Hanover, Co, South Anna R. II-25-1978, Kondratieff (VPI).

Specimens in Alcohol: 76 L and 2 ♂♂: IN (PU); NC (CU); TN (UF); VA (VPI).

Baetis tricaudatus Dodds
(Figs. 5, 11, 12, 16)

Baetis tricaudatus Dodds, 1923:111.
Baetis intermedius Dodds, 1923:110. NEW SYNONYM.
Baetis incertans McDunnough, 1925b:220; Traver, 1937:73.
Baetis vagans McDunnough, 1925b:219; Ide, 1937:221; Burks, 1953:131; Leonard and Leonard, 1962:85; Bergman and Hilsenoff, 1978b:133 NEW SYNONYM.
Baetis rusticans, Ide, 1937:223 (misidentification of larva).

Body Length. — 5-8 mm.

Head. — Antennae: pedicel with scattered fine setae, pores, and robust setae. Labrum (Fig. 16a): 1 + 3-8 setae. Right Mandible: 3 + 4 denticles; several spines at base of incisors (often absent in worn incisors). Left Mandible: 3 + 1 + 3 denticles; innermost denticle often divided. Maxillary Palpi: extending as far as galea-lacinia (Fig. 16b); apex asymmetrical with small short apical projection. Labial Palpi (Fig. 16c): median lobe of segment 2 moderate with 3-6 dorsal setae and sometimes 1 or 2 short robust setae. Paraglossae: innermost setal row with approximately 8 setae.

Thorax. — Pronotum usually with 2 distinct submedial dark bilobed marks (Fig. 16d). Legs: femur with basal lateral area extending longitudinally, forming "J" shaped pale area; surface composed of ridges with small spines (Fig. 5); dorsal setae of femur as in Fig. 16e; tarsus and tibia with ventral setae longer than dorsal setae, tibia often with few long setae on dorsum (Fig. 16f); claws with 9-11 denticles and occasionally with 1 pair of subapical fine setae.

Abdomen. — Dorsal abdominal color pattern sometimes distinct, terga 5, 9, and 10 paler than others, darker terga sometimes with submedian dark dots and indistinct pale median areas (Fig. 16d). Tergal Surfaces: with scales, crescent-shaped scale bases, and fine setae; posterior margins with triangular spines and fine setae. Paraprocts: surfaces with pores, fine and robust setae. Gills: rounded posteriorly,

not elongate (Fig. 16g); margins serrate with fine setae (Fig. 12). Caudal Filaments: unbanded; median terminal filament extremely variable in length, 0.1—0.8 length of cerci.

Discussion. — *B. tricaudatus* larvae can usually be identified by the dark bilobed submedian dark marks on the pronotum and the three unbanded tails. It is most closely related to *B. bicaudatus, B.* sp. A and *B. foemina* within the *rhodani* group. It differs from these species respectively by the following characteristics: 1) three unbanded tails of which the median terminal filament may be much shorter than the cerci but not less than one-tenth of the cercal lengths; 2) gill margins which are serrate with fine setae (Fig. 12); and 3) gills that are not elongate, viz. the length being less than twice the width (Fig. 16g).

We herein place *B. vagans* as a junior synonym of *B. tricaudatus,* and consider it generally as representative of a smaller eastern form of the species. This conclusion is based on examinations of: 1) the type material of both names, 2) extensive analysis of larval characters, and 3) S.E.M. preparations of specimens from widely scattered populations. No characters were found which consistently distinguish either adults or larvae.

B. intermedius was described by Dodds (1923) on the basis of a short median terminal filament and a restricted habitat relating to current velocity. The following similarities between short and long filament individuals have been found: 1) emergence dates (Dodds, 1923); 2) distributions (the long filament form, however, is more abundant and widespread); and 3) all morphological structures in both adults and larvae (except for the median terminal filament). The occasional extreme variation in the length of the median terminal filament among individuals of single populations negates the validity of this character as a specific criterion in this instance.

Ide (1937) incorrectly associated a form of *B. tricaudatus* with an adult of the *fuscatus* group (*B. rusticans*). This particular form, which was only tentatively identified by Ide because it was not reared, was separated from *B. tricaudatus* (as *B. vagans*) on the basis of the two previously discussed variable characters: size and the length of the median terminal filament.

B. tricaudatus is the most widespread *Baetis* species in N.A. It ranges north from Alaska and Quebec south to Arizona, New Mex-

ico, Tennessee, and North Carolina. It appears to be absent from the extreme southeast, from Texas to South Carolina. In mid-temperate latitudes, this mayfly is bivoltine and individuals of the second generation are smaller in size (Ide, 1937).

The larvae seem to prefer rapids and can be found most often clinging to stones.

Material Examined. — HOLOTYPE: ♂, *Baetis vagans* McDunnough, Covey Hill, QUE. 17-VI-1924, No. 1262, C.H. Curran, genitalia on slide (CNC). HOLOTYPE: ♂, *Baetis incertans* McDunnough, Covey Hill, QUE. 2-VII-1924, G.S. Walley (CNC); PARATYPES: 15 ♂♂, *Baetis vagans* McDunnough, 2 genitalia on slides, No. 1262, 24-VI-1924 (CNC). PARATYPES: 2 L, *Baetis tricaudatus* Dodds, head, Bae 3 (CNC), Type No. 9032 (ANSP).

Slide Mounts: ALTA: 1 L, Crows Nest Pass, Glacier Cr, VII-13-1930, Pepper (CNC); 1 L, Old Man R below traffic Lethbridge, V-27-1930, Pepper (CNC); AZ: 1 L, Gila Co, Tonto Cr at Kohl's Ranch, VII-19-1970, Allen (PU); 1 L, Navajo Co, Ft Apache Ind Res N Frk White R, (78° F) at White R, VII-5-1964, Allen (CSU); 1 L, Yavapai Co, Beaver Cr, VII-7-1964, Allen (CSU); 1 L, Yavapai Co, Verde R above Clarksdale off Hwy 89, IV-9-1968, Koss, Baumann (PU); 1 L, Yavapai Co, Verde R above Clarksdale off Hwy 89a, V-6-1969, Koss, Provonsha (PU); BC: 1 L, Cranbrook, IX-2-1930, Pepper (CNC); 6 L, Jesmond, VIII-27, 31-1938, IX-8-1938, VIII-4, 21, 25-1937, Jacob (CNC); 1 L, Peachland, Trepanier Cr, VII-1-1934, Gartrell (CNC); 2 L, Penticton, IV-22-1935, IX-28-1933, A.N. Gartrell (CNC), CA: 1 L, Blaney Meadows, San Joaquin R, VIII-1948, Day (CAS); 4 L, Coyote Cr, III-11-1950, Day (CAS); 1 L, Darwin Cr, VIII-1948, Day (CAS); 1 L, Los Angeles Co, Little Rock Cr, 1 mi above Little Rock Dam, IV-27-1968, Collins (CSU); 1 L, Deer Cr Trib Nevada City, VI-20-1948, Day (CAS); 2 L Tuolumne R 3 mi E Shiloh, V-8-1955, Day (CAS); CO: 1 L, Tolland, V-30-1936 (CNC); IL: 5 L, Elgin, Botanical Gardens, IV-19-1939, V-23-1939, Burks, Riegel, V-9-1939, Ross, Burks (INHS); 2 L, Elgin, Rainbow Spring, IV-19-1939, Burks, Riegel, V-9-1939, Ross, Burks (INHS); IN: 3 L (1 reared), Cass Co, stream at US 24, 7 mi W US 31, IV-17-1976, Minno, et al (PU); 4 L, Warren Co, W Branch Kickapoo Cr,

V-21-1976, Minno, Morihara; Little Pine Cr at Highbridge, III-8-1973, reared, Huff; III-25-1972, Lockwood; Trib of Little Pine Cr 1 mi W Greenhill, III-20-1975, Provonsha, Harris (PU); MT: 1 L, Bozeman, Rocky Canyons, VIII-9-1928, McDunnough (CNC); 1 L, 2 Med R Glacier Nat Prk, VI-16-1932, M.J.M. (CU); NM: 2 L, Catron Co, San Francisco R near Luna on Hwy 180, VII-22-1970, Allen (CSU); 2 L, Mora Co, Mora R, VII-1-1964, Allen (CSU); 1 L, Otero Co, Rio Penasco, VII-12-1969, Koss, et al (PU); 1 L, Rio Arriba Co, Rio Brazos, Brazos, III-21-1967, Baumann (PU); 1 L, San Juan Co, Shiprock, San Juan R, VII-5-1970, Koss, et al (PU); 1 L, San Miguel Co, Pecos R, VII-2-1964, Allen (CSU); NC: 1 L, Rocky Broad R, VI-23-1930 (CU); NS: 1 L, Truro, IV-30-1913, Matheson (CU); ONT: 1 L, Ottawa, (CNC); 1 L, Manitoulin Is, Bluejay Cr, VIII-21-1957, Ide (ROM); OR: 1 L, Benton Co, Berry Cr, X-18-1958 (PU); 2 L, Benton Co, Berry Cr Lab, VI-17-1964, Kevy (CSU); 1 L, Deschutes Co, Deschutes R, 5 mi NW Bend on Hwy 20, VIII-6-1967, Allen (CSU); QUE: 1 L, Fairy L Cr, V-22-1930, Walley (CNC); 3 L, Upper Lindsay Cr, Wakefield, VI-2-1930, McDunnough (CNC); SD: 1 L, Lawrence Co, Jim Cr, VI-13-1975, McCafferty, et al (PU); 1 L, Lawrence Co, Boxelder Cr, VI-13-1975, McCafferty, et al (PU); 4 L, Lawrence Co, Spearfish Cr, VI-14-1975, McCafferty, et al (PU); 4 L, Lawrence Co, Iron Cr, VI-14-1975, McCafferty, et al (PU); 1 L, Pennington Co, Rapid Cr, at mouth of Dark Canyon, Rapid City, VI-13-1975, McCafferty, et al (PU); UT: 1 L, Wasatch Co, Provo R, Stewart's Ranch, VI-17-1947, Edmunds (CAS); VA: 1 L, Montgomery Co, Mill Cr, III-12-1977, Kondratieff, et al (VPI); WY: 2 L, Firehole R, Yellowstone Nat Prk (CNC); 1 L, Big Horn Co, Two-Trees Cr, V-31-1968, Kropf (CAS).

Specimens in Alcohol: 908 L and 42 ♂♂: AK (PU); ALTA (CNC); AZ (CSU, PU, UU); BC (CNC); CA (CAS, CSU, PU); CO (USNM, UU), ID (PU, UU); IL (INHS); IN (PU); MAN (CNC); MI (PU); MO (USNM); MT (PU, USNM); NC (CU); NM (CSU, PU); NV (CAS); NY (CU); OH (CU, USNM); ONT (CNC, ROM); OR (CSU, PU); PA (USNM); QUE (CNC); SD (PU); TN (UF); UT (CAS, USNM, UU); WA (UU); WY (CNC, PU).

S.E.M. Preparations: AZ: 1 L, Apache Co, Hall Cr, VII-3-1964, Allen (CSU); 1 L, Gila Co, Tonto Cr, VII-19-1970, Allen (CSU);

IL: 1 L, Elgin, Trout Spg, III-7-1940, Burks, Mohr (INHS); 1 L, Elgin, III-9-1939, Ross, Burks (INHS); OR: 1 L, Portland, VI-19-1882, Henshaw (CU); SD: 1 L, Lawrence Co, Spearfish Cr, VI-9-1961, Edmunds, Peters (PU); VA (ISNM).

Baetis bicaudatus Dodds
(Figs. 3, 17)

Baetis bicaudatus Dodds, 1923:110.

Body Length. — 5-7 mm.

Head. — Antennae: scape and pedicel with robust and fine setae (Fig. 3). Labrum: quadrate; 1 + 5-10 setae. Right Mandible (Fig. 17a): 3 + 4 denticles; outermost denticle as wide as combined widths of next 2 denticles; base of incisors with spines. Left Mandible: 3 + 1 + (3-4) denticles; outermost denticle as in right mandible; base of incisors smooth. Maxillary Palpi: extending slightly further than galea-lacina. Labial Palpi (Fig. 17b): segment 2 with moderate median lobe and 3-7 dorsal setae. Paraglossae: innermost setal row with 9-10 setae.

Thorax. — Pronotal color pattern usually distinct with 2 submedian bilobed dark areas (Fig. 17f). Legs (Fig. 17d): femur with lateral "L" shaped pale area composed of small spiny ridges, dorsal setae long and acute, ventral setae very short; tibia with dorsal setae only slightly larger than ventral setae; ventral setae of tarsus longer than ventral setae of tibia; dorsal setae of tarsus small and inconspicuous; claws with 9-11 denticles and sometimes subapical setae.

Abdomen. — Dorsal color pattern indistinct with submedian dark dots and anterior diagonal dashes usually present on most terga (Fig. 17f). Tergal Surfaces: with scales, scale bases, and fine setae; posterior margins with blunt triangular spines and fine setae. Paraprocts: surfaces with numerous pores, robust setae, small spiny ridges, and fine setae; posteromedial spines irregularly spaced and varying in size and shape. Gills: rounded posteriorly (Fig. 17g); margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament reduced to 1 or 2 segmented stub.

Discussion. — The bilobed dark submedian marks on the pronotum (Fig. 17f), the two-tailed condition, and the broad gills (Fig. 17g) distinguish this species from most N.A. *Baetis*. It can be distinguished from *B. tricaudatus* by the reduced median terminal filament (Fig. 17f).

Dodds (1923) described this species from female adults and larvae and observed extreme ecological conditions (usually turbulent water) under which these larvae were found. He subsequently (Dodds, 1924) recorded differences in gill and leg sizes between *B. bicaudatus* and the closely related *B. tricaudatus* which he attempted to relate to dissimilarities in habitat. However, these dif-

ferences are not apparent in our specimens, which are indistinguishable without the aid of the characteristic median terminal filaments. The adults of these species appear to be identical (the adult males of *B. bicaudatus* have been reared from larvae from Utah but never described). *B. bicaudatus* and *B. tricaudatus* are herein retained as valid species because of ecological differences and distributional patterns.

This is a widespread western boreal species having been collected as far south as New Mexico and ranging north into British Columbia and Alberta. Edmunds (1952) collected *B. bicaudatus* from a wide variety of cold streams between 4,300-10,500 feet in Utah and noted that this was often the only mayfly species present in streams at higher altitudes. This adaptation to cold water indicates that *B. bicaudatus,* similar to other cold-adapted *Baetis,* probably overwinters in the egg stage.

The absence of males in many populations suggests parthenogenesis may be present to some degree (McCafferty and Morihara, 1979).

B. Bicaudatus exhibits high drift rates with predictable diel periodicity, and is often a major component in drift samples (Anderson and Lehmkuhl, 1968; Waters, 1969; Pearson and Kramer 1972; Brusven, 1970).

Material Examined. — PARATYPE: 1 L, *Baetis bicaudatus* Dodds, Tolland, COLORADO, August 1921, Type No. 9031 (ANSP).

Slide Mounts: ALTA: 2 L, Blairmore, VI-21-1930 (CNC); 2 L, Crows Nest Pass, Glacier Cr, VI-7-1930, Pepper (CNC); 1 L, Waterton Lakes, Pass Cr, VI-28-1929, Pepper (CNC); BC: 1 L, Dunn Peak, NT R, VIII-11-1937, Jacob (CNC); 1 L, Hope Mts, VII-30-1932, Gartrell (CNC); 1 L, Jesmond, Porcupine Cr, VIII-24-1938, Jacob (CNC); CA: 1 L, Alpine Glen, W Frk Carson R, VII-2-1950, Day (CAS); 2 L, Eure Valley, VII-4-1948, Day (CAS, UF); CO: 1 ♂, Monte Vista, VII-9-1946, Harmston (CAS); 1 L, Tolland, V-30-1936 (CNC); UT: 1 L ♂ reared, Salt Lake Co, Big Cottonwood Cr at Stairs Power Plant, 5475′, V-10-1967, Argyle (UU); 1 ♂, same locale as preceding, VI-13-1965, Nebeker (PU); 1 L, Wasatch Co, Provo R, Stewarts Ranch, VI-18-1947, Edmunds (CAS).

Specimens in Alcohol: 57 L and 68 ♂♂ and ♀♀: ALTA (CNC); BC (CNC); CA (CAS, CSU, UF); CO (CU, PU); ID (FAM); NM (PU); OR (PU); UT (PU, UU); WA (PU); WY (CNC).

S.E.M. Preparations: UT: 2 L, Wasatch Co, Provo R, Stewarts Ranch, VI-18-1947, Edmunds (UU).

Baetis foemina McDunnough
(Fig. 18)

Baetis foemina McDunnough, 1936:33.

Body Length. — 4 mm.

Head. — Antennae (Fig. 18a): scape and pedicel with pores, fine setae, and less numerous robust setae. Labrum: 1 + 7-11 setae. Right Mandible: 3 + 4 denticles; outermost denticle as wide as combined widths of next 2 denticles; base of incisors with spines. Left Mandible: 3 + 1 + 3 denticles: innermost denticle often divided. Maxillary Palpi: extending slightly further than galea-lacinia. Labial Palpi (Fig. 18b): segment 2 with moderate medial projection and 3-5 dorsal setae. Paraglossae: narrow; innermost setal row with 8-11 setae.

Thorax. — Pronotal color pattern indistinct and often uniformly brown. Legs: femur with pale "J" shaped area, dorsal setae much longer than ventral setae; dorsal and ventral setae of tibia similar in shape and numbers (Fig. 18c); ventral setae of tarsus increasing in size distally and much larger than dorsal setae; claws with 10-12 denticles and 1 pair subapical setae.

Abdomen. — Dorsal abdominal color pattern indistinct, most terga similar with 2 submedial dark dots (Fig. 18d). Tergal Surfaces (Fig. 18f): with scales, scale bases, and fine setae; posterior margins with blunt spines and fine setae. Sterna: with robust setae. Paraprocts: surface with pores, small spiny ridges, fine setae, and 1 or 2 robust setae. Gills: elongate, about 2.3 times longer than wide (Fig. 18e); margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament reduced to stub consisting of 3 or fewer segments.

Discussion. — This two-tailed species can be distinguished from the rest of the *rhodani* group and in particular, *B. bicaudatus,* by its elongate gills (Fig. 18e). The single record of *B. foemina* is from the eastern Canadian tundra (approximately 63° N). Males of this species are unknown either as larvae or adults. The larvae were associated through rearing with the adult females (McDunnough, 1936).

Because of similarities (viz. the two-tailed condition) between this species and *B. bicaudatus,* it is possible that *B. foemina* is a cold adapted form of *B. bicaudatus.* A corresponding situation also occurs in the *vernus* group where *B. macani* and *B. hudsonicus,* although being nearly identical to other *vernus* group

members with respect to almost every morphological character studied thus far, are distinguished by elongate gills. Hence, gills of this form seem to be characteristic of most extreme northern forms of *Baetis*. Parthenogenesis may also sometimes be an adaptation in northern forms (McCafferty and Morihara, 1979).

Material Examined. — HOLOTYPE: ♀, Lake Harbour, Baffin Island, 7-VIII-1935, W.J. Brown, No. 4069 (CNC).

Slide Mounts: NWT: 7 L, Lake Harbour, Baffin Island, VIII-4, 7, 12-1935, Brown (CNC).

Specimens in Alcohol: 63 L same data as above.

Baetis sp. A
(Fig. 19)

Body Length. — 6-8 mm.

Head. — Antennae: scape and pedicel with both fine and robust setae, and pores. Labrum: 1 + 3-11 setae. Mandibles: shapes of denticles variable with age, but distal denticle widest. Maxillary Palpi: extending as far as galea-lacinia; small cone-shaped elevation near apex. Labial Palpi (Fig. 19a): median lobe of segment 2 moderate; segment 2 with 4-8 dorsal setae and sometimes 1 or 2 short robust setae. Paraglossae (Fig. 19b): innermost setal row with 9-15 setae.

Thorax. — Pronotal Surface: with fine setae and less numerous robust setae. Legs (Fig. 19c): strongest setae on dorsum of femur and venter of tarsus; claws with 11-12 denticles and subapical setae often present.

Abdomen. — Dorsal color pattern sometimes distinct (Fig. 19d), with terga 4 and 5 paler than terga 3 and 6, and tergum 5 with submedian dark dots. Tergal Surfaces: with scales, scale bases, and fine and robust setae; margins with spines and fine setae (Fig. 19e). Paraprocts (Fig. 19f): surface with pores, fine setae, and robust setae; posteromedial margins with sharp spines. Gills: rounded posteriorly; margins serrate with fine setae and also robust setae (Fig. 19g). Caudal Filaments: unbanded; median terminal filament 0.4-0.8 length of cerci.

Discussion. — *B.* sp. A larvae can be separated from all other N.A. *Baetis* by the robust setae which occur on the gill margins (Fig. 19g) but are absent from the posterior tergal margins (Fig. 19e). This species is similar to *B. tricaudatus* in general appearance and morphological structure. The abdominal color pattern of tergum 4 in *B.* sp. A is more similar to tergum 5 than to tergum 3 (Fig. 19d); in *B. tricaudatus* tergum 4 more closely resembles tergum 3 instead of 5 (Fig. 16d).

This species is from California and New Mexico but is probably widespread throughout the Southwest. *B.* sp. A appears to be

associated with streams at elevations of less than 6,000 feet.

Material Examined. — Slide Mounts: CA: 3 L, Los Angeles Co, Monrovia Canyon Cr, VI-26-1967, Collins (CSU); 4 L, Los Angeles Co, W Fork San Gabriel R at Glenn Campground, XII-7-1965, Vann (CSU); 1 L, Mt Diablo, V-18-1947, Chandler (CAS); NM: 1 L, Catron Co, San Francisco R at Glenwood, VII-21-1970, Allen (CSU); 1 L, Otero Co, Rio Penasco, 3 mi below Mayhill, Sacramento Mtns, Lincoln Nat For, VII-25-1970, Allen (CSU).

Specimens in Alcohol: 37 L: CA (CAS, CSU); NM (CSU, PU).

Baetis sp. B
(Fig. 20)

Body Length. — 7-9 mm.

Head. — Antennae: scape and pedicel with scales bases, fine and robust setae. Labrum (Fig. 20a): 1 + 5-7 setae. Right Mandible: 3 + 4 denticles; several spines at base of incisors (may be absent in worn incisors). Left Mandible: 3 + 1 + 4 denticles; base of incisors smooth. Maxillary Palpi: extending as far as galea-lacinia; apex asymmetrical. Labial Palpi (Fig. 20b): median lobe of segment 2 moderate, segment 2 with 5-8 dorsal setae and sometimes with 1 or 2 short robust setae. Paraglossae (Fig. 20c): with 5 rows of subapical pectinate setae; innermost setal row with 9-13 setae.

Thorax. — Pronotum with indistinct color pattern. Legs (Fig. 20d): femur with lateral surface composed of ridges with small spines; largest dorsal setae acute (Fig. 20e); tibia and tarsus with similar setal arrangements; ventral setae longer than dorsal setae; claws with 10-13 denticles and no subapical fine setae.

Abdomen. — Dorsal abdominal color pattern indistinct, usually with submedian pair of dark dots and anteriorly converging dark dashes, tergum 5 may be paler than other terga. Tergal Surfaces (Fig. 20f): with crescent-shaped scale bases, fine setae, scales, and robust setae; posterior margins with spines, and fine and robust setae; robust setae of posterior margins larger than spines. Paraprocts: surfaces with pores, scale bases, scales, and fine and robust setae; posteromedian marginal spines regularly spaced; robust setae near margins larger than spines. Gills: rounded posteriorly; margins smooth, with fine and robust setae (Fig. 20g). Caudal Filaments: unbanded; median terminal filament 0.4—0.8 length of cerci.

Discussion. — The larvae of *B.* sp. B are unique from all other N.A. *Baetis,* including other members of the *rhodani* group, by the five rows of subapical paraglossal setae (Fig. 20c), smooth gill margins with fine and robust setae (Fig. 20g), and the presence of robust setae on the posterior margins of the terga (Fig. 20f). This species appears to be most closely related to *B.* sp. A, especially in

light of the robust marginal setae found on the gill margins (Fig. 19g).

B. sp. B is currently represented by two specimens collected from the Southwest.

Material Examined. — Slide Mounts: AZ: 1 L, Apache Co, Apache Nat For, Hall Cr on Hwy 373 (8100'), VII-3-1964), Allen (CSU); NM: 1 L; Grant Co, Cherry Cr, 14 mi N Silver City, IX-9-1967, Koss (PU).

Baetis brunneicolor McDunnough
(Fig. 21)

Baetis brunneicolor McDunnough, 1925a:173, 1932:79; Ide, 1937:221; Leonard and Leonard, 1962:88; Burks, 1953:135.

Baetis hiemalis Leonard, 1950:155; Leonard and Leonard, 1962:88. NEW SYNONYM.

Baetis anachris Burks, 1953:133. NEW SYNONYM.

Baetis phyllis Burks, 1953:134. NEW SYNONYM.

Body Length. — 6-10 mm.

Head. — Antennae: scape and pedicel with scattered fine setae and pores; apical surface of pedicel with small spines usually visible. Labrum (Fig. 21a): 1 + 3-7 setae. Right Mandible: 3(1) + 4 denticles; spines at base of incisors. Left Mandible: 3 + 1 + 3 denticles; basal denticle divided. Maxillary Palpi: extending as far as galea-lacinia. Labial Palpi (Fig. 21b): segment 2 with median lobe moderate and 3-5 dorsal setae, sometimes robust setae present. Paraglossae: innermost setal row (Fig. 21c) with 10-15 pectinate setae.

Thorax. — Pronotal color pattern indistinct. Legs (Fig. 21d): femur with dorsal setae longer than ventral setae; tibia and tarsus with similar very short dorsal setae, ventral setae longer; claws with 11-14 denticles and no subapical setae.

Abdomen. — Dorsal color pattern variable, uniform brown with submedian dark dots or large pale submedian areas with pale median band (Fig. 21e), sometimes terga 5, 9, and 10 paler than other terga. Tergal Surfaces: with scales, fine setae, and scale bases; posterior margins with spines and fine setae which both disappear laterally. Paraprocts (Fig. 21f): surfaces with scales, scale bases, fine setae, and robust setae; robust setae when present usually near posteromedial margins. Gills: rounded to broadly pointed posteriorly (Fig. 21g); margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament about 0.6-0.9 length of cerci.

Discussion. — *B. brunneicolor* can be easily separated from other members of the *vernus* group in N.A. by the shape of the gills (Fig. 21g) and its southern distribution. The labial palpi (Fig. 21b) and unbanded tails distinguish the larvae from the *fuscatus* group (Figs. 24e, 25e) which are morphologically quite similar with regard

to the adult male genitalia. The larval distinctions between *B. brunneicolor* and the *rhodani* group can occasionally be difficult due to similarities in color patterns and the shapes of the labial palpi. The pronotal color pattern (Fig. 16d) and the presence or absence of numerous robust setae on the pedicel (Fig. 3) will separate these species.

B. brunneicolor was first described by McDunnough (1925a) from adults which are larger and darker than adults of the *fuscatus* group. McDunnough (1932) constructed a brief key which included the larva of this species; however, Ide (1937) was the first to formally describe this stage. Ide's figure of the labial palpus appears to be inaccurate, and contrary to Ide's statement, it certainly is not the same type as that found in *B. frondalis.*

Leonard (1950) described *B. hiemalis* and recognized a close relationship between it and *B. brunneicolor.* Differences were reported in size, color patterns, gills, labial palpi, and the proportionate lengths of the tails. Because each of these differences has proven to be inconsistent, we place *B. hiemalis* as a junior synonym of *B. brunneicolor.*

B. anachris was described by Burks (1953) from larvae and adults collected on the same date and from the same locality. The examination of type material and supplementary specimens has indicated that the larvae and adults are morphologically identical to *B. brunneicolor. B. anachris* (which we place as a junior synonym) was apparently applied to an extremely variegated form of *B. brunneicolor* which occurs more frequently in the southern parts of the species' range.

Burks (1953) justified the description of *B. phyllis* on differences from *B. brunneicolor* found in adult males. Our comparison of paratypes did not confirm such differences. Since the larvae are also identical, we place *B. phyllis* as a junior synonym of *B. brunneicolor.*

B. brunneicolor primarily occurs in northeastern N.A. It has been collected as far south as Indiana (where we have reared specimens) and Illinois (Burks, 1953). It probably occurs in the Carolinas also. In the North, McDunnough (1932) reported this species to be common along areas of the north shore of the Gulf of St. Lawrence.

FIGURE 1. Antennal pedicel and flagellum, dorsal view, *B. pygmaeus,* S.E.M. 500x.

Material Examined. — HOLOTYPE: ♂, *Baetis brunneicolor* McDunnough, Ottawa, West. ONT. 25-V-1921, A.W. Richardson, No. 1238 (CNC). HOLOTYPE: ♂, *Baetis anachris* Burks, genitalia and HW on slides, IL, Matanzas, Havana, June 13, 1946, Mohr-Burks, Acc. No. 47099 (INHS). HOLOTYPE: ♂, *Baetis phyllis* Burks, Vandalia, ILL. Apr. 16, 1946, Acc. No. 49263, Mohr and Burks (INHS). PARATYPES: 2 ♂♂, *Baetis brunneicolor* McDunnough, genitalia on slide, OTTAWA, No. 1283 (CNC). PARATYPES: 6 L, *Baetis hiemalis* Leonard, slides and alcohol, MI, Crawford Co, Au Sable R, IX-11-1948 to X-13-1948, J.W. and F.A. Leonard (UM). PARATYPES: 2 L, *Baetis anachris* Burks, on slides, IL, Havana, White Oak Cr, June 12, 1948, Burks, Stannard, Smith (INHS). PARATYPE: ♂, *Baetis phyllis* Burks, 1 L, IL, Vandalia, IV-16-1946, C.O. Mohr, B.D. Burks, Acc. No. 49263 (INHS).

Slide Mounts: IL: 2 L, 1 ♂, Dundee, V-23-1939, Burks, Riegel (INHS); 1 L, Matanzas, Havana, VI-13-1946, Mohr, Burks, Acc. No. 47099 (INHS); 1 ♂, Matanzas Lake, Havana, XI-5-1939, Ross, Burks (INHS) IN: 1 L ♂ reared, Tippecanoe Co, Little Pine Cr, V-3-1976, Morihara (PU); MAN: 1 L, Churchill, VII-15-1937, Brown (CNC); MI: 2 L, Cheboygan Co, Carp Cr, VIII-8-1936, Lyman (PU); ONT: 1 L, Tillsonburg, VI-1-1931, Walley (CNC); QUE: 6 L, Bradore Bay, VIII-2-1930 (CNC); 1 L, Thunder R, VIII-19-1930 (CNC).

Specimens in Alcohol: 184 L and 9 ♂♂: IL (INHS); IN (PU); MAN (CNC); MI (ROM); NC (?) (CU); SD (PU); VA (USNM).

Baetis macani bundyae Lehmkuhl
(Fig. 22)

Baetis macani Kimmins, 1957:27; Macan, 1957:58; Müller-Liebenau, 1969:112.
Baetis bundyi Lehmkuhl, 1973:343.
Baetis bundyae: Edmunds, 1974:289.
Baetis macani bundyae: Morihara and McCafferty, 1979a:36.

Body Length. — 5-7 mm.

Head. — Antennae: scape with scattered fine setae; pedicel with scattered fine setae and small surface spines usually blunt or truncate. Labrum: 1 + 3-6 setae. Right Mandible: 3(1) + 4 denticles; incisors with basal spines. Left Mandible: 3 + 1 + 3 denticles; innermost denticle divided basally. Maxillary Palpi: extending slightly further than galea-lacinia. Labial Palpi (Fig. 22a): segment 2 with median lobe moderate and 5-7 dorsal setae. Paraglossae (Fig. 22b): innermost setal row with approximately 10 strongly pectinate setae.

Thorax. — Pronotal color pattern indistinct. Legs: setae (Fig. 22c) on all segments similar in form but differ in density and placement; setae on dorsum of femur more numerous than on venter; setae on tibia evenly scattered; most setae on tarsus regularly spaced in single row on dorsum and venter; claws with 12-17 denticles and no subapical setae.

Abdomen. — Dorsal abdominal color pattern indistinct, terga 5, 9, and 10 usually paler than other terga, most terga with dark submedial dots and large pale lateral areas. Tergal Surfaces (Fig. 22d): with scales, scale bases, and fine setae; posterior margins with moderately long spines and fine setae. Paraprocts: surfaces with fine setae and pores. Gills: elongate, about 3 times longer than wide (Fig. 22e); margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament 0.5-0.8 length of cerci.

Discussion. — This species is most closely related to *B. hudsonicus* from which it differs only in the relative lengths of the larval median terminal filaments. Similarities in habitat and distribu-

FIGURE 2. Antennal pedicel and flagellum, dorsal view, *B. ephippiatus,* S.E.M. 1600 x.

tion of these two forms and the fact that the median terminal filament has been shown to vary greatly within populations of other *Baetis* leads to suspicions of conspecificity.

B. macani bundyae was described from larvae from ponds in the Canadian arctic. Subsequently, adults were reared and the relationship with the European *B. macani macani* became apparent (Morihara and McCafferty, 1979a). These subspecies may be separated on the basis of the labial palpi in which segment two is relatively shorter in *B. macani bundyae* (Fig. 22a).

This species has been collected as far south as approximately 60 ° N in both N.A. and Europe. Apparently because of this extreme northern distribution, the eggs overwinter in ice. Details of the life cycle have been reported by Lehmkuhl (1973) and Brittain (1975). *B. macani* may also be collected in moving water but such records of this have usually been in connection with lake outlets (Müller-

Liebenau, 1969).

Material Examined. — PARATOPOTYPE: 1 L, *Baetis bundyae* Lehmkuhl, Canada, NWT, Keewatin, Rankin Inlet, 62.45 N, 94.27 W, D.M. Lehmkuhl, 28 July 1972, from ponds (US).

Slide Mounts: NWT: 3 L, Keewatin, Rankin Inlet, Char R, VII-26-1973, Lehmkuhl (US); 2 L, Keewatin, Rankin Inlet, Pond, VII-28-1973, Lehmkuhl (US).

Specimens in alcohol: 5 L and 4 ♂♂: NWT (US).

Baetis hudsonicus Ide
(Fig. 23)

Baetis hudsonicus Ide, 1937:221.

Body Length. — 7-9 mm.

Head. — Antennae: pedicel with scattered fine setae and surface with small spines. Labrum (Fig. 23a): 1 + 3-6 setae. Right Mandible: 3 (1) + 4 denticles; spines at base of incisors. Left Mandible: 3 + 1 + 3 denticles; innermost denticle divided basally. Maxillary Palpi: extending slightly further than galea-lacinia. Labial Palpi (Fig. 23b): segment 2 with median lobe moderate, 3-6 dorsal setae, and short stout setae similar to those on segment 3. Paraglossae (Fig. 23c): innermost setal row with approximately 10 setae.

Thorax. — Pronotal color pattern indistinct and generally uniformly brown. Legs (Fig. 23d): strong sharp setae similar in shape and size on all segments (Fig. 23e); ventral setae of tarsus more regularly spaced relative to setae on other leg segments; claws with 13-16 denticles and no subapical setae.

Abdomen. — Dorsal abdominal color pattern indistinct but submedian dark dots apparent on most terga. Tergal Surfaces: with scales, fine setae, and scale bases; posterior margins with elongate spines. Paraprocts: spines on posteromedial margins regularly spaced and nearly uniform in size and shape. Gills (Fig. 23f): elongate, 2.7 times longer than wide; margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament subequal in length to cerci.

Discussion. — *B. hudsonicus* is most closely related to *B. macani*. These two species have elongate gills in common in addition to other *vernus* group characteristics. *B. hudsonicus* larvae, however, are larger and possess a longer median terminal filament which is almost equal in length to the cerci.

The status of *B. hudsonicus* as a valid species can only be fully substantiated when associated adults become known and more larvae become available for examination.

B. hudsonicus is known from the Canadian tundra, and only as females. McCafferty and Morihara (1979) discussed its possible

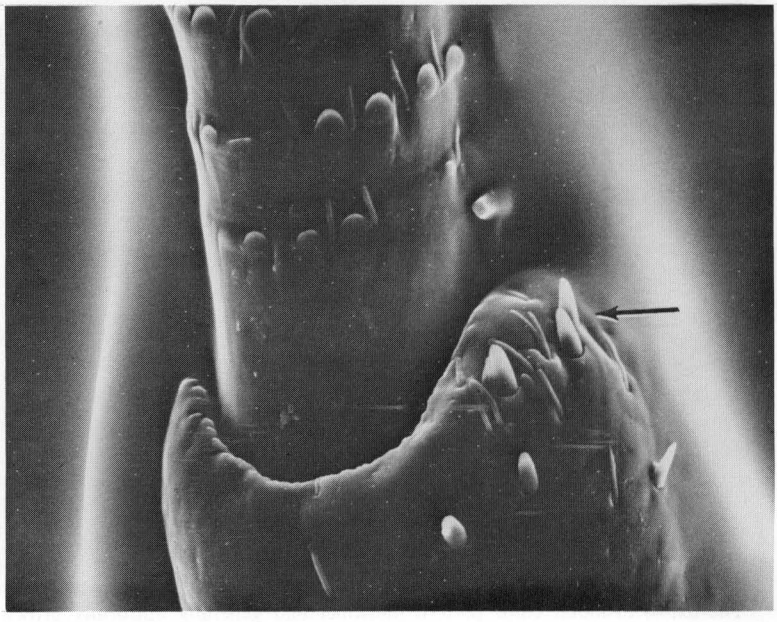

FIGURE 3. Antennal pedicel and flagellum, dorsal view, *B. bicaudatus,* (robust setae indicated), S.E.M. 625x.

parthenogenesis.

Material Examined. — Slide Mounts: MAN: 5 L, Churchill, VII-22-1936, McClure (CNC, ROM).

Baetis intercalaris McDunnough
(Fig. 24)

Baetis intercalaris McDunnough, 1921:118; Ide, 1937:227; Berner, 1950:221; Leonard and Leonard, 1962:90.

Body Length. — 5-6 mm.

Head. — Antennae: scape and pedicel with few scattered fine setae. Labrum (Fig. 24a): evenly rounded laterally; 1 + 3-5 setae. Right Mandible (Fig. 24b): 3 (1) + 4 denticles; secondary denticle sometimes absent. Left Mandible (Fig. 24b): 3 + 3; very small intermediate denticle sometimes visible. Maxillary Palpi: extending as far as galea-lacinia. Labial Palpi (Fig. 24c): broad; median lobe of segment 2 poorly developed; 3-4 dorsal setae on segment 2. Paraglossae: innermost setal row with 5-9 setae.

Thorax. — Pronotal color pattern usually distinct (Fig. 24e), 1 pair of submedian dark inverted "U" shaped marks often present. Legs: femur with strong dorsal setae (Fig. 24d), only fine setae at distal margins; tibia with dorsal fine setae, venter with short strong setae similar to setae on venter of femur; tarsus with dorsum relatively bare, venter with setae similar to ventral setae of tibia; claws with 11-14 denticles and no subapical setae.

Abdomen. — Dorsal color pattern usually distinct (Fig. 24e), terga 5 and 10 paler than other terga, variegated terga 2-4 and 6-7 with 3 round pale areas near posterior margins, lateral pale areas sometimes slightly larger than central one or all 3 very small and almost nonexistent. Tergal Surfaces (Fig. 24f): with triangular scales, fine setae, and scale bases; posterior margin with spines slightly larger than surface scales. Paraprocts (Fig. 24g): surfaces with scales, small pores, and fine setae; 7-11 posteromedial marginal spines. Gills: posteriorly rounded; margins serrate. Caudal Filaments: banded; median terminal filament 0.5-0.8 length of cerci.

Discussion. — Within the *fuscatus* group, *B. intercalaris* can be identified by the 3 similar round pale areas near the posterior margins of dark, well marked terga. It is most closely related to *B. flavistriga,* and the larvae can be separated only on the basis of differences in dorsal abdominal maculation. The adults of these two species were collected simultaneously and were subsequently described by McDunnough (1921). He was able to separate the male adults by differences in the turbinate eyes and wing venation.

Ide (1937) described the larvae of *B. intercalaris* and noted the similarities between this species and *B. flavistriga.* In addition to the abdominal maculation, Ide separated these species by the type of banding in the caudal filaments. We found this latter character too variable to be consistently useful.

B. intercalaris is widespread throughout eastern N.A. It occurs in the south from Florida to Alabama north to Manitoba and Quebec.

The larvae are found in a wide variety of habitats including rocky substrates and submerged vegetation of streams. McDunnough (1923) collected the adults of two generations in one year near the type locality in Ontario, but Bergman and Hilsenhoff (1978b) found this species to be univoltine in Wisconsin. The biology of *B. intercalaris* in Florida is reported by Berner (1950) where it was found to emerge throughout the year.

Material Examined. — HOLOTYPE: ♂, *Baetis intercalaris* McDunnough, Ottawa, ONT. 11-VI-1920, No. 204 (CNC). PARATYPES: ♂♂ *Baetis intercalaris* McDunnough, Ottawa,

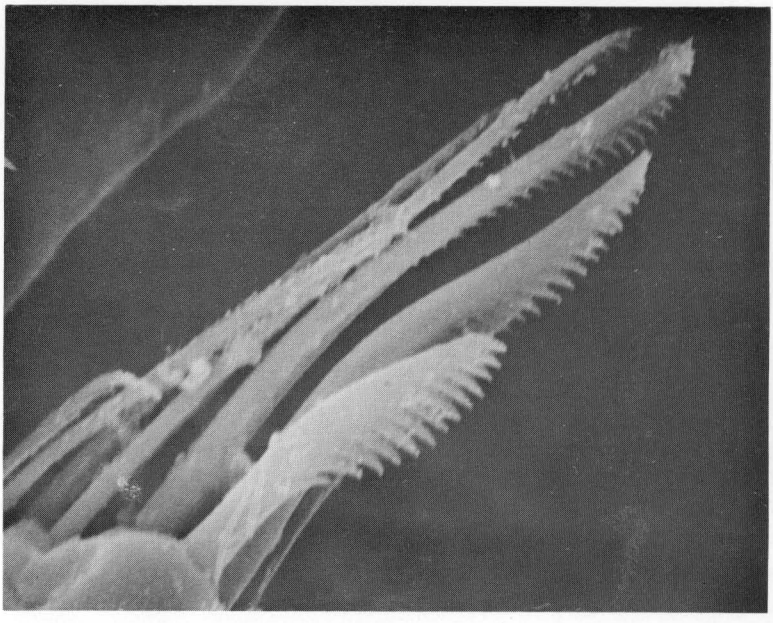

FIGURE 4. Pectinate apical setae of glossa, *B. ephippiatus,* S.E.M. 1950x.

ONT. 11-VI-1920, No. 204, 2 slides (CNC).

Slide Mounts: AL: 1 L, Dallas Co, UF Cat No 6-2154-1, Berner No 3514.0 (UF); FL: 1 L, Escambia Co, Berner No 3482.29 (UF); 1 L, Liberty Co, Sweetwater Cr, IV-29-1946, Berner No 2002.4 (UF); 1 L, Liberty Co, Sweetwater Cr, Berner No. 3007.5 (UF); IN: 1 L, Benton Co, Sugar Cr at Hwy 71, 3 mi N Freeland, VII-3-1972, McCafferty, et al (PU); 1 ♂, Crawford Co, Stinking Fork Blue R, V-14-1976, Provonsha, Minno (PU); 6 L, 1 ♂, Fountain Co, E frk Coal Cr at US Hwy 41 13 mi S Attica, V-22-1973, McCafferty, et al (PU); 1 L, Fountain Co, Coal Cr at US Hwy 41 2 mi S Veedersburg, VII-12-1972, Provonsha, Levine (PU); 1 L, Fountain Co, N frk Coal Cr, VI-28-1972, Provonsha, Levine (PU); 1 L, Franklin Co, Whitewater R, V-23-1975, McCafferty, et al (PU); 1 L, Harrison Co, Blue R 1 mi E White Cloud, VIII-23-1973, Provonsha, Black (PU); 2 L, Howard Co, Wildcat Cr, VIII-3-1972, Levine, Finni (PU); 2 L, Owen Co, Mill Cr, VII-17-1975, Provon-

sha, Minno (PU); 1 ♂, Posey Co, Wabash R, VIII-12-1974, Provonsha, Dersch (PU); 1 L, Tippecanoe Co, Burnett's Cr, VII-10-1976, Morihara (PU); 1 L, Tippecanoe Co, Burnett's Cr at Hwy 225, VIII-3-1975, Black (PU); 1 L, Tippecanoe Co, Moots Cr 4 mi NE Battleground, V-22-1975, Provonsha, Harris (PU); 1 L, Vermillion Co, Little Vermillion R at Hwy 71 4 mi W Newport, VI-28-1972, Provonsha, Levine (PU); 1 L, Warren Co, Little Pine Cr, VII-16-1973, Provonsha, Black (PU); 1 ♂, Warren Co, 4 mi W of Hills, V-22-1975, Provonsha, Harris (PU); MAN: 1 ♂, Aweme, Bae 18 (CNC); MS: 1 L, Lauderdale Co, Berner No 3519.8 (UF); 2 L, Lafayette Co, Berner No 3531.4 (UF); ONT: 4 L, Elwood, VIII-1945, Ide (ROM); 1 L, Tilsonburg, VI-1-1931, Walley (CNC); TN: 1 L, Straw Pls nr Knoxville, VI-1931, Shipe (CU); QUE: 3 L, Cascades Pt, VIII-30-1930 (CNC); 1 L, Fulford, VII-25-1930, Milne (CNC); WV: 2 L, Back Cr, VII-24-1946 (CU).

Specimens in Alcohol: 93 L and 19 ♂♂: AL (UF); FL (UF); IN (PU); MI (UF); MS (UF); NC (UF); ONT (CNC, ROM); PA (USNM); QUE (CNC); WV (INHS).

S.E.M. Preparations: IN: 4 L, Montgomery Co, Sugar Cr, VI-1-1973, McCafferty, et al (PU).

Baetis flavistriga McDunnough
(Figs. 6, 10, 25)

Baetis flavistriga McDunnough, 1921:120; Ide, 1937:227.

Baetis phoebus McDunnough, 1923:41; Ide, 1937:224; Leonard and Leonard, 1962: 91; Bergman and Hilsenhoff, 1978b:132. NEW SYNONYM.

Baetis nanus McDunnough, 1923:43. NEW SYNONYM.

Baetis pallidulus McDunnough, 1924:8.

Baetis levitans McDunnough, 1925b:216; Ide, 1937:225; Leonard and Leonard, 1962:86. NEW SYNONYM.

Baetis cingulatus McDunnough, 1925b:216 (not Stephens, 1835); Ide, 1937:225; Leonard and Leonard, 1962:87.

Baetis quebecensis Hubbard, 1974:358 (new name for *B. cingulatus* McDunnough, 1925b, not Stephens, 1835).

Body Length. — 4-6 mm.

Head. — Antennae (Fig. 25a): scape and pedicel with few scattered fine setae. Labrum (Fig. 25b): evenly rounded laterally; 1 + 2-5 setae. Right Mandible: 3 (1) + 4 denticles; spines at base of incisors. Left Mandible: 3 + 1 + 3 denticles; intermediate denticle always smallest (even on worn incisors). Maxillary Palpi: extending as far as galea-lacinia. Labial Palpi (Fig. 25c): 2-5 dorsal setae on segment 2. Paraglossae (Fig. 25d): innermost setal row with less than 10 pectinate setae.

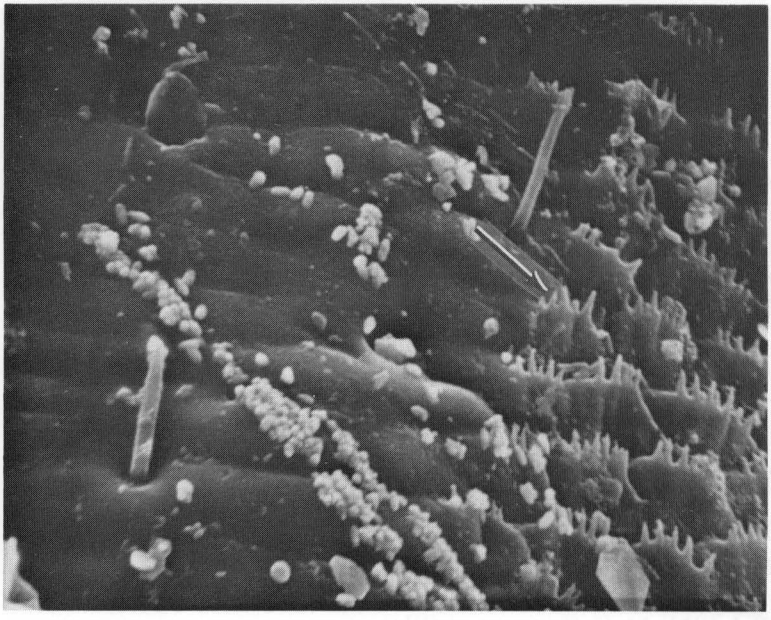

FIGURE 5. Lateral surface of femur, *B. tricaudatus,* (spiny ridges indicated), S.E.M. 2240x.

Thorax. — Pronotum with a distinctive pattern (Fig. 25e), 2 submedial inverted "U" shaped dark marks on pale background. Legs: dark areas at base, middle and apex of femur, base and apex of tibia, and apex of tarsus; dorsal setae of femur (Fig. 25f) longer than ventral setae; setae on venter of tarsus and tibia similar; no large robust setae on dorsum of tibia and tarsus; claws with 9-15 denticles and no subapical setae.

Abdomen. — Dorsal color patterns usually distinct (Fig. 25e) with terga 5, 9, and 10 paler than other terga; darker terga with pale submedian dots, anteriorly converging pale streaks, and large kidney shaped pale areas. Tergal Surfaces (Fig. 25g): with scales, scale bases, and fine setae; posterior margins with spines and fine setae. Paraprocts (Fig. 25h): surfaces with fine setae and pores. Gills: posteriorly rounded; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.5-0.8 length of cerci.

Discussion. — The distinct dark bands on the tails and the middle femora, and the kidney shaped pale areas of the darker abdominal terga, will separate *B. flavistriga* from all other N.A. *Baetis*. *B. flavistriga* and *B. intercalaris* can be distinguished from

each other by the number of pale areas near the posterior margins of the darker abdominal terga. *B. flavistriga* has two kidney shaped pale areas while *B. intercalaris* has three small round areas.

B. flavistriga is most closely related to the sympatric *B. intercalaris*. Further studies may show these forms to be conspecific, but for now, slight morphological differences in the larvae and adults as well as differences in biology justify a tentative retention of these two names.

We place *B. phoebus, B. nanus,* and *B. levitans* as junior synonyms of *B. flavistriga*. McDunnough (1923 and 1925b) originally differentiated the above on the basis of slight differences in the adult males (primarily coloration and size). Ide (1937) subsequently applied these names to larvae he associated with adult males through rearing, and suggested the possibility that he was dealing with a single species. Our comparison of type materials and study of more extensive collections of adults and larvae (some of which were reared) have indicated that discrete morphological differences are nonexistent.

B. flavistriga is one of the most abundant and common *Baetis* species in eastern N.A. It has been collected as far west as Manitoba and the Black Hills of South Dakota, and south into Arkansas. *B. flavistriga* appears to be absent from regions southeast of the Mississippi and Ohio Rivers.

This mayfly generally inhabits streams with rocky substrates. In Wisconsin, *B. flavistriga* was found to be either univoltine with a prolonged hatching period or bivoltine with overlapping generations (Bergman and Hilsenhoff, 1978b).

Material Examined. — HOLOTYPE: ♂, *Baetis flavistriga* McDunnough, Ottawa, ONT, IV-14-1920, J. McDunnough (CNC). HOLOTYPE: ♂, *Baetis phoebus* McDunnough, Ottawa West. ONT. V-25-1921, A.W. Richardson, No. 524 (CNC). HOLOTYPE: ♂, *Baetis levitans* McDunnough, Covey Hill, QUE, VI-25-1923, C.H. Curran, No. 1260 (CNC). HOLOTYPE: ♂, *Baetis cingulatus* McDunnough, Covey Hill, QUE, VI-20-1924, G.S. Walley, No. 1257 (CNC). PARATYPES: ♂♂, *Baetis flavistriga* McDunnough, Ottawa, ONT. Bae 35, 35a, 2 genitalia on slides (CNC). PARATYPES: 2 ♂♂, *Baetis phoebus* McDunnough, Cave Creek, OTTAWA, Bae 25, 25a No. 527 (CNC). PARATYPES:

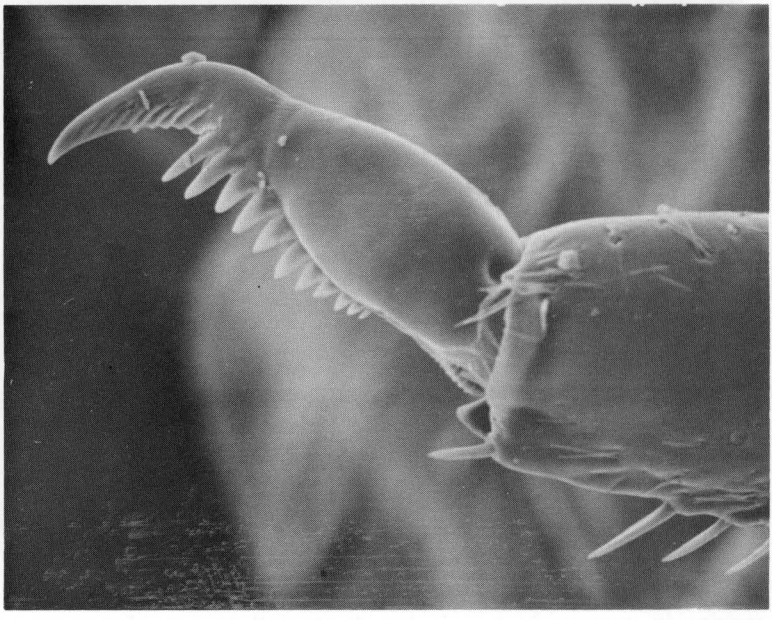

FIGURE 6. Tarsal claw, *B. flavistriga,* S.E.M. 525x.

2 ♂♂, *Baetis levitans* McDunnough, Covey Hill, QUE, Bae 29, 29a No. 1260 (CNC). PARATYPE: ♂, *Baetis nanus* McDunnough, Ottawa, ONT, Baet 36, No. 529 (CNC). PARATYPE: ♂, *Baetis cingulatus* McDunnough, Covey Hill, QUE, Bae 20a, No. 1257 (CNC).

Slide Mounts: IN: 1 L, Dekalb Co, Shank Drain, V-30-1975, Provonsha, Minno (PU); 2 L, Elkhart Co, Elkhart R, Preserve at Benton, VIII-2-1977, Provonsha, et al (PU); 1 L, Elkhart Co. Elkhart R, VIII-2-1977, Minno, Yocom (PU); 1 L, Elkhart Co, Elkhart R, 4 mi E Benton, VIII-2-1977, Minno, Yocom (PU); 2 L, Fountain Co, Coal Cr, VI-28-1972, Provonsha, Levine (PU); 1 L, Fountain Co, Big Shawnee Cr at 330 E 3 mi E Rob Roy, VI-28-1972, Provonsha, Levine (PU); 1 L, Fountain Co, Coal Cr at Veedersburg, VIII-7-1974, Provonsha, Dersch (PU); 1 L, small str at St Rd 1, 1 mi S Cedar Grove, V-16-1974, Provonsha, Dersch (PU); 3 L, Franklin Co, Whitewater R, V-23-1975, Provonsha, Heath (PU); 1

L, Jennings Co, Green Brk, Crosley St Fish and Game Area, VII-19-1972, Provonsha, Levine (PU); 1 L, Lawrence Co, Fishing Cr, VI-20-1972, Provonsha, Levine (PU); 1 L, Marion Co, Fall Cr, VIII-22-1975, Provonsha, Pask (PU); 1 L, Martin Co, Lost R at Windom, VII-3-1974, Provonsha, et al (PU); 2 L, Montgomery Co, Bower Cr, VI-1-1973, McCafferty, et al (PU); 2 L, Owen Co, Mill Cr, VII-17-1975, Provonsha, Minno (PU); 1 L, Parke Co, Little Racoon Cr at Hwy 236 1/2 mi E. Guion, VII-12-1972, Provonsha, Levine (PU); 1 L, Perry Co, Poison Cr, V-15-1975, Provonsha, et al (PU); 1 L, Tippecanoe Co, Moots Cr, V-22-1975, Provonsha, Harris (PU); 1 L ♂ reared, Warren Co, small trb of Big Pine Cr 1/2 mi W Kramer, V-31-1973, Provonsha, Black (PU); 1 L, Warren Co, small str 4 mi W Hills, V-22-1975, Provonsha, Harris (PU); 1 L, Warren Co, Little Pine Cr, VII-16-1973, Provonsha, Black (PU); 2 L, Warren Co, Little Pine Cr, Highbridge, V-31-1973, Provonsha, Black (PU); MAN: 1 L ♂ reared, Churchill, VII-17-1937, Brown (CNC); MD: 1 L, Gareet Co, Hoges Run, 6-11-66, Glime (USNM); MI: 1 L, Cheyboygan Co, Douglas Lake, VII-15-1938, Lyman (UF); 1 L, Fort Jackson, VIII-1932, Harper (CU); OH: 2 L, Leroy, Paine Cr, Hell Hollow, VIII-20-1933, Traver (CU); ONT: 2 L, Dundas, V-31-1931, Walley (CNC); Green's Cr, VI-1-1928, Adams (CNC); 2 L, Silver Cr at 2nd C. Collingwood Twsp, Grey Co, VI-18-1950, Ide (ROM); 2 L, Manitoulin Is, Manitou R rpds nr mouth, VIII-22-1957, Ide (ROM); 1 L, L Nipissing, VII-5-1929, Ide, Franks (ROM); 1 L, Nogies Cr, Bobcaygeon, VI-5-1931, McDunnough (CNC); 2 L, Remic Rpds, Ottawa R, at Champlain Bridge, VII-30-1935, Ide (ROM); 3 L, Ottawa, Rideau R, V-27-1930, Milne (CNC); 1 L, Walsh, VI-10-1931, Walley (CNC); PA: 1 L, Lebanon Co, 4 mi N Annville, IX-26-1974, Spangler (USNM); QUE: 1 L, Bradore Bay, VII-10-1930, Brown (CNC); 1 L, Cascades Pt, VI-24-1930 (CNC); 1 L, Cascades Pt, VII-3-1930, Walley (CNC); 1 L, Cascades Pt, VIII-26-1930, Milne (CNC); 2 L, Fulford, VII-25-1930, Milne (CNC); 1 L, Huntington Co, Covey Hill, Allen Brook, VII-1-6-1966, Koss, Koss (PU); 1 L, Knowlton, Gardner Cr, Sutton Mts, VII-12-1929, Milne (CNC); 1 L, Knowlton, Penny's Pasture Cr, VII-2-1929, McDunnough (CNC); 1 L, Knowlton, Hillside Cr, VII-13-1929, Milne (CNC); 1 L, Lachine, VI-19-1929, Walley (CNC); 3 L, Wakefield, Lapeche

FIGURE 7. Surface of abdominal sternum, *B. intercalaris* (clubbed fine seta indicated), S.E.M. 2100x.

R, V-28-1930, Walley, McDunnough (CNC); 1 L, Waterloo, Waterloo Cr, VI-27-1929, McDunnough (CNC); SD: 2 L, Lawrence Co, Boxelder Cr, VI-13-1975, McCafferty, et al (PU); 1 L, 1 ♂, Pennington Co, Rapid Cr, at mouth of Dark Canyon, Rapid City, VI-13, 14-1975, McCafferty, et al (PU); 1 L, Pennington Co, Grizzly Bear Cr, VI-13-1975, McCafferty, et al (PU); 1 ♂, Pennington Co, Rapid City, at light, VI-13-1975, McCafferty, et al (PU).

Specimens in Alcohol: 141 L and 13 ♂♂: AR (PU); IN (PU); MAN (CNC); NH (CNC); ONT (CNC, ROM); PA (PU); QUE (CNC, PU).

S.E.M. Preparations: IN: 1 L, Warren Co, Little Pine Cr at Highbridge, X-8-1974, Dersch (PU); ONT: 1 L, Bobcaygeon, Nogies Cr, VI-5-1931, McDunnough (CNC).

Baetis sp. C
(Fig. 26)

Body Length. — 5-7 mm.

Head. — Antennae (Fig. 26a): scape and pedicel with fine scattered setae and pores. Labrum: evenly rounded laterally; 1 + 4-6 setae. Right Mandible (Fig. 26b): 3 (1) + 4 denticles; basal spines present on incisors. Left Mandible (Fig. 26b): 3 + 1 + 3 denticles; innermost denticle divided. Maxillary Palpi: extending as far as galea-lacinia. Labial Palpi (Fig. 26c): segment 2 with median lobe moderate, and with 4-5 dorsal setae. Paraglossae: innermost setal row with 8-10 pectinate setae.

Thorax. — Pronotal color pattern distinct with submedial inverted "J" shaped dark marks (Fig. 26d); surface with scale bases, scales, and fine setae. Legs: dorsal setae of femur blunt; dorsum of tibia and tarsus almost bare with short robust setae and longer fine setae; venter of femur, tibia, and tarsus with similar strong sharp setae, and with fine setae equal in length to strong setae; claws with 11-14 denticles and no subapical setae.

Abdomen. — Dorsal color pattern distinct (Fig. 26e). Tergal Surfaces: with scale bases, fine setae, and scales; posterior margins with sharp spines and fine setae. Paraprocts: surfaces with fine setae and small cone-shaped structures; posteromedial spines irregular in size. Gills: posteriorly rounded; margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament 0.8 length of cerci.

Discussion. — The striking dorsal color pattern of *B.* sp. C (Fig. 26e) is similar to that of *B. insignificans* (Fig. 14e). *B.* sp. C, however, is three-tailed as opposed to the two-tailed *B. insignificans*. This species is closely related to the *fuscatus* group based on its similar pronotal color patterns, mouthpart structure, and chaetotaxy of the larvae.

B. sp. C appears to be common in the extreme Southwest. Adults have not been associated with these larvae.

Material Examined. — Slide Mounts: AZ: 1 L, Yavapai Co, Verde R, IV-9-1968, Koss and Baumann (PU); NM 3 L, Catron Co, Gila R, VIII-29-1969, Koss, Koss and VII-9-1969, Koss, et al (PU).

Specimens in Alcohol: 93 L: AZ (PU); NM (PU).

Baetis longipalpus Morihara and McCafferty
(Fig. 27)

Baetis propinquus, Bergman and Hilsenhoff, 1978b:132 (not Walsh).
Baetis longipalpus Morihara and McCafferty, 1979b:131.

Body Length. — 4-5 mm.

Head. — Antennae (Fig. 27a): scape and pedicel mostly bare with scattered fine setae and pores; scape with distal lobe. Labrum: evenly rounded laterally; dorsal

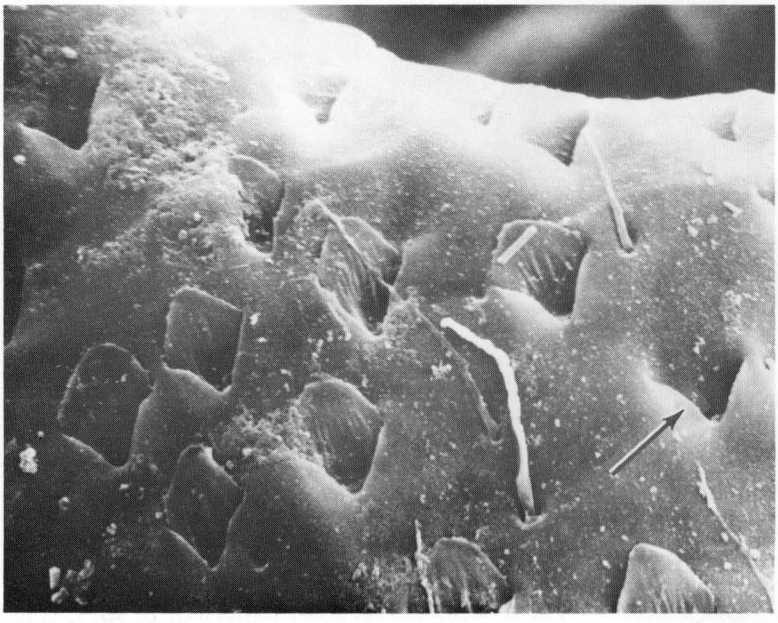

FIGURE 8. Surface of abdominal sternum, *B. hageni* (angulate scale base indicated), S.E.M. 1400x.

setae simple, scattered more densely anteriorly. Right Mandible: 3 (1) + 4 denticles; row of fine setae at base of incisors. Left Mandible: 3 (1) + 3 denticles; base of incisors bare. Maxillary Palpi (Fig. 27b): extending much further than galea-lacinia; terminal segment greatly enlarged medially. Labial Palpi (Fig. 27c): slender; segment 2 with median lobe undeveloped and with 2-5 dorsal setae. Paraglossae: innermost setal row with 6-8 very long slender pectinate setae.

Thorax. — Pronotal color pattern usually distinct and variable (Figs. 27d, e); surface shagreened with fine setae. Legs: slight differences in setal patterns and surface texture between different pairs of legs, generally longer setae on dorsum of femur and venter of tibia and tarsus compared to opposite sides of respective segments; surfaces of femur and tibia rough; claws with 10-15 denticles and no subapical setae.

Abdomen. — Dorsal color pattern distinct, variable (Figs. 27e, f), tergum 7 as pale as or paler than adjacent terga. Tergal Surfaces: with scale bases, scales, and fine setae; posterior margins with sharp spines and fine setae. Paraprocts (Fig. 27g): surfaces with scale bases and fine setae; posteromedial margins with slender sharp spines. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.6-0.8 length of cerci.

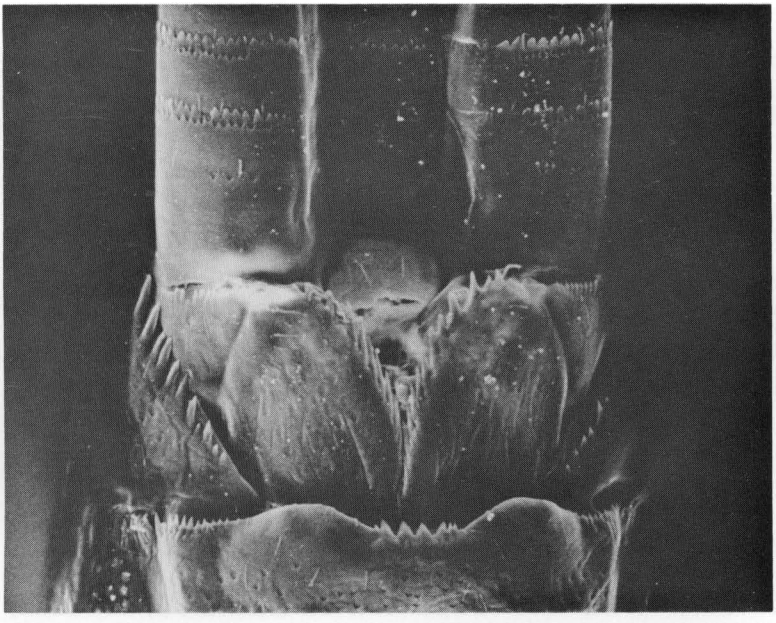

FIGURE 9. Terminal segments of abdomen and base of caudal filaments, *B. ephippiatus*, S.E.M. 176x.

Discussion. — The maxillary palpi (Fig. 27b) attain their greatest proportionate size in this species compared to all other *Baetis*. Other diagnostic characters include the relatively pale tergum 7 (Fig. 27e) and the slender labial palpi (Fig. 27c).

B. longipalpus is a distinctive species within the *propinquus* group. On the basis of larval and adult male features, it is most closely related to *B. ephippiatus*. *B. longipalpus* represents a specific lineage derived from the ancestral hypothetical stem species of the *propinquus* group (Morihara and McCafferty, 1979b).

B. longipalpus is a large river species which is abundant in fast flowing rocky areas (Morihara and McCafferty, 1979b). It has only been recorded from Indiana, and Wisconsin (as *B. propinquus*) where it is probably univoltine (Bergman and Hilsenhoff 1978b). Adult emergence occurs primarily in August.

Material Examined. — HOLOTYPE: ♂, *Baetis longipalpus*

Morihara and McCafferty, IN: Posey Co, Wabash R at Old Dam, New Harmony, VIII-12-1974, Provonsha, Dersch (PU). PARATYPES: 16 ♂♂, 1 ♀, 6 L, same collecting data as for holotype (PU, USNM).

Slide Mounts: IN: 2 L, Martin Co, E fork White R at Hindostan Falls Public Fishing Site, VI-20-1974, VII-17-1975, Provonsha, et al (PU); 6 L, 1 ♂, Posey Co, Wabash R at Old Dam, New Harmony, VIII-12-1974, VII-20-1977, Provonsha, McCafferty, et al (PU); WI: 1 L ♂ reared, Richland Co, Wisconsin R, VIII-22-1975, Bergman (UW).

Specimens in Alcohol: 206 L, 56 ♂♂: IN (PU); WI (UW).

Baetis ephippiatus Traver
(Figs. 2, 4, 9, 28)

Baetis ephippiatus Traver, 1935:687; Berner, 1940:44.
Baetis propinquus, Berner, 1940:43. (not Walsh).

Body Length. — 4-6 mm.

Head. — Antennae: scape with scattered fine setae and distal lobe; pedicel with fine setae. Labrum (Fig. 28a). 1 + 4-6 branched setae. Right Mandible: 3 (1) + 4 denticles; row of fine setae at base of incisors. Left Mandible: 3 (1) + 3 denticles; innermost denticle divided basally. Maxillary Palpi: extending further than galea-lacinia and shallowly excavated apically. Labial Palpi (Fig. 28b): segment 2 with median lobe almost as large as segment 3, and with 5-6 dorsal setae. Paraglossae (Fig. 28c): broad; innermost setal row with 6-7 pectinate setae.

Thorax. — Pronotum sometimes with large pale median area or with 4 irregular pale areas on each side. Legs: strong sharp setae on dorsum of femur and venter of tarsus and tibia; ventral robust setae of tarsus in dense single row; claws with 10-13 denticles and no subapical setae.

Abdomen. — Color pattern highly variable with submedial anterior pale areas on most terga and sometimes defined posteriorly by pale dot. Tergal Surfaces (Fig. 28d): with scales, scale bases, and fine setae; posterior margins with very sharp spines and fine setae. Paraprocts (Fig. 28e): surfaces with pores and fine setae; posterior margins with approximately 20 well developed sharp spines. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.7-0.9 length of cerci.

Discussion. — The labial palpi (Fig. 28b) and labral setae (Fig. 28a) will separate this larva from other N.A. *Baetis* including members of the *propinquus* group. Proper examination of the labrum requires a slide preparation. Also, the branched submarginal setae have a tendency to catch debris making them sometimes difficult to see. The adults are far easier to identify and

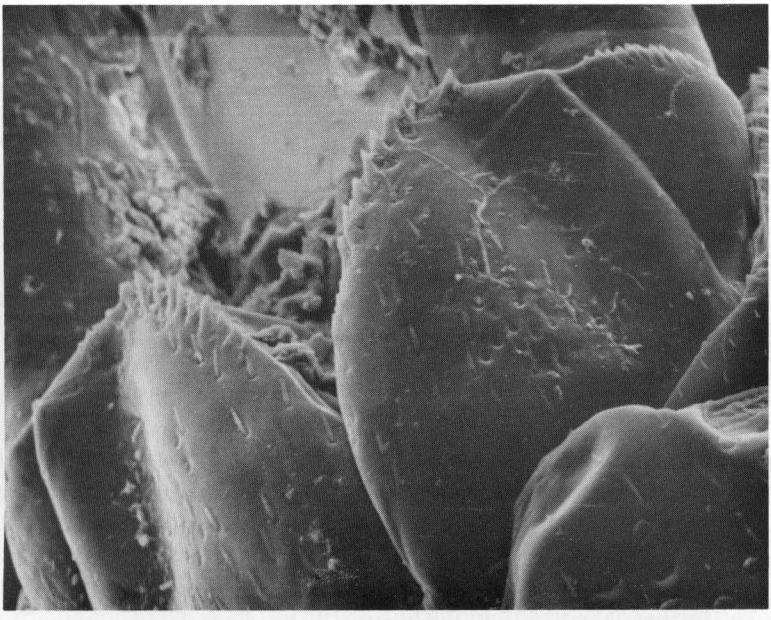

FIGURE 10. Paraprocts, *B. flavistriga*, S.E.M 440x.

should be referred to whenever possible (Morihara and McCafferty, 1979b).

Traver (1935) described *B. ephippiatus* and observed a truncate "penis-cover" between the basal segments of the forceps. Berner (1940) misidentified a color variation of this species as *B. propinquus* and figured it accordingly. Berner correctly associated and described the larvae of *B. ephippiatus* (under this name), and on the basis of adult characters placed it in *Acentrella* (or the *lapponicus* group referred to herein). Adult and larval morphological characters clearly indicate that this species belongs to the *propinquus* group. The independent reduction of the hind wing has confused this issue previously.

B. ephippiatus represents a somewhat intermediate lineage between the derived *atrebatinus* group (sensu Müller-Liebenau, 1969) and the ancestral *B. dardanus* and *B. longipalpus*. The adult male genitalia of *B. ephippiatus* retains the ancestral character states while the larvae possess derived states shared by *B. frondalis* and *B.*

propinquus (Morihara and McCafferty, 1979b). The derived larval features include the robust paraglossae, and the enlarged median lobes of segment two of the labial palpi.

This species is distributed throughout the southeastern portion of the United States. It occurs as far west as Alabama and north into Indiana and Virginia; the northern records are new.

The biology of this species in Florida was reported by Berner (1950) where he found the larvae in sand-bottom streams clinging to vegetation. He also observed differences in habitat between this species and *B. propinquus* (as *B. spinosus*) in which *B. ephippiatus* occupied areas of relatively greater turbulence than *B. propinquus*.

Material Examined. — Slide Mounts: AL: 1 ♂, Walker Co, Berner No. 3492.22 (UF); FL: 1 L, Escambia Co, Berner No. 3482.27 (UF); GA: 1 ♂, Ft Valley, Rome 1931, Fattig (CNC); IN: 1 ♂, Martin Co, E Frk White R at Hindostan Falls Pub Fishing Site, VII-2-1974, Provonsha, et al (PU); 1 L, Tippecanoe Co, W Lafayette at light, VII-29-1974, Provonsha (PU); MS: 2 L, Calhoun Co, Berner No. 3523.1 (UF); 1 L, Clay Co, Berner No. 3522.1 (UF), 1 L, Holmes Co, Berner No. 3521.1 (UF); 1 L, Sunflower Co, Berner No. 3525.8 (UF); VA: 1 L, Carroll Co, New R, VIII-6-1976, Kennedy (VPI).

Specimens in Alcohol: 23 L and 20 ♂♂: AL (UF); FL (UF); GA (CNC, UF); MS (UF).

Baetis frondalis McDunnough
(Fig. 29)

Baetis frondalis McDunnough 1925a:173; Ide, 1937:229; Burks, 1953:128; Bergman and Hilsenhoff, 1978b: Morihara and McCafferty, 1979b:133.

Baetis australis Traver, 1932:230; 1935:682; Berner, 1950:218.

Baetis baeticatus Burks, 1953:129.

Body Length. — 5-8 mm.

Head. — Antennae: scape with pores (sometimes absent), fine setae, and distal lobe (Fig. 29a); pedicel with pores and fine setae. Labrum (Fig. 29b): rectangular; 1 + 6-11 setae expanded and often fringed distally. Right Mandible: 3 (1) + 4 denticles; secondary denticle sometimes absent; row of fine setae at base of incisors. Left Mandible: 3 (1) + 1 + 3 denticles; innermost denticle often divided basally. Maxillary Palpi: extending beyond galea-lacinia; apex asymmetrical, with small subapical excavation. Labial Palpi (Fig. 29c): segment 2 with medial projection almost as large as segment 3, and with 5-6 dorsal setae. Paraglossae: broad; innermost setal row with 8-11 strongly pectinate setae.

Thorax. — Pronotum often with distinct color pattern, 3-4 pale lateral areas in addition to pale median area. Legs: femur with ventral setae shorter and more acute than equally numerous dorsal setae; tarsus and tibia with ventral setae more acute, longer, and more numerous than dorsal setae (Fig. 29d); claws with 9-16 denticles and no subapical setae.

Abdomen. — Dorsal color pattern variable, usually with pair of submedial pale dots and anterior pale streaks, these areas often expanded and coalesced, sometimes with median pale line often incomplete at middle of tergum; tracheae sometimes pigmented and easily visible. Tergal Surfaces (Fig. 29e): with scales, scale bases, and fine setae; posterior margins with very sharp spines and fine setae. Paraprocts: surfaces with pores, scales, and fine setae; posteromedial spines long and acute. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.7-0.9 length of cerci.

Discussion. — The larvae of *B. frondalis* can be separated with difficulty from the closely related *B. ephippiatus* and *B. propinquus* on the basis of the dorsal setal arrangement on the labra. The labrum of *B. frondalis* has an irregular row of subapical setae composed of a variable number of distally expanded setae (Fig. 29b); in *B. ephippiatus* this row is composed of setae which are branched (Fig. 28a); and in *B. propinquus* the submarginal setae are simple and occur in small aggregates (Fig. 30b). The adults are more easily distinguishable than the larvae and should be used for identification whenever possible (Morihara and McCafferty, 1979b).

The close relationship between *B. frondalis* and the Eurasian *B. atrebatinus* had long been recognized by Ide (1937) who first described the larvae of *B. frondalis* from reared material. Because of the unique form of the submarginal labral setae and other synapomorphic character states present in both of these species, Morihara and McCafferty (1979b) considered *B. atrebatinus* to be a sibling of *B. frondalis.*

Variation with respect to the number of submarginal labral setae is evident between southern and northern specimens. Greater numbers of labral setae are found on *B. frondalis* from the southernmost portion of its range, i.e. Florida.

Ide (1937) collected *B. frondalis* from aquatic vegetation in moderate current in streams in Ontario. In Florida, Berner (1950) (as *B. australis*) recorded this species from streams with sand and silt-bottom, and found it on vegetation and submerged debris of all sorts. Parthenogenesis was reported to be deuterotokous and facultative in this species (Bergman and Hilsenhoff, 1978a).

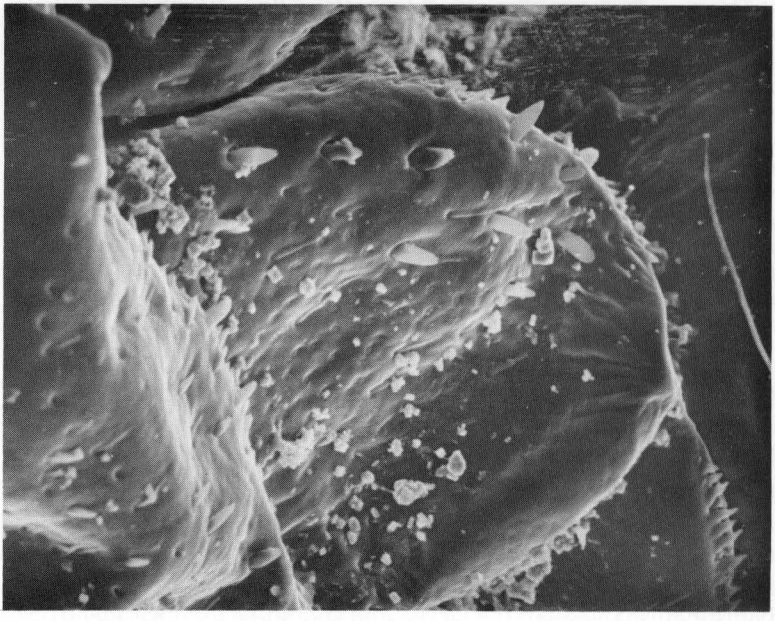

FIGURE 11. Paraproct, *B. tricaudatus,* S.E.M. 483x.

B. frondalis is widespread throughout eastern N.A. In the Southeast it is associated with the coastal plains (Berner, 1950). Westernmost material examined were from Ontario, Wisconsin, Illinois, and Alabama.

Material Examined. — HOLOTYPE: ♂, *Baetis frondalis* McDunnough La Prairie, QUE. 8-VII-1924, G.S. Walley, No. 1281 (CNC); HOLOTYPE: ♂, *Baetis australis* Traver, Goshen Swp. N.C. 11-IV-29, JGN, No. 1098.1, genitalia on slide (CU). PARATYPE: ♂, *Baetis frondalis* McDunnough, O. Golf Club, *Que.* 23-VIII-1924, G.S. Walley, No. 1281, genitalia and HW on slide (CNC).

Slide Mounts: FL: 1 L ♂ reared, Alachua Co, Little Hatchet Cr, IX-13-1940, Berner No. 3010.0 (UF); 4 L reared, Santa Rosa Co, Riley Spring Branch, 2nd strm W of Riley Landing 4.5 mi NW of Holt, IV-24, 25-1971, Peters, Peters (FAM); IL: 1 ♂ gen, Oakwood, V-29-1948, Burks, Evers (INHS), 1 ♂ HW, W Chicago,

VII-9-1948, Ross, Burks (INHS); IN: 2 L, Dekalb Co, Shank Drain, V-30-1975, Provonsha, Minno (PU); 3 L, Warren Co, Jordan's Cr, 8 mi W Rainsville, V-31-1973, Provonsha, Black (PU); ONT: 7 L, Singhampton, Mad R, VII-12-1928, Ide (ROM).

Specimens in Alcohol: 249 L and 23 ♂♂: AL (UF); FL (UF); IN (PU); NS (PU); PA (USNM); ONT (ROM).

S.E.M. Preparations: ONT: 4 L, Singhampton, Mad R, VII-12-1928, Ide (ROM).

Baetis propinquus (Walsh)
(Fig. 30)

Cloe vicina Walsh, 1862:380 (not Hagen).

Cloe propinqua Walsh, 1863:207.

Baetis propinquus (Walsh): Eaton, 1871:121; McDunnough, 1925a:172. Morihara and McCafferty, 1979b:130.

Baetis spinosus McDunnough, 1925a:174; Berner, 1940:49, 1950:211; Bergman and Hilsenhoff, 1978b:133.

Body Length. — 4-6 mm.

Head. — Antennae: scape with distal lobe; scape and pedicel (Fig. 30a) with fine setae and scale bases; apical surface of pedicel with small spines. Labrum (Fig. 30b): 1 + 2-7 simple setae, often arranged in clumps with 2 submarginal setae nearest to submedial seta nearly contiguous. Right Mandible: 3 (1) + 1 + 4 denticles. Left Mandible: 3 (1) + 1 + 3 denticles. Maxillary Palpi: extending nearly as far as galea-lacinia; terminal segment excavated medially near apex (Fig. 30c). Labial Palpi (Fig. 30d): segment 2 with median lobe as large as segment 3 and with 3-7 dorsal setae. Paraglossae (Fig. 30e): broad; innermost setal row with 10-15 pectinate setae.

Thorax. — Pronotal color pattern distinct (Fig. 30f), variable. Legs (Fig. 30g): femur with dorsal setae longer than ventral setae; tibia and tarsus with dorsal setae (Fig. 30h) shorter than ventral setae; claws with 11-15 denticles and no subapical setae.

Abdomen. — Dorsal color pattern distinct (Fig. 30f), and extremely variable. Tergal Surfaces: with scale bases, fine setae, and scales; posterior margins with sharp spines and fine setae. Paraprocts: surfaces with scale bases, fine setae, and short strong setae; posteromedial margins with sharp spines. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.6-0.9 length of cerci.

Discussion. — The larvae of *B. propinquus* can be identified by paired submarginal setae of the labrum (Fig. 30b) and the large median lobes of the labial palpi (Fig. 30d).

On the basis of adult and larval morphological characteristics, this species appears to be most closely related to *B. tricolor,* a

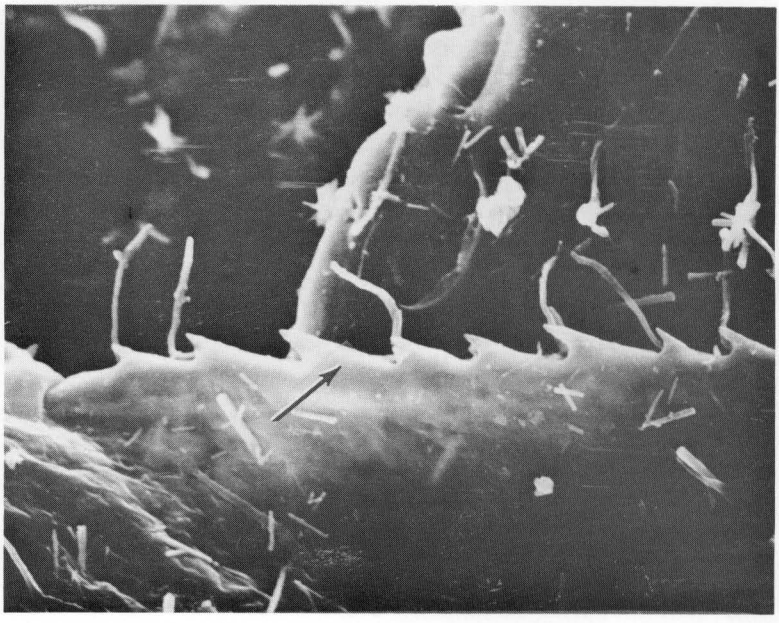

FIGURE 12. Gill margins, *B. tricaudatus* (serrate margins indicated), S.E.M. 2280x.

widespread Eurasian species (Morihara and McCafferty, 1979b).

B. propinquus is distributed throughout eastern N.A. It occurs in the north from Manibota to Quebec south to Florida and Alabama and scattered locations between.

Berner (1950) presented an account of the biology of this species as it occurs in Florida. He considered *B. propinquus* to be one of the most adaptable of all mayflies in that area because of its ubiquity. Bergman and Hilsenhoff (1978a and b) in their studies of *Baetis* in Wisconsin found this species (as *B. spinosus*) to be biologically similar to the closely related *B. frondalis*. Both species are bivoltine, overwinter as eggs, and are deuterotokously and facultatively parthenogenetic.

Material Examined. — LECTOTYPE: ♂, *Baetis propinquus* (Walsh), Rock Island Ill. Type 11218 (MCZ). HOLOTYPE: ♂, *Baetis spinosus* McDunnough, Darlinglord, MAN., 16-VII-1924, N. Criddle, type No. 1291 (CNC). PARATYPE: ♂, *Baetis spinosus*

McDunnough, same data as holotype, wings and genitalia on slide (CNC).

Slide Mounts: AL: 2 L, Bibb Co, Berner No. 3496.3 and 3496.4 (UF); 1 L, Coosa Co, Berner No. 3504.5 (UF); 3 L, Walker Co, Berner No. 3492.23 (UF); 1 L, Alachua Co, Hatchet Cr, 10/5 1940, Berner No. 3008.1 (UF); 1 L, Alachua Co, Santa Fe R, 3-12-1938, Berner No. 660.0 (UF); 1 L, Okalloosa Co, Blackwater R, 4.5 mi NW of Holt, VI-4-1971, Peters, et al. (FAM); IN: 1 L reared, Benton Co, Big Pine Cr, VI-7-1976, Minno, Bacon (PU); 2 L reared, Benton Co, Mud Cr, V-25-1976, Provonsha, Minno (PU); 4 ♂♂, LaGrange Co, Pigeon R, at 1100 E, IX-8-1973, Provonsha (PU); 1 L, Parke Co, Little Racoon Cr at Hwy 236 1/2 mi E Guion, VII-12-1972, Provonsha, Levine (PU); 1 L reared, Pulaski Co, Tippecanoe R, VIII-4-1976, Provonsha, Minno (PU); 1 L ♂ reared, Warren Co, Little Pine Cr, VII-16-1973, Provonsha, Black (PU); MS: 1 L, Lafayette Co, Berner No. 3531.4 (UF); NS: 1 L, Annapolis R, VI-25-1950 (PU).

Specimens in Alcohol: 69 L and 71 ♂♂: AL (UF); FL (FAM, INHS, PU, UF); IN (PU).

Baetis macdunnoughi Ide
(Fig. 31)

Baetis macdunnoughi Ide, 1937:230; McCafferty and Morihara, 1979:27.
Baetis herodes Burks, 1953:130 (erroneous association of male larvae).

Body Length. — 4-6 mm.

Head. — Antennae: scape and pedicel mostly bare with few fine scattered setae. Labrum: 1 + 3 setae. Right Mandible: 3 (1) + 4 denticles; row of fine setae at base of incisors; tuft of feathered setae between prostheca and molars. Left Mandible: 3 (1) + 1 + 3 denticles; innermost denticle often divided; tuft of feathered setae between prostheca and molars, smaller and with fewer setae compared to right mandible. Maxillary Palpi: extending as far as galea-lacinia. Labial Palpi (Fig. 31a): median lobe of segment 2 projecting anteromedially; segment 2 with 4-5 dorsal setae. Paraglossae: innermost setal row with 7-8 strongly pectinate setae.

Thorax. — Pronotal color pattern usually distinct (Fig. 31b). Legs: dorsal setae of femur larger than ventral setae; dorsum of tibia and tarsus bare except for fine setae and 1 or 2 robust apical setae on tibia (Fig. 31c); venter of tibia and tarsus with numerous strong setae; claws with 12-16 denticles and no subapical setae.

Abdomen. — Dorsal color patterns usually distinct (Fig. 31b), terga 8-10 pale, darker terga with pale submedian dots and anteriorly converging dashes and pale round posterior areas. Tergal Surfaces (Fig. 31d): with angulate scale bases, fine setae, and pores; posterior margins with well developed sharp spines. Paraprocts

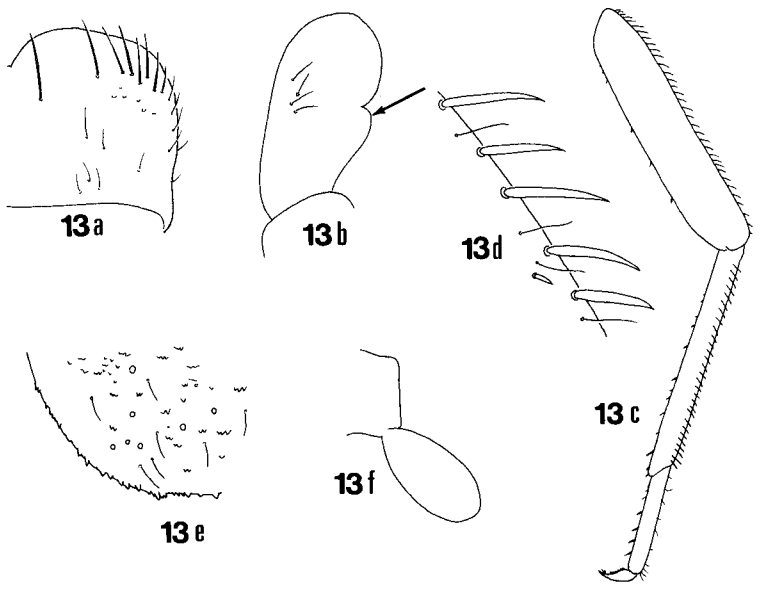

FIGURE 13. *B. lapponicus:* a. labrum; b. labial palpus (median lobe indicated); c. leg; d. dorsal setae of femur; e. paraproct; f. gill 4.

(Fig. 31e): surfaces with fine setae, angulate scale bases, pores, small conical structures, and spines; posterior margin prolonged. Gills: 1-6 broadly acute at apex; gill 7 symmetrically elongate, more slender and acute than anterior gills (Fig. 31f); anterior and posterior margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.7-0.9 length of cerci.

Discussion. — Larvae of *B. macdunnoughi* can be identified by the labial palpi (Fig. 31a) and the seventh pair of gills (Fig. 31f). The labial palpi are similar to those found on *B. pygmaeus,* which is closely related to *B. macdunnoughi.* The shapes of the seventh gills will separate these two species (Figs. 31f, 32g). The adults of *B. macdunnoughi* and *B. pygmaeus* are very similar (McCafferty and Morihara, 1979).

Ide (1937) described this species on the basis of female adults and larvae, and distinguished it from *B. pygmaeus* by female adult coloration and hind wing characteristics. Our examination of larvae collected and presumably identified by Ide as *B. macdunnoughi* has indicated that his figure of the seventh gill (Ide, 1937:Fig. 13b) was

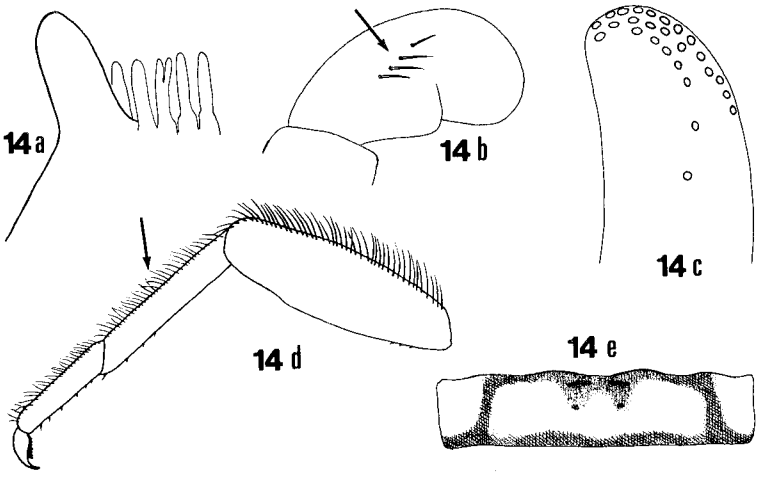

FIGURE 14. *B. insignificans:* a. primary denticle of left mandibular molar; b. labial palpus (dorsal setae indicated); c. paraglossa; d. leg (dorsal setae indicated); e. abdominal tergum 6.

inaccurate and probably the result of marginal infolding.

Burks (1953) described *B. herodes* from adults and larvae (Holotype: adult male). Edmunds (1962) correctly recognized *B. herodes* as a junior synonym of *B. hageni*. The male larvae upon which Burks based his original description of this stage and sex were misidentified. They are male larvae of *B. macdunnoughi* and thus this part of Burks' concept and description of *B. herodes* is applicable to *B. macdunnoughi* not *B. hageni*.

B. macdunnoughi has been collected only in Illinois, Indiana, North Carolina, southeastern Canada, and Wisconsin.

Parthenogenetic reproduction was experimentally demonstrated in Wisconsin populations of this species by Bergman and Hilsenhoff (1978a). Although these authors concluded that the species was entirely made up of females, males have since been described and found to be common in southern populations (McCafferty and Morihara, 1979).

Material Examined. — Slide Mounts: IL: 2 L, Herod, Gibbon's Cr, IV-8, 10-1947, Burks (INHS); IN: 1 L, Crawford Co, Stinking Frk at Blue R, V-14-1976, Provonsha, Minno (PU); 1 L, 1 L ♂

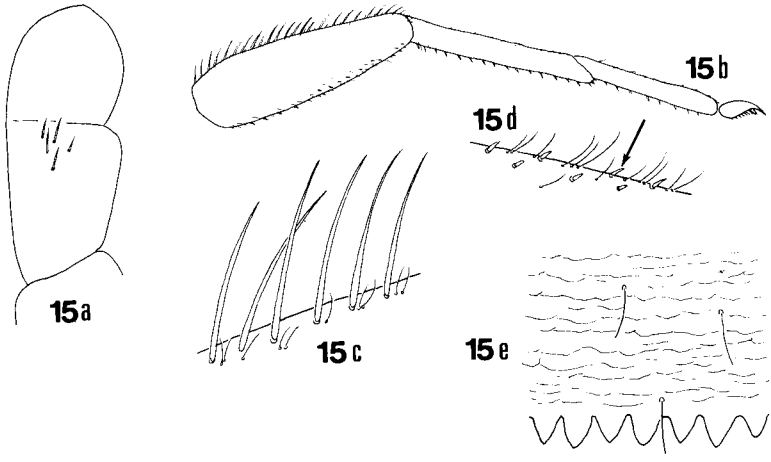

FIGURE 15. *B. amplus:* a. labial palpus; b. leg; c. dorsal setae of femur; d. dorsal setae of tibia (small robust seta indicated); e. surface and posterior margin of abdominal tergum 6.

reared, Perry Co, Poison Cr, V-14-1975, Provonsha, Minno (PU); ONT: 1 L, Grey Co, Beaver R, V-20-1957, Ide (ROM).

Specimens in Alcohol: 55 L, 1 ♂ and 2 ♀ ♀ : IN (PU); NC (CU).

Baetis pygmaeus (Hagen)
(Figs. 1, 32)

Cloe pygmaea Hagen, 1861:54.

Baetis pygmaeus (Hagen): McDunnough, 1925a:172; Ide, 1930:221, 1937:230; Leonard and Leonard, 1962:85; Bergman and Hilsenhoff, 1978b:133.

Baetis spiethi Berner, 1940:52; 1950:224. NEW SYNONYM.

Body Length. — 3-5 mm.

Head. — Antennae (Fig. 1): scape and pedicel mostly bare with scattered fine setae; robust setae rare. Labrum (Fig. 32a): 1 + 2-4 setae. Right Mandible (Fig. 32b): 3 (1) + 4 denticles; row of fine setae at base of incisors; tuft of feathered setae between prostheca and molars. Left Mandible (Fig. 32b): 3 (1) + 3 denticles; innermost denticle divided; tuft of setae between prostheca and molars with fewer setae and smaller than similar tuft on right mandible. Maxillary Palpi: extending slightly further than galea-lacinia. Labial Palpi (Fig. 32c): segment 2 projecting anteromedially with 4-6 dorsal setae. Paraglossae (Fig. 32d): innermost setal row with 4-10 strongly pectinate setae.

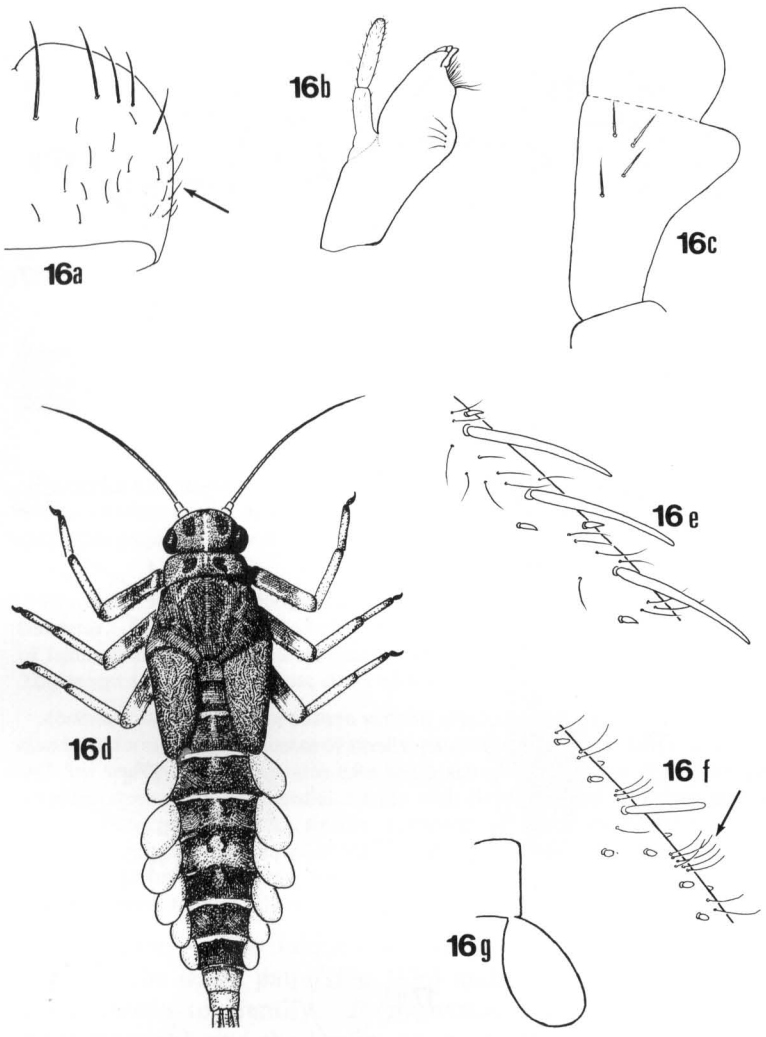

FIGURE 16. *B. tricaudatus:* a. labrum (fine setae indicated); b. maxilla; c. labial palpus; d. whole dorsal view, ♂; e. dorsal setae of femur; f. dorsal setae of tibia (fine setae indicated); g. gill 3.

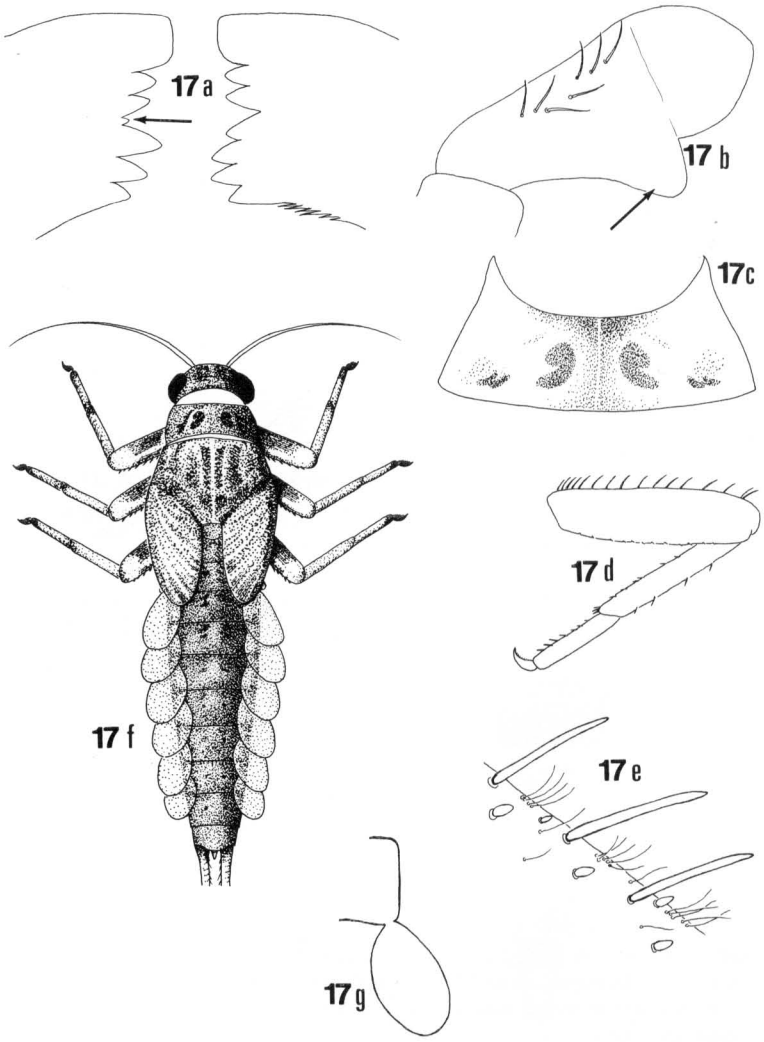

FIGURE 17. *B. bicaudatus:* a. incisors of mandibles (intermediate denticle indicated); b. labial palpus (median lobe indicated); c. pronotum; d. leg; e. dorsal setae of femur; f. whole dorsal view, ♂; g. gill 4.

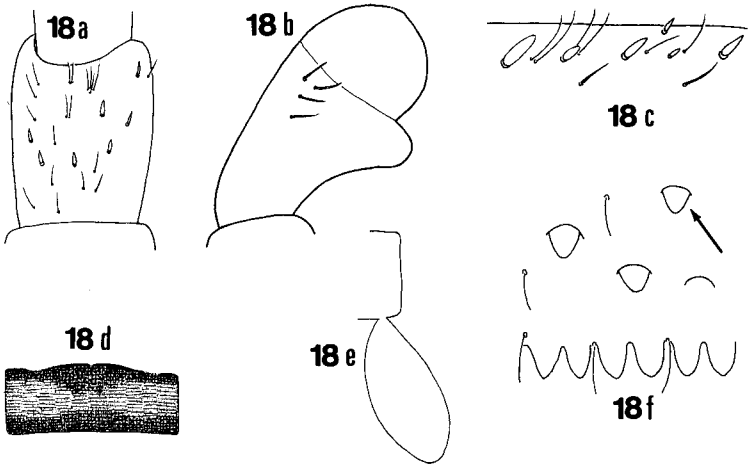

FIGURE 18. *B. foemina:* a. antennal pedicel, dorsal view; b. labial palpus; c. dorsal setae of tibia; d. abdominal tergum 6; e. gill 4; f. surface and posterior margin of abdominal tergum 6 (scale indicated).

Thorax. — Pronotal color pattern variable (Fig. 32 e-g); surface shagreened with fine setae. Legs: ventral setae larger than dorsal setae on tibia and tarsus; dorsum of femur with large setae sparse; usually dorsum of tibia with only fine setae (Fig. 32h) except 1 strong apical seta; claws with 14-17 denticles and no subapical setae.

Abdomen. — Dorsal color pattern variable (Fig. 32g, i, j), usually with a pale median band formed by coalescence of smaller pale areas. Tergal Surfaces: with scales and fine setae; posterior margins with sharp spines. Paraprocts (Fig. 32k): prolonged posteriorly; posteromedial margin with slender spines of almost uniform length. Gills: pair 7 atypical, slender, asymmetrically teardrop shaped (Fig. 32g), anterior margin smooth, posterior margin serrate with fine setae; gills 1-6 rounded posteriorly or broadly pointed, margins serrate with fine setae. Caudal Filaments: banded; median terminal filament 0.6-0.9 length of cerci.

Discussion. — The unique shape of the seventh pair of gills (Fig. 32g) and the labial palpi (Fig. 32c) make this one of the easier *Baetis* species to identify. *B. pygmaeus* is closely related to *B. macdunnoughi,* and the larvae can be distinguished only by differences in the seventh pair of gills.

The present identity of *B. pygmaeus* is based on McDunnough's (1925a) interpretation of the partially destroyed holotype which no longer exists (Burks, 1953); thus, some of the early references to

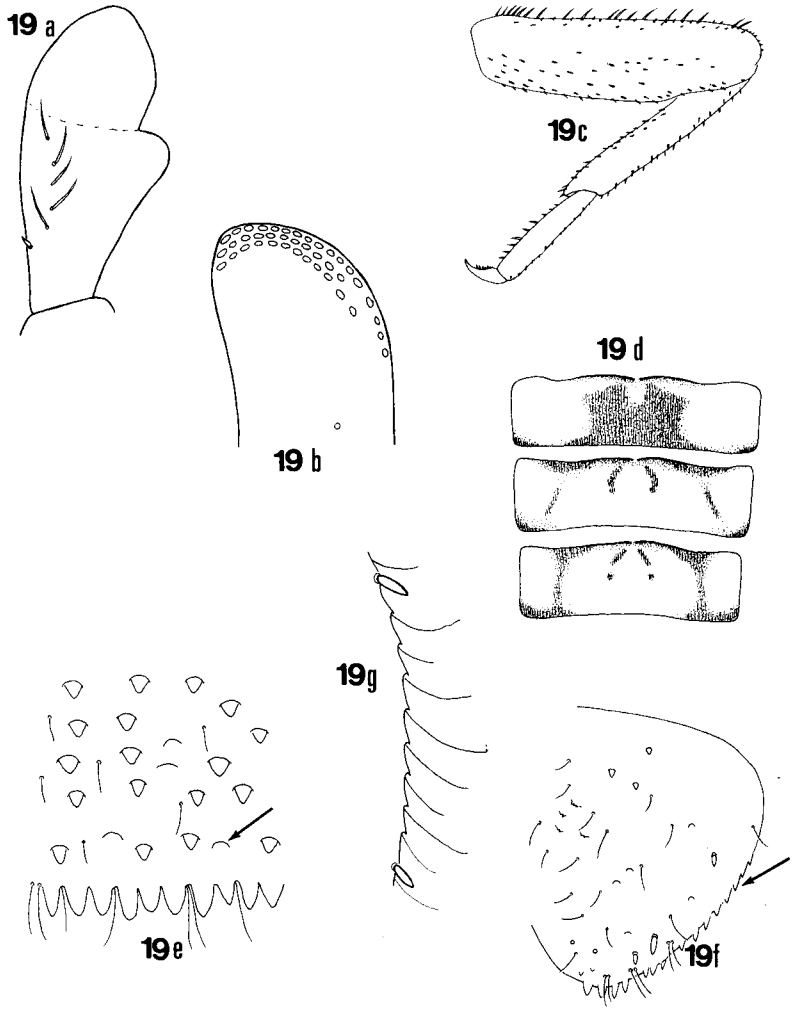

FIGURE 19. *B.* sp. A: a. labial palpus; b. paraglossa; c. leg; d. terga 3-5; e. surface and posterior margin of abdominal tergum 6 (crescent-shaped scale base indicated); f. paraproct (posteromedial spines indicated); g. gill margin.

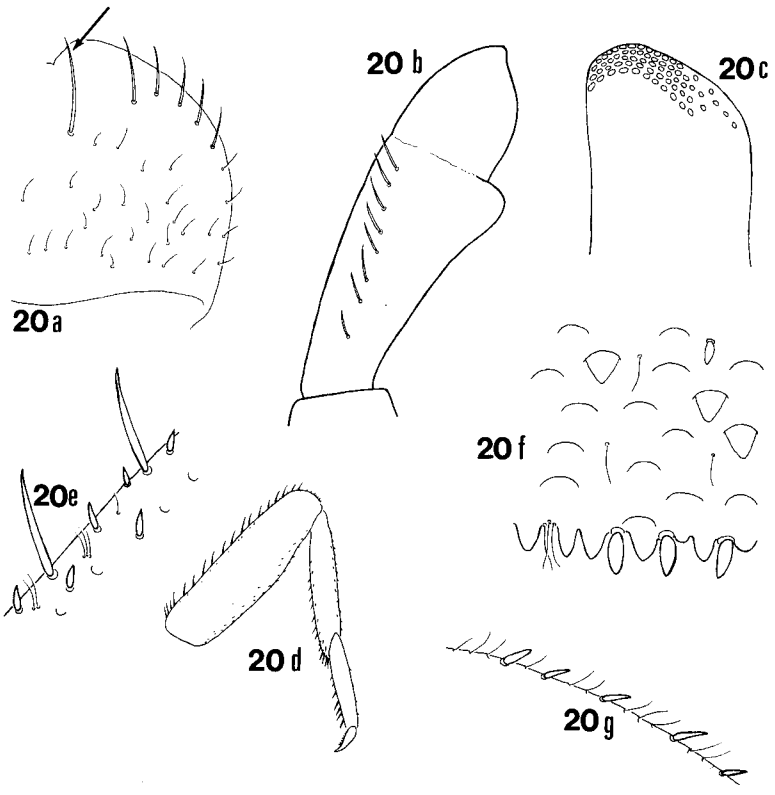

FIGURE 20. *B.* sp. B: a. labrum (submedial seta indicated); b. labial palpus; c. paraglossa; d. leg; e. dorsal setae of femur; f. surface and posterior margin of abdominal tergum 6; g. gill margin.

this species in the literature may not apply. The first adequate description of the larval stage of *B. pygmaeus* was given by Ide (1937).

Berner (1940) described *B. spiethi* from material he reared in Florida. The examination of larvae and paratypes of *B. spiethi,* larvae of *B. pygmaeus* from Ide's collections, and specimens from geographically intermediate populations, has indicated that the larvae are identical. The small number of adults examined are separable only by the presence (*B. spiethi*) or absence (*B.*

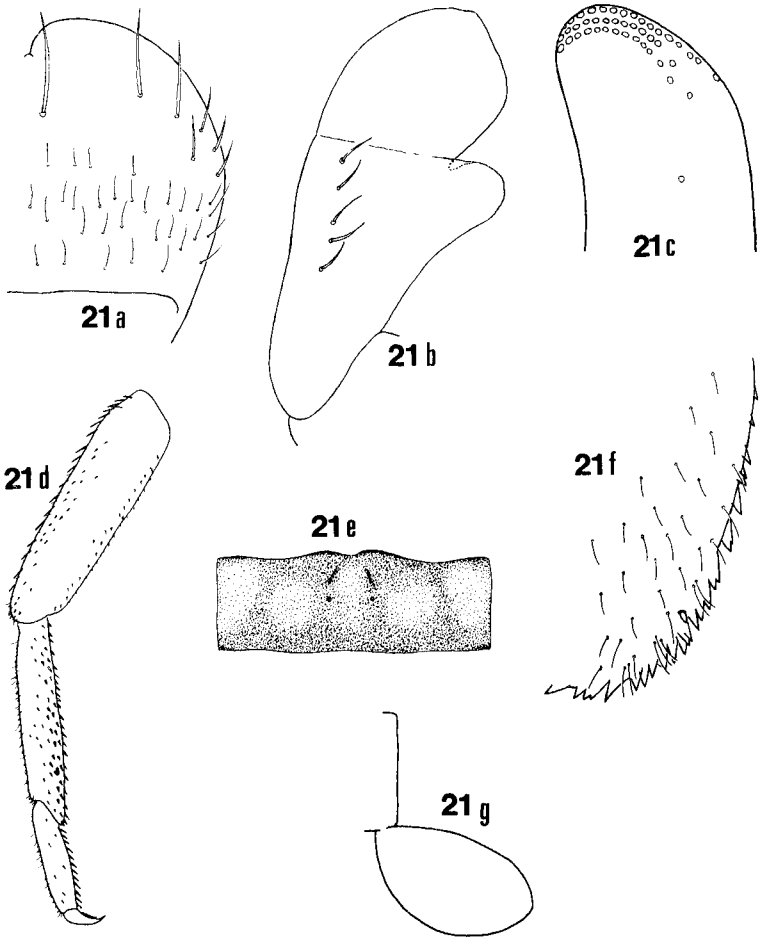

FIGURE 21. *B. brunneicolor:* a. labrum; b. labial palpus; c. paraglossa; d. leg; e. abdominal tergum 6; f. paraproct; g. gill 4.

pygmaeus) of a marginal intercalary in the first interspace of the forewing. This difference may prove to be inconsistent under more extensive observations. We place *B. spiethi* as a junior synonym of *B. pygmaeus.*

B. pygmaeus is distributed throughout eastern N.A. It has been

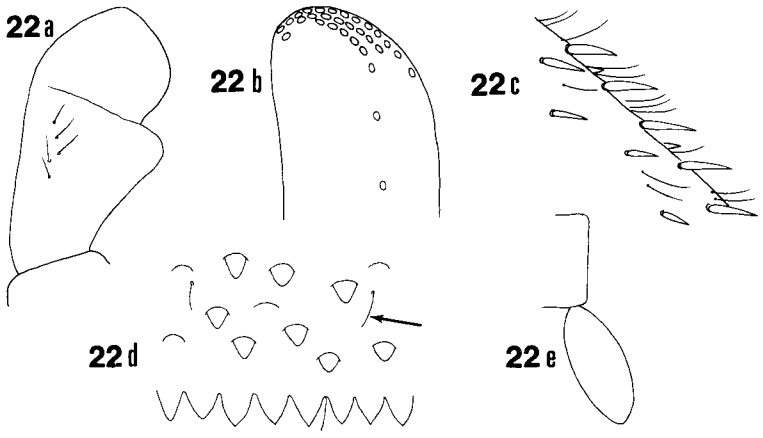

FIGURE 22. *B. macani bundyae:* a. labial palpus; b. paraglossa; c. dorsal setae of tibia; d. surface and posterior margin of abdominal tergum 6 (fine seta indicated); e. gill 6.

collected in southeastern Canada as well as Florida and west to Mississippi.

Berner (1950) reported the biology of this species (as *B. spiethi*) in Florida where he found larvae of all ages at all times of the year. Larvae occur in a wide variety of habitats including rocky substrates (Bergman and Hilsenhoff, 1978b) and submerged vegetation near stream edges in shallow sluggish current (Leonard and Leonard, 1962).

Material Examined. — PARATYPES: 2 ♂♂, *Baetis spiethi,* Berner, Alachua Co, FLA. Hatchet Creek, Cat. No. V-639-1, May 6, 1939, L. Berner No. 1293.2 1-1940; 1 ♂, Cat. No. X-1139-1, Oct. 11, 1939, L. Berner No. 1352.5, 1-1940; 1 ♂, Cat. No. IV-1339-1, 4-13-1939, L. Berner, Em. 4-14, No. 1280.7, 1-1940 (MCZ 25522).

Slide Mounts: AL: 1 L, Bibb Co, Berner No. 3496.2 (UF); FL: 1 L, Putnam Co, Johnson, Berner No. 3088.0 (UF); 1 L, Walton Co, Freeport, V-2-1946, Berner No. 2011.0 (UF); 1 L, 2 wings, Jonesboro, Br. Clear Cr, V-15-1946, Mohr, Burks (INHS); IN: 1 L, Stueben Co, Crooked Cr, 450 W, Nevada Mills, V-20-1972, Lehman (PU); MS: 1 L, Amite Co, Berner No. 3874.1 (UF); MO: 1

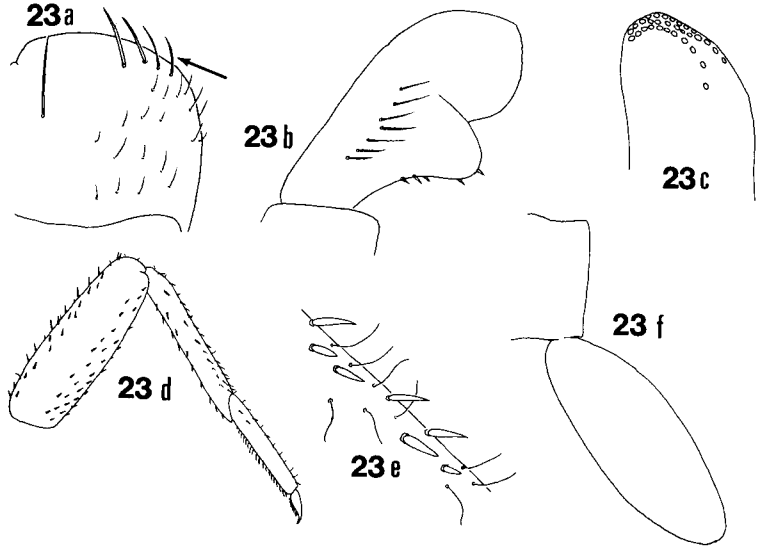

FIGURE 23. *B. hudsonicus:* a. labrum (submarginal setae indicated); b. labial palpus; c. paraglossa; d. leg; e. dorsal setae of tibia; f. gill 3.

L, Monroe Co, Salt R, IV-5-1972, Lorenz (PU); ONT: 1 L, Clear Cr, Miner's Bay, V-26-1931, Walley (CNC); 2 L, Sand Cr, Lake Nipissing, VI-8-1929, Ide (CNC); 1 L, Manitoulin Is, Bluejay Cr, VIII-22-1957, Ide (ROM); 1 L, McIntyre, VII-23-1930, Ide (CNC); QUE: 1 L, Kazabazua, VIII-18-1931, Brown (CNC); hind wing, La prairie, VI-14-1927, Brown (INHS).

Specimens in Alcohol: 58 L and 52 ♂♂: FL (UF); IN (PU); MO (PU, USNM); NC (CU); ONT (CNC, ROM); QUE (CNC).

S.E.M. Preparation: MO: 1 L, Barry Co, Roaring R, Roaring R St Prk, X-26-1971, Baumann (USNM).

Baetis alius Day
(Fig. 33)

Baetis alius Day, 1954:32.

Body Length. — 5-7 mm.

Head. — Antennae: pedicel with few scattered fine setae and small spines near apex. Labrum (Fig. 33a): 1 + 3 setae. Right Mandible (Fig. 33b): 3 + 4 denticles; with spines at base of incisors. Left Mandible (Fig. 33b): 3 + 1 + 3 denticles; with

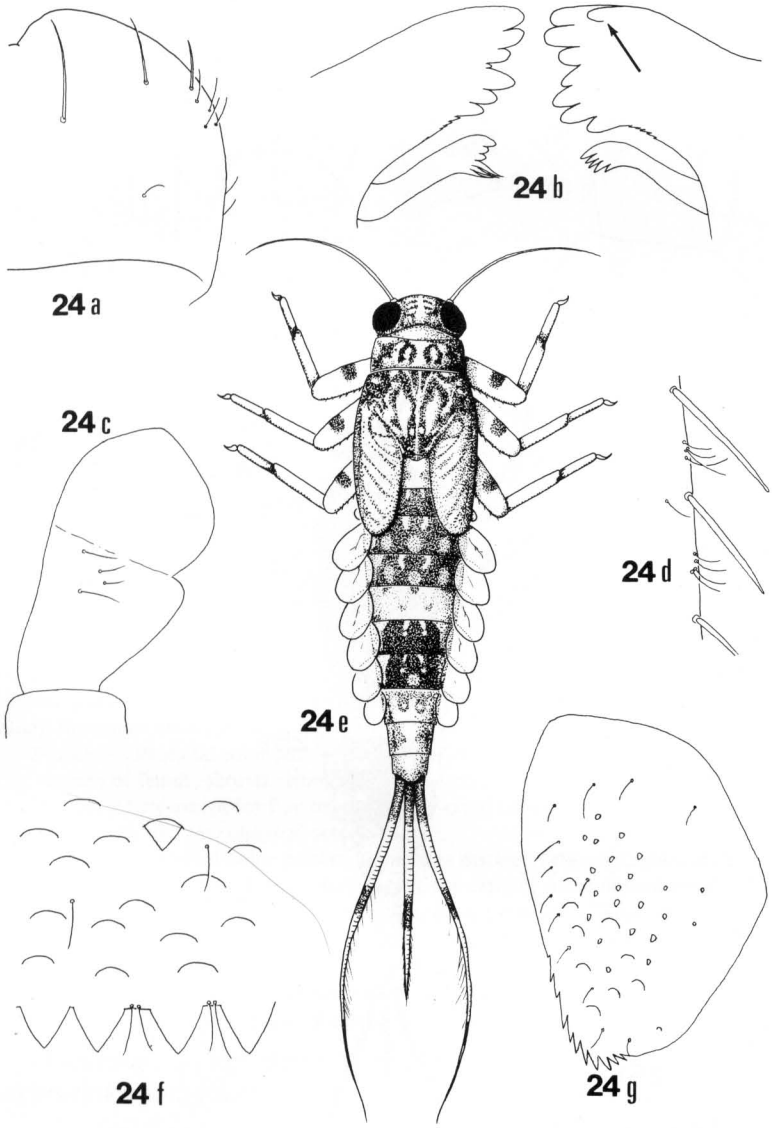

FIGURE 24. *B. intercalaris:* a. labrum; b. incisors of mandibles (distal shortened denticle indicated); c. labial palpus; d. dorsal setae of femur; e. whole dorsal view, ♀; f. surface and posterior margin of abdominal tergum 6; g. paraproct.

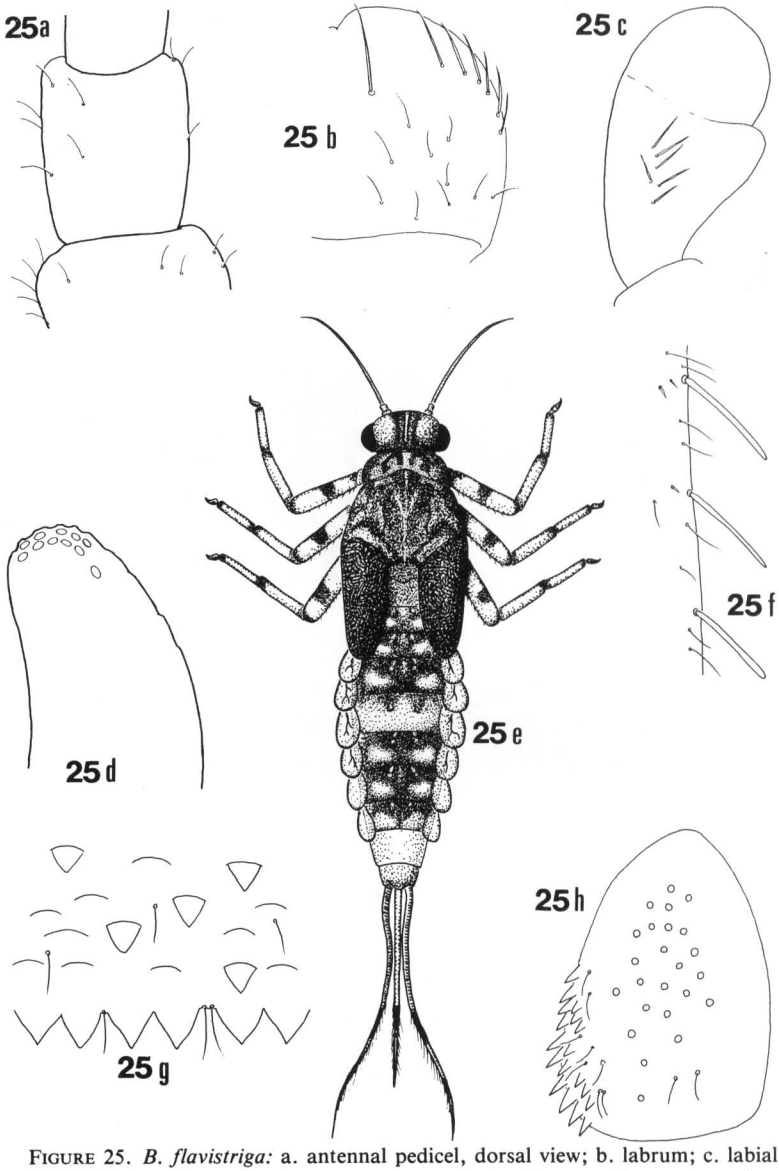

FIGURE 25. *B. flavistriga:* a. antennal pedicel, dorsal view; b. labrum; c. labial palpus; d. paraglossa; e. whole dorsal view, ♂; f. dorsal setae of femur; g. surface and posterior margin of abdominal tergum 6; h. paraproct.

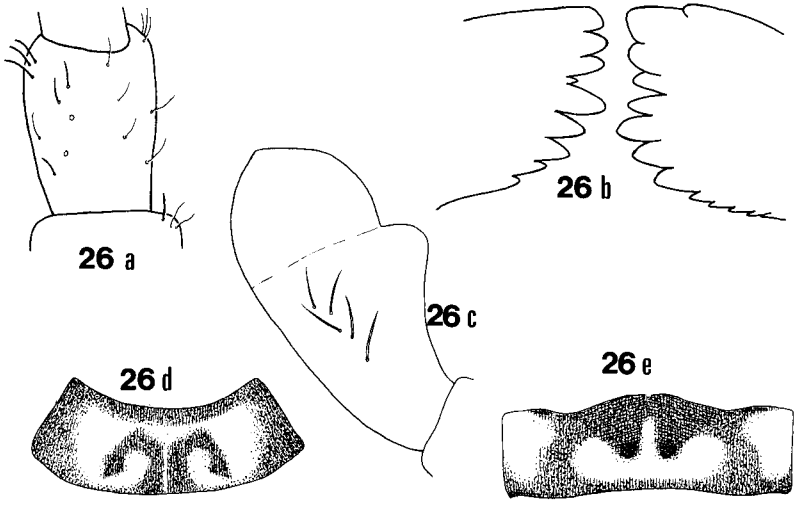

FIGURE 26. *B.* sp. C: a. antennal pedicel, dorsal view; b. incisors of mandibles; c. labial palpus; d. pronotum; e. abdominal tergum 6.

fewer spines (or none) at base of incisors relative to right mandible. Maxillary Palpi: extending slightly beyond galea-lacinia. Labial Palpi (Fig. 33c): segment 2 with 5-6 dorsal setae, no pores, and median lobe moderately developed. Paraglossae (Fig. 33d): innermost setal row with less than 10 setae.

Thorax. — Pronotal color pattern usually distinct (Fig. 33e). Legs: longest setae on dorsum of femur, shorter strong setae on venter; dorsum of tibia (Fig. 33f) and tarsus nearly bare except for fine setae and very small robust setae; tarsal claws with 12-13 denticles and no subapical setae.

Abdomen. — Dorsal color pattern sometimes distinct, tergum 5 relatively pale, and terga 3-4 and 6-8 uniformly dark except for extreme anterolateral areas (Fig. 33g). Tergal Surfaces (Fig. 33h): with scales, scale bases, and fine setae; posterior margins with blunt triangular spines and fine setae. Paraprocts (Fig. 33i): surfaces similar to tergal surfaces; posteromedial spines arranged irregularly. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament 0.6-0.8 length of cerci.

Discussion. — The larvae of *B. alius* are most similar in general appearance to those of *B. tricaudatus,* however, the two species differ considerably in many aspects. In well marked individuals the pronotal patterns differ (Figs. 16d, 33e). Also, terga 3-4 and 6-8 of *B. alius* are almost entirely dark except for anterolateral areas; in *B. tricaudatus* these terga have pale indistinct median and posterior

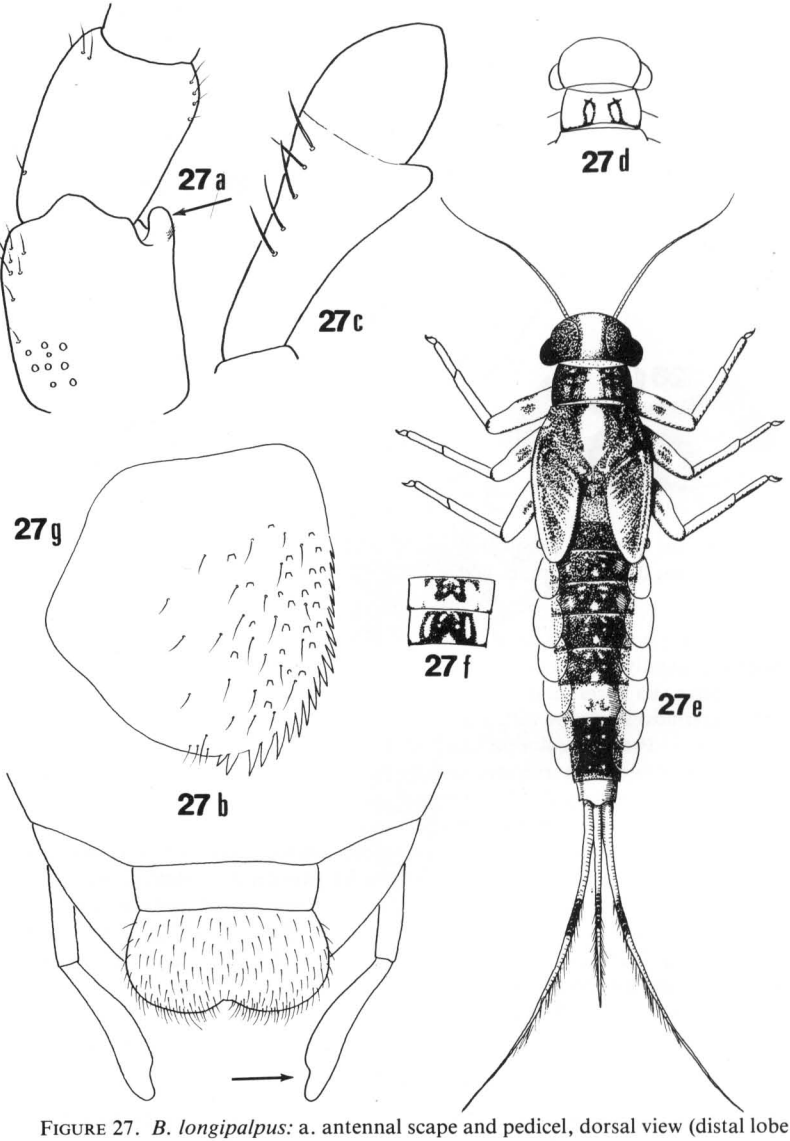

FIGURE 27. *B. longipalpus:* a. antennal scape and pedicel, dorsal view (distal lobe indicated); b. anterior view of mouthparts (subapical excavation of maxillary palpus indicated); c. labial palpus; d. pronotum; e. whole dorsal view, ♂; f. abdominal terga 4 and 5; g. paraproct.

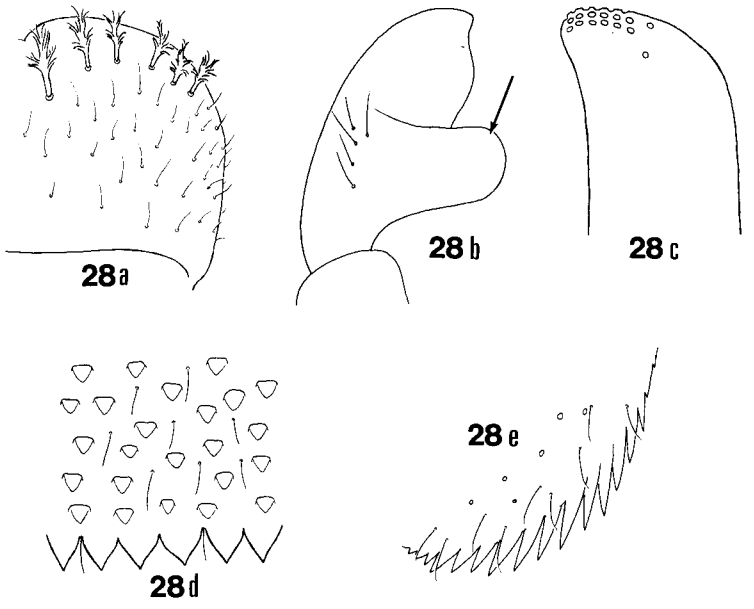

FIGURE 28. *B. ephippiatus:* a. labrum; b. labial palpus (median lobe indicated); c. paraglossa; d. surface and posterior margin of abdominal tergum 6; e. paraproct.

areas (Fig. 16d). Structural differences in the labial palpi (Figs. 16c, 33c) and the dorsal setae of the tibiae (Figs. 16f, 33f) can also be used to separate the two. General larval similarities are superficial and the adults are quite distinct. The phyletic relationships of *B. alius* are unclear at present.

B. alius was described by Day (1954) from a series of adults and larvae. We have determined that a large number of larvae in Day's series are actually individuals of *B. tricaudatus.* Thus, the extremely brief larval description was based on two species. Fortunately, the adults (which are similar to those of the *fuscatus* group) were not mixed and were all correctly applied to *B. alius.*

B. alius is known only from northern California.

Day (1954) observed the adults of this species swarming 6 to 10 feet above the water from 10:30 AM to 3:00 PM. Adults have been collected in October and November.

Material Examined. — PARATYPES: 10 ♂♂, *Baetis alius*

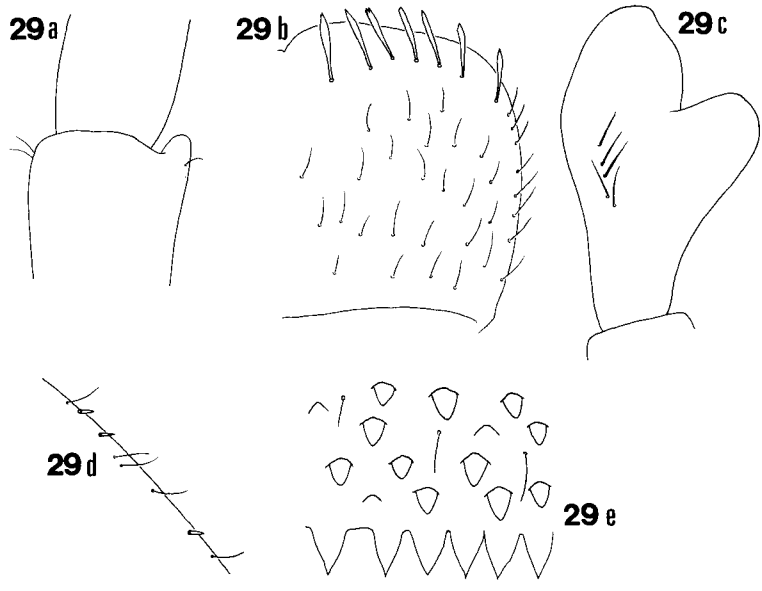

FIGURE 29. *B. frondalis:* a. antennal scape and pedicel, dorsal view; b. labrum; c. labial palpus; d. dorsal setae of tibia; e. surface and posterior margin of abdominal tergum 6.

Day, Russian R. Geyserville. CALIF. W.C. Day, IX-12-1949, in alcohol (CU); 30 ♂♂, Russian R., Geyserville. CALIF. W.C. Day, X-15-1949, XI-12-1949; in alcohol and on slides (CAS).

Slide Mounts: CA: 12 L and 2 ♂♂, Sonoma Co, Geyserville, Russian R, XI-12-1949, Day (CAS).

Specimens in alcohol: 18 L: CA (CAS).

Baetis hageni Eaton
(Figs. 8, 34, 35)

Baetis hageni Eaton, 1883-8:169; Edmunds, 1962:4.
Baetis parvus Dodds, 1923:113; Ide, 1930:219. NEW SYNONYM.
Baetis herodes Burks, 1953:130.

Body Length. — 5-7 mm.

Head. — Antennae: scape and pedicel with scattered fine setae; pores, and small spines on distal surface. Labrum (Fig. 34a): 1 + 2-6 setae. Right Mandible (Fig. 34b): 3 (1) + 4 denticles; ventral row of fine setae on incisors; prostheca slender, bifid, and pectinate with 1 branch shorter. Left Mandible (Fig. 34b): 3 (1) + 1 + 4

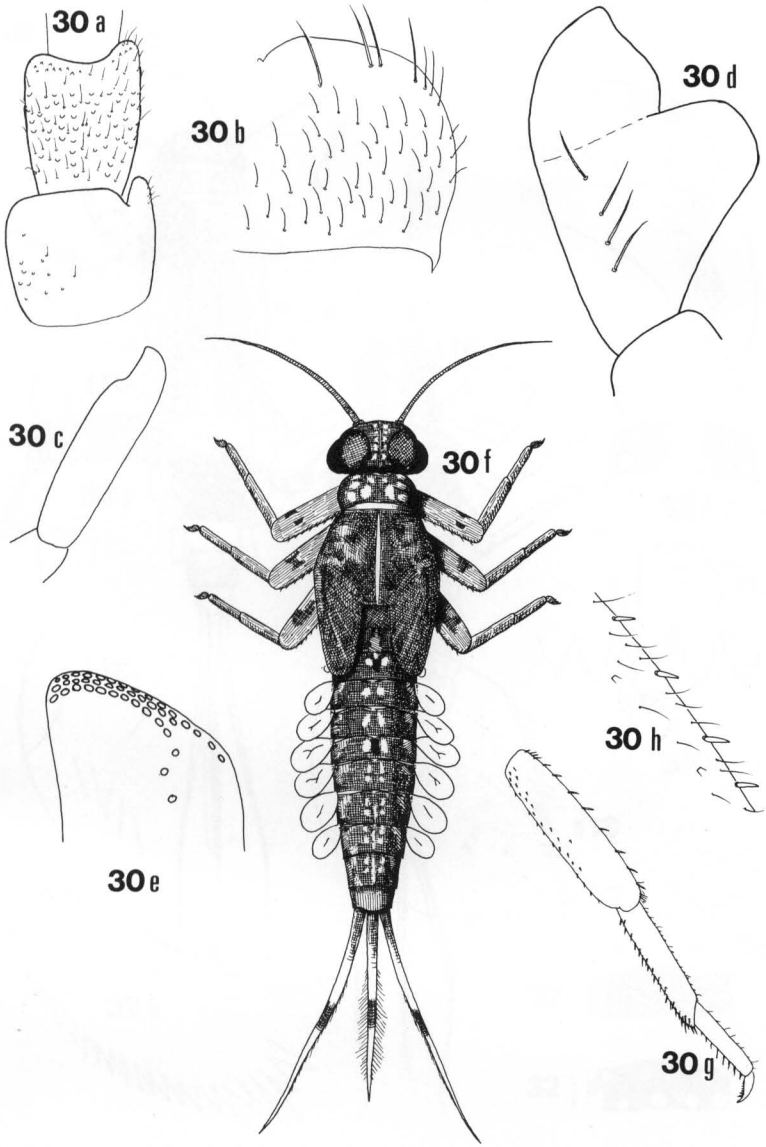

FIGURE 30. *B. propinquus:* a. antennal scape and pedicel, dorsal view; b. labrum; c. terminal segment of maxillary palpus; d. labial palpus; e. paraglossa; f. whole dorsal view, ♂; g. leg; h. dorsal setae of tibia.

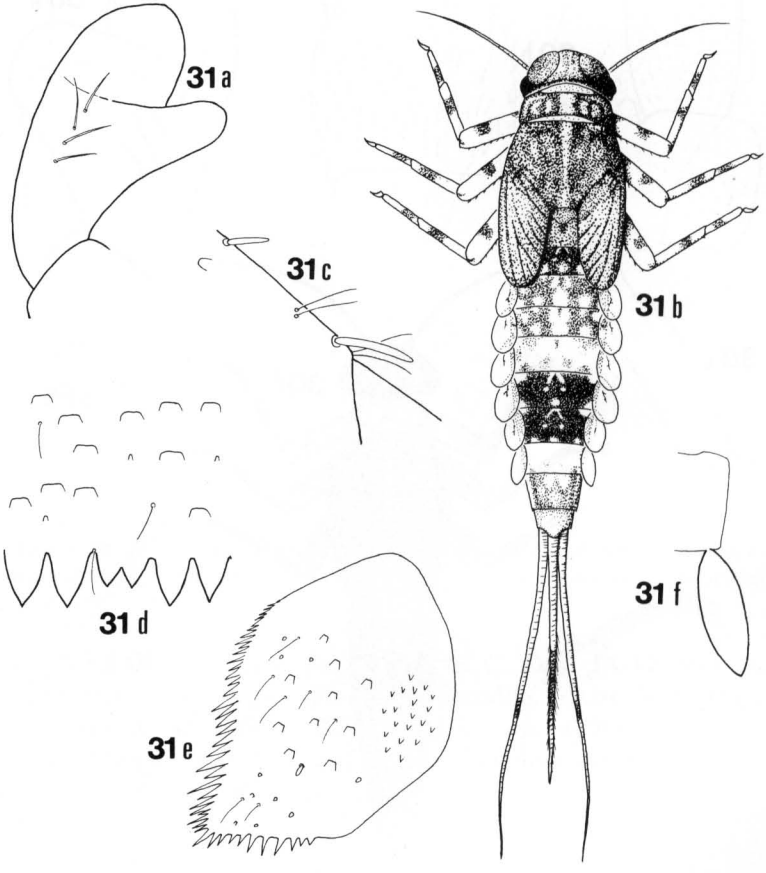

FIGURE 31. *B. macdunnoughi:* a. labial palpus; b. whole dorsal view, ♂; c. dorsal apical setae of tibia; d. surface and posterior margin of abdominal tergum 6; e. paraproct; f. gill 7.

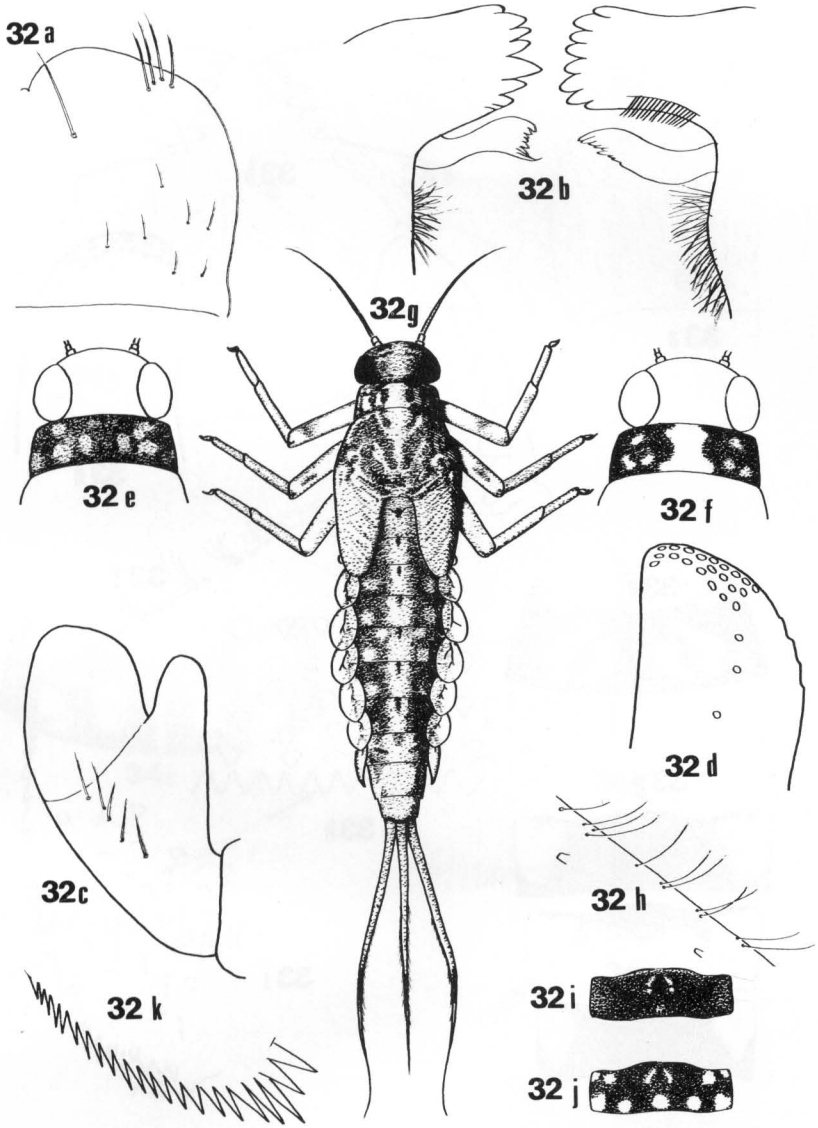

FIGURE 32. *B. pygmaeus:* a. labrum; b. mandibles; c. labial palpus; d. paraglossa; e.-f. pronota; g. whole dorsal view, ♀; h. dorsal setae of tibia; i.-j. terga 3; k. posteromedial marginal spines of paraproct.

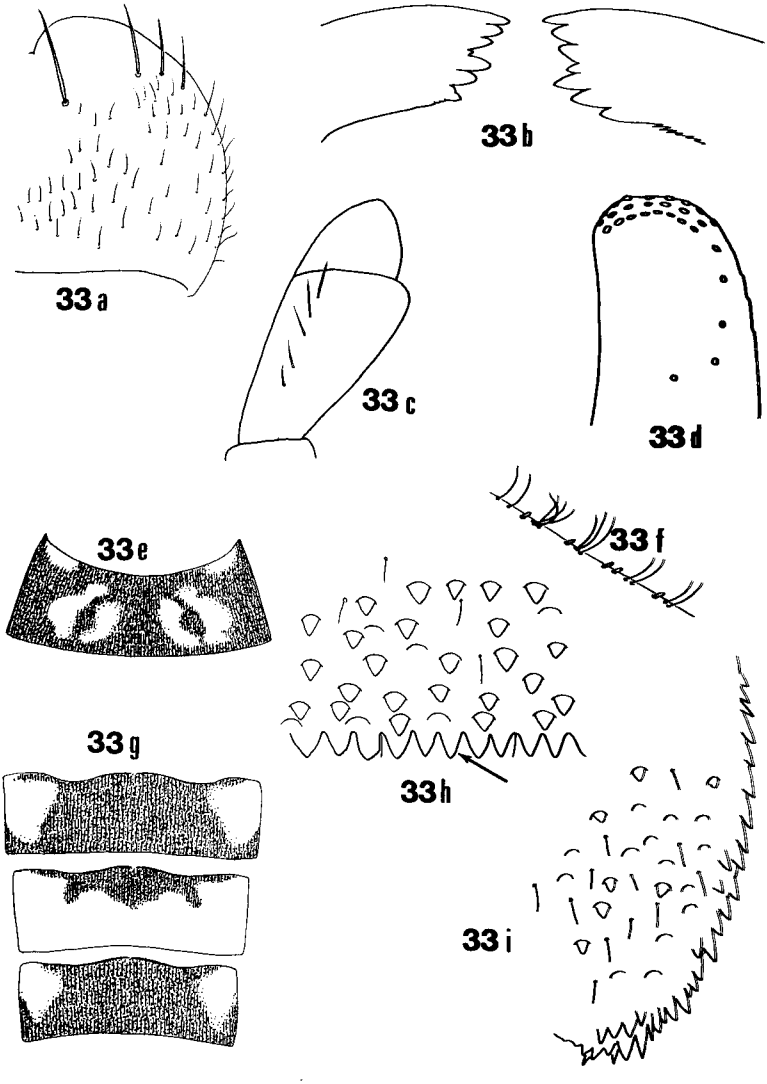

FIGURE 33. *B. alius:* a. labrum; b. incisors of mandibles; c. labial palpus; d. paraglossa; e. pronotum; f. dorsal setae of tibia; g. terga 4-6; h. surface and posterior margin of abdominal tergum 6 (spine indicated); i. paraproct.

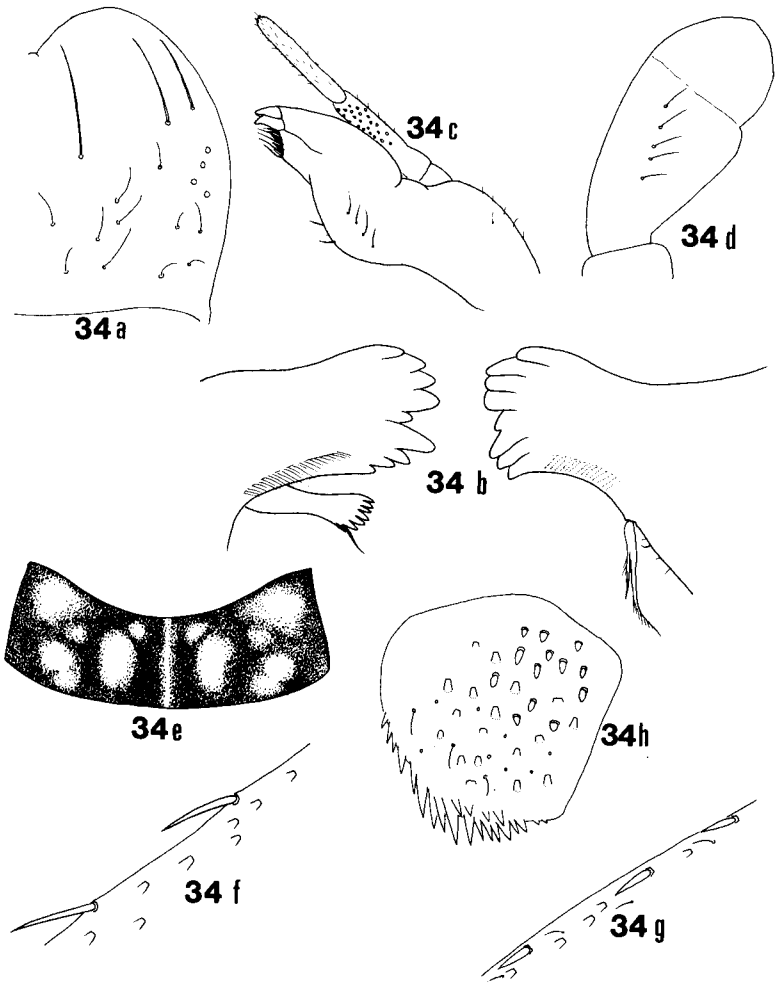

FIGURE 34. *B. hageni:* a. labrum; b. mandibular incisors and prosthecae; c. maxilla; d. labial palpus; e. pronotum; f. dorsal setae of femur; g. dorsal setae of tibia; h. paraproct.

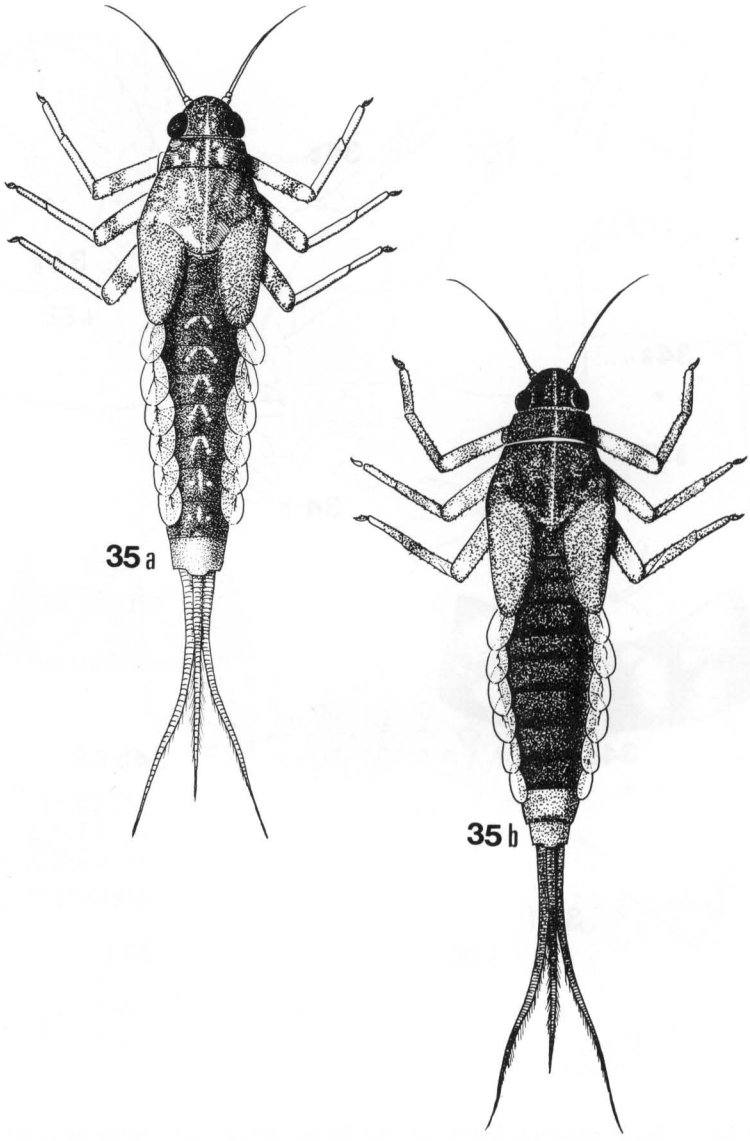

FIGURE 35. a., b. color pattern variations, *B. hageni,* whole dorsal views, ♀ ♀.

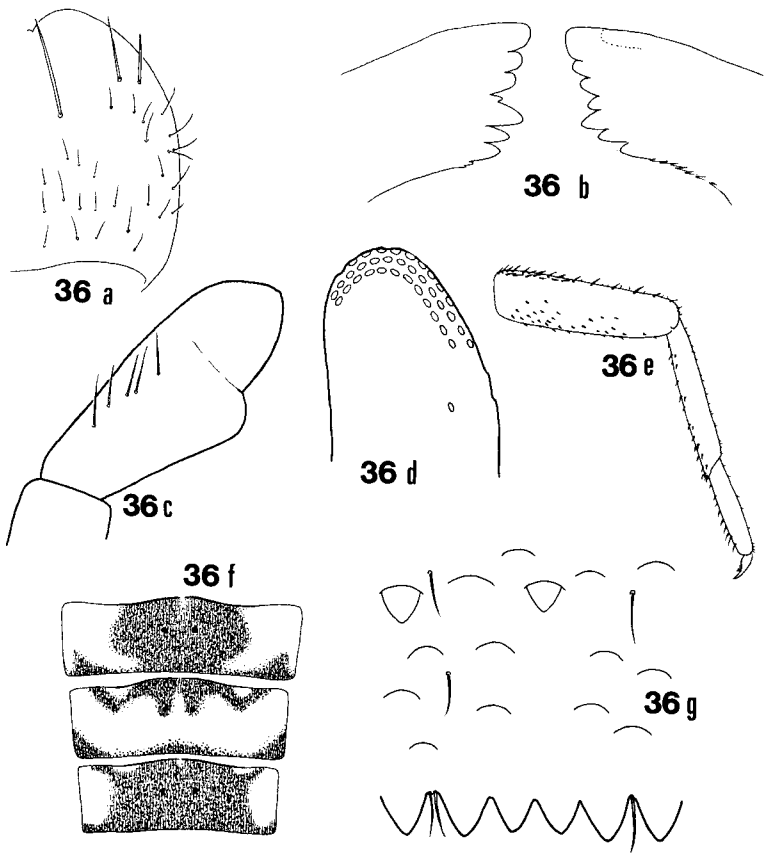

FIGURE 36. *B. pluto:* a. labrum; b. incisors of mandibles; c. labial palpus; d. paraglossa; e. leg; f. abdominal terga 4-6: g. surface and posterior margin of abdominal tergum 6.

denticles; ventral row of fine setae as in right mandible. Maxillary Palpi (Fig. 34c): extending slightly further than galea-lacinia; Labial Palpi (Fig. 34d): 4-7 dorsal setae on segment 2. Paraglossae: slender; innermost setal row with less than 10 setae.

Thorax. — Pronotum uniformly brown or with a distinct color pattern (Fig. 35a, b). Legs: 10-13 large dorsal setae on femur (Fig. 34f) with 1 apical pair; ventral setae of femur smaller; tibia with large setae similar on venter and dorsum (Fig. 34g) and more numerous on venter; tarsus with strong sharp setae on venter only; claws with 12-17 denticles and no subapical setae.

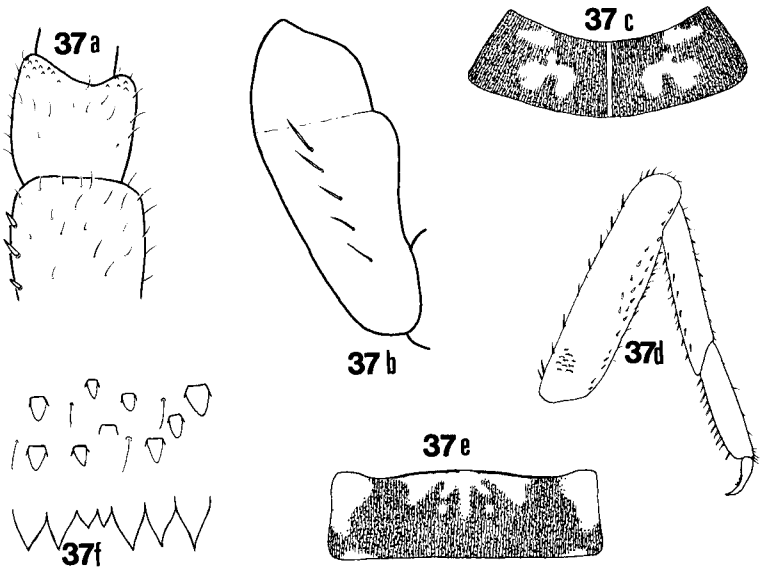

FIGURE 37. *B. quilleri:* a. antennal scape and pedicel, dorsal view; b. labial palpus; c. pronotum; d. leg; e. abdominal tergum 6; f. surface and posterior margin of abdominal tergum 6.

Abdomen. — Dorsal color pattern (Fig. 35) sometimes with 1 pair submedian pale dots and anteriorly converging pale streaks or pale markings absent, posterior terga sometimes paler than anterior terga. Tergal Surfaces: with scales, angulate scale bases, and fine setae; posterior margins with pointed spines sometimes bifid (absent laterally). Paraprocts (Fig. 34h): surfaces with robust setae, angulate scale bases, pores, and fine setae; 12-15 slender, sharp spines on posteromedial margin. Gills: absent on segment 1; slightly elongate; margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament 0.7-0.8 length of cerci.

Discussion. — *B. hageni* is the only N.A. *Baetis* in which gills on the first abdominal segment are absent. The occasionally white terminal abdominal segment(s) is a good field diagnostic character.

On the basis of adult characteristics, this species appears to be most closely related to *B. devinctus* although the larvae of *B. devinctus* are unknown. *B. hageni* can be assigned to the *muticus* group of Europe (Müller-Liebenau, 1974).

Dodds (1923) described *B. parvus* from adults collected from

Colorado unaware of the identity of *B. hageni*. The status of *B. hageni* had been uncertain until recently due to insufficient descriptions and the type specimen which was considered unidentifiable. Edmunds (1962) corrected this situation when he associated the type of *B. hageni* with an adequate description that had already been published (Burks, 1953, *B. herodes*). Adults from western N.A. that match Dodds' description proved indistinguishable from the type material of Burks' (1953) junior synonym. In addition, no differences in the larvae associated with these adults were observed.

Examination of the larval material on which Burks (1953) (as *B. herodes*) had based his descriptions indicated that he had been dealing with two distinct species. His description of the male larva was actually applicable to *B. macdunnoughi*. The single female larva described by Burks, however, is correctly identified. Examination of reared material of both *B. hageni* and *B. macdunnoughi* from Indiana have confirmed these conslusions.

B. hageni seems to be a northern transcontinental species. We have seen specimens collected as far south as Missouri and north to Quebec and British Columbia.

This species appears to be bivoltine in Wisconsin (Bergman and Hilsenhoff, 1978b). In the Rocky Mountains it occupies a wide variety of streams but is most abundant below 6,500 feet (Edmunds, 1952 and Jensen, 1966). Parthenogenesis may be thelytokous and obligatory in certain populations (Bergman and Hilsenhoff, 1978a). We have seen males collected from several localities.

Material Examined. — HOLOTYPE: ♂, *Baetis herodes* Burks, Herod, ILL. Acc. No. 47194, Apr. 9, 1947, B.D. Burks (INHS). PARATYPES: 3 ♂♂, *Baetis herodes* Burks, in alcohol, Spencer, IND., McCormick's Cr, 27 Apr. 48, W.E. Ricker (INHS).

Slide Mounts: ALTA: 1 L, Glacier Cr, Crows Nest Pass, VII-13-1930, Pepper (CNC); BC: 1 L, Garnet Valley, Summerland, IX-22-1934, Gartrell (CNC); IL: 1 L, Herod, IV-4-1947, Burks, V-1-1936, Ross and Mohr (INHS); IN: 1 L, Lawrence Co, Gullets Cr, IV-25-1975, Provonsha, Minno (PU); 1 L ♂ reared, Tippecanoe Co, Flint Cr at West Point, V-2-1975, Provonsha (PU); MO: 1 L, Barry Co, Roaring R, X-26-1971, Baumann (USNM); ONT: 1 L, Ottawa Golf Club Cr, V-17-1930, McDunnough, Walley

(CNC); QUE: 1 L, Fairy Lake Cr, Hull, V-13-1930, McDunnough (CNC); SD: 1 L, Lawrence Co, Jim Cr, 3 mi S Nemo, VI-13-1975, McCafferty, et al (PU); 2 L, Pennington Co, Rapid Cr at mouth of Dark Canyon, Rapid City, VI-13, 14-1975, McCafferty, et al (PU); WY: 1 L, Firehole R, Yellowstone Nat Prk, VII-22-24-1928, McDunnough (CNC).

Specimens in Alcohol: 78 L and 27 ♂♂: ALTA (CNC); CA (CAS); ID (PU); IL (INHS); IN (PU); MO (PU, USNM); MT (CAS), ONT (CNC); QUE (CNC, PU); SD (PU).

S.E.M. Preparation: IN: 1 L, Lawrence Co, Gullets Cr, IV-25-1975, Provonsha, Minno (PU).

Baetis pluto McDunnough
(Fig. 36)

Baetis pluto McDunnough, 1925b:218; Ide, 1937:223.

Body Length. — 4-6 mm.

Head. — Antennae: scape and pedicel with fine setae. Labrum (Fig. 36a): evenly rounded laterally; 1 + 2-3 setae. Right Mandible (Fig. 36b): 3 (1) + 4 denticles; with spines at base of incisors. Left Mandible (Fig. 36b): 3 + 1 + 3 denticles; innermost denticle basally divided. Maxillary Palpi: short, not extending as far as galea-lacinia. Labial Palpi (Fig. 36c): segment 2 at least twice as long as segment 3, with 5 dorsal setae. Paraglossae (Fig. 36d): innermost setal row with 11-14 strongly pectinate setae.

Thorax. — Pronotal color pattern indistinct with darker median shading usually visible. Legs (Fig. 36e): femur with strong sharp dorsal setae and short robust ventral setae; ventral setae of tibia slightly longer than dorsal setae; tarsus with ventral setae increasing in length apically and much longer than dorsal setae; claws with 11-13 denticles and no subapical setae.

Abdomen. — Dorsal color pattern distinct (Fig. 36f), tergum 5 relatively pale with dark submedian dots which often coalesce with anterior streaks. Tergal Surfaces (Fig. 36g): with scale bases, scales, and fine setae; posterior margins with blunt spines and fine setae. Paraprocts: approximately 10 large spines on posteromedial margin; surface with pores and fine setae. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: banded; median terminal filament about 0.7-0.8 length of cerci.

Discussion. — *B. pluto* is the only *Baetis* with three banded tails and slender labial palpi (Fig. 36c). Larvae of this species were described by Ide (1937) and based on reared specimens. Relationships to other *Baetis* are unclear although Ide had grouped it with *B. tricaudatus* (as *B. vagans*) and *B. rusticans*. While the adults are similar to the adults of the *vernus* and *fuscatus* groups, the lar-

vae are more difficult to place.

The distribution of this species appears to be Appalachian, although it has been reported from the St. Lawrence Valley region (McDunnough, 1930). We have seen specimens of *B. pluto* which were collected as far south as Virginia.

Material Examined. — HOLOTYPE: ♂, Covey Hill, QUE., 27-VI-1924, G.S. Walley, slide Bae No. 31, type No. 1264 (CNC). PARATYPE: ♂, Broadview, QUE., 21-VI-1923, R. Ozburn, No. 1264 (CNC).

Slide Mounts: PA: 1 L, Monroe Co, Cerll Poropoco Cr, VII-29-1965, Glime (USNM); VA: 3 L, Carroll Co, New R, XI-21-1976, Kennedy (VPI).

Baetis quilleri Dodds
(Fig. 37)

Baetis quilleri Dodds, 1923:112.
Baetis endymion Traver, 1935:686. NEW SYNONYM.
Baetis erebus Traver, 1935:687. NEW SYNONYM.
Baetis cleptis Burks, 1953:130. NEW SYNONYM.
Baetis leechi Day, 1954:29. NEW SYNONYM.

Body Length. — 4-6 mm.

Head. — Antennae (Fig. 37a): scape with both robust and fine setae; pedicel with fine setae, rarely with stout setae as in scape, and apical surfaces with short spines. Labrum: 1 + 2-4 setae. Right Mandible: 3 (1) + 4 denticles; row of fine setae at base of incisors; tuft of setae between prostheca and molars. Left Mandible: 3 (1) + 1 + 3 denticles; incisors without basal setae; tuft of setae between prostheca and molars similar to tuft on right mandible. Maxillary Palpi: extending as far as or beyond galea-lacinia. Labial Palpi (Fig. 37b): slender; segment 2 with median lobe poorly developed and with 4-6 dorsal setae. Paraglossae: innermost setal row with less than 10 weakly pectinate setae.

Thorax. — Pronotum sometimes with a distinctive pattern (Fig. 37c). Legs (Fig. 37d): dorsal setae of femur longer than ventral setae; small surface spines restricted to basal half of femur; dorsal setae of tibia slender and acute to robust and blunt; ventral setae of tibia more conspicuous than dorsal setae; tarsus without numerous large dorsal setae, ventral setae strong and acute; claws with 10-13 denticles and no subapical setae.

Abdomen. — Distinct dorsal color pattern sometimes present (Fig. 37e); terga 8-10 paler than anterior terga. Tergal Surfaces (Fig. 37f): shagreened with fine setae, scales, and angulate scale bases; posterior margins with very sharp spines variable in size and fine setae. Paraprocts: surfaces similar to rest of abdomen; posteromedial margins with large sharp spines. Gills: rounded posteriorly; margins serrate with fine setae. Caudal Filaments: unbanded; median terminal filament 0.5-0.8 length of cerci.

Discussion. — The shape of the labial palpi (Fig. 37b) and the tufts of setae on the mandibles (as in Fig. 32b) will allow correct identification of *B. quilleri.* The pronotal pattern resembles a pair of eyes and does not vary as much as the abdominal maculation.

B. quilleri was described by Dodds (1923) from a female adult with a unique hooklike costal projection on the hind wing. Subsequently, *B. endymion* Traver (1935), *B. erebus* Traver (1935), *B. cleptis* Burks (1953), and *B. leechi* Day (1954) were described from adult males all of which possessed this character state. Larvae had not previously been known. Distinctions between these names were based on coloration, overall wing to body length, size, proportions, and venation of the hind wing, and, in the case of *B. cleptis,* a supposed simple median projection between the forceps bases. Color, size, and wing characters have proven to be variable and overlapping, and our examination of a paratype slide of the genitalia of *B. cleptis* has revealed a distinct, bilobed median projection typical of other adult male type specimens and descriptions of previously mentioned names. In addition, a single, widespread larval form is associated with all (we have reared adults from Texas). Hence, it appears that *B. endymion, B. erebus, B. cleptis,* and *B. leechi* represent no more than color variations of a geographically widespread species, and we place all of them as junior synonyms of *B. quilleri.*

The characteristic costal projection and venation of the hind wings, and the male genitalia are very similar to some *Centroptilum* species (e.g., *C. selandorum* Edmunds) and may indicate a close relationship.

Although *B. quilleri* has been collected as far east as Illinois and north to the Black Hills of South Dakota and to Idaho, it appears to be most common in the extreme southwestern portions of the United States, including Texas. This species probably extends into Central America.

At lower altitudes, and in the southwestern portions of its range, adults have been collected from January to May (Traver, 1935) and also in September (Burks, 1953 and Day, 1954). At higher altitudes (5,000-7,000 feet), emergence has been reported in June and July (Dodds, 1923). Because the larvae were previously unknown, nothing is known of their biology.

Material Examined. — HOLOTYPE: ♂, *Baetis cleptis* Burks, Detroit, ILL. Sept. 15, 1939, Ross and Mohr (INHS). PARATYPES: 3 ♂♂, *Baetis endymion* Traver, OKLA., Johnson Co, 19-III-1932, O. Sandoz, wings and genitalia on slides (CNC). PARATYPE: 1 ♂, *Baetis cleptis* Burks, Detroit, ILL. Sept. 15, 1939, Ross and Mohr, wings and genitalia on slides. PARATYPES: 8 ♂♂, *Baetis leechi* Day, CALIF., Conn Cr., Napa Co., 24-IX-1949, W.C. Day, wings and genitalia on slides (CAS and CNC).

Slide Mounts: AZ: 1 L, Apache Co, Apache Nat For, Little Colorado R (70° F) on Hwy 73, VII-3-1964, Allen (CSU); 1 ♂, Phoenix (at light), VII-22-1955, Denning (CAS); CA: Los Angeles Co, W Frk San Gabriel R at junction Bear Cr, VII-21-1965, Vann (CAS); NM: 1 L, Catron Co, Gila R, VII-9-1969, Koss, et al (PU); 2 L, Grant Co, Sapilla Cr, IX-10-1967, Koss, Argyle (PU); 1 L, Grant Co, 14 mi N Silver City, Cherry Cr, IX-9-1967, Koss (PU); SD: 1 L, Fall River Co, Fall R, VI-11-1975, McCafferty, et al (PU); 2 L, Fall River Co, Hot Brk, VI-12-1975, McCafferty, et al (PU); TX: 2 ♂♂, Blanco Co, Little Blanco R at Twin Sisters at US Hwy 281, V-6-1977, McCafferty, et al (PU); 1 L, Blanco Co, Blanco R 6 mi W Blanco, V-6-1977, McCafferty, et al (PU); 1 L ♂ reared, Brazos Co, Narasota R Hwy 6, VII-30-1969, Bjork (PU); 4 L, Kerr Co, Turtle Cr at Tx Hwy 16, V-6-1977, McCafferty, et al (PU); UT: 1 ♂, Washington Co, Santa Clara Cr nr Santa Clara, III-22-1953, Edmunds (CAS).

Specimens in Alcohol: 304 L and 96 ♂♂: AZ (CAS, CSU, PU); CA (CSU, PU); MO (USNM); NM (PU); OK (PU); SD (PU); TX (PU).

SUMMARY

Detailed examination of larval microstructure, reared adults, and type material from all stages has been used to comparatively analyze species of North American *Baetis,* and has led to a revision of species classification and an improved understanding of relationships within the genus. An illustrated key to 24 species based on larval characters is presented. For these species which are known as larvae descriptions, figures, diagnoses, and discussions of biologies, distributions, and species relationships are provided.

Five species are described for the first time as larvae; however, only two of these are nominal (*Baetis insignificans* McDunnough and *Baetis quilleri* Dodds); three are not associated with adults and remain unnamed at the present. Most of the species treated show close relationships with European or Eurasian congeners and are grouped accordingly. Newly discovered synonyms include: *B. tricaudatus* Dodds (=*B intermedius* Dodds, *B. vagans* McDunnough, NEW SYNONYMS); *B. brunneicolor* McDunnough (=*B hiemalis* Leonard, *B. anachris* Burks, *B. phyllis* Burks, NEW SYNONYMS); *B. flavistriga* McDunnough (=*B. phoebus* McDunnough, *B. nanus* McDunnough, *B. levitans* McDunnough, NEW SYNONYMS); *B. pygmaeus* (Hagen) (=*B. spiethi* Berner, NEW SYNONYM); *B. hageni* Eaton (=*B. parvus* Dodds, NEW SYNONYM); and *B. quilleri* Dodds (=*B. endymion* Traver, *B. erebus* Traver, *B. cleptis* Burks, *B. leechi* Day, NEW SYNONYMS).

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