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A Revision of the Genus *Ephemerella* (Ephemeroptera: Ephemerellidae)
VI. The Subgenus *Serratella* in North America¹

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ABSTRACT

The 13 known species of the subgenus *Serratella* include *E. (S.) velmae* from California. This new species, like *E. carolina* Berner and Allen, and *E. spiculosa* Berner and Allen, is known only from the nymphal stage. *Ephemerella molita* McDunnough is of uncertain status;

E. teresa Traver (= *E. cognata* Traver), new synonymy. Illustrated keys are given to the known nymphs and adults, and distributions and complete synonymies are given for each species.

Part I of this revision (Allen and Edmunds 1959) dealt with the subgenus *Timpanoga* Needham, Part II (Allen and Edmunds 1961a) with the subgenus *Caudatella* Edmunds, Part III (Allen and Edmunds 1961b) with the subgenus *Attenuatella* Edmunds, Part IV (Allen and Edmunds 1962a) with the subgenus *Dannella* Edmunds, and Part V (Allen and Edmunds 1962b) with the subgenus *Drunella* Needham.

In the following species accounts, collections made by the authors are indicated by the initials GFE and/or RKA. Abbreviations for collections in which specimens are deposited are as follows: AMNH, American Museum of Natural History; CAS, California Academy of Sciences; CNC, Canadian National Collection; CU, Cornell University; INHS, Illinois Natural History Survey; JRT, J. R. Traver personal collection; OSU, Oregon State University; SC, Sheridan College; UCSC, University of California, Sagehen Creek Station; UF, University of Florida; VKM, V. K. Mayo personal collection. Specimens without designation are deposited in the collection of the University of Utah.

Subgenus *Serratella* Edmunds

(*Ephemerella*) Section 'II McDunnough 1931b, 203.

(*Ephemerella*) *serrata* group Traver 1932, 146; Traver 1935, 565; Traver 1937, 73; Burks 1953, 65.

Serratella Edmunds 1959, 544 (as subgenus); type *serrata* Morgan, by original designation; Berner and Allen 1961, 149.

McDunnough (1931b) divided the genus *Ephemerella* into five sections. Into one of these he placed five species, *Ephemerella deficiens* Morgan, *E. sordida* McDunnough, *E. frisoni* McDunnough, *E. serratoides* McDunnough and *E. serrata* Morgan. Traver (1935) placed 11 North American species together as the *serrata* group, and Edmunds (1959) named them as the subgenus *Serratella*.

The subgenus *Serratella* may be characterized in the male adult by the following combination of characters: (1) lateral cerci and median terminal filament subequal, (2) terminal segment of genital forceps less than twice as long as broad (figs. 2 to 10), (3) penes without dorsal or ventral spines and penis

lobes with a lateral subapical projection, if lateral processess are lacking then foretibia is longer than foretarsus, and (4) third foretarsus shorter than second.

The nymphal stages are characterized by the following combination of characters: (1) imbricated gills on segments 3 to 7 (fig. 1), (2) ventral margin of fore femora without tubercles, (3) maxillary palpi absent or reduced in size (fig. 41, as compared with fig. 42, not reduced), and (4) caudal filaments subequal with whorls of apical segmental spines and usually without intersegmental setae; when present they are sparse (fig. 16).

As treated here, the subgenus *Serratella* contains 13 North American species: *Ephemerella deficiens* Morgan, *E. levis* Day, *E. velmae* new species, *E. sordida* McDunnough, *E. frisoni* McDunnough, *E. micheneri* Traver, *E. tibialis* McDunnough (= *angusta* Traver, 1934: 211), *E. teresa* Traver (= *cognata* Traver 1934: 231, NEW SYNONYMY), *E. serratoides* McDunnough, *E. serrata* Morgan, *E. spiculosa* Berner and Allen, *E. carolina* Berner and Allen, and *E. molita* McDunnough which is herein considered to have uncertain status. In addition to these North American species the subgenus is represented by three other species in Asia.

The following keys will serve to identify the species of the subgenus *Serratella*.

MALE IMAGOES³

1. Western North American species; eastern limits in New Mexico, Colorado, Wyoming, Montana, and Alberta (fig. 66)..... 2
- Eastern North American species; western limits in Mississippi, Missouri, Illinois, Michigan, and Ontario (figs. 67, 68)..... 5
- 2 (1). Penis lobes with lateral, subapical projection (figs. 2, 3)..... 3
- Penis lobes without a lateral, subapical projection (figs. 4, 5)..... 4
- 3 (2). Fore tibia longer than fore tarsus; genitalia as in fig. 2..... *micheneri*
- Fore tibia shorter than fore tarsus; genitalia as in fig. 3..... *levis*
- 4 (2). Penes constricted near base; inner margin of each penis lobe with a subapical notch (fig. 4)..... *tibialis*
- Penes not constricted near base, sides nearly parallel; inner margin of each penis lobe without a subapical notch..... *teresa*

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² The research upon which this report is based was supported by grants from the National Science Foundation and the University of Utah Research Fund.

³ The male imagoes of *E. velmae*, *E. carolina*, *E. molita*, and *E. spiculosa* are unknown.

- 5 (1). Abdominal sterna with four black dots; tubercle between bases of forceps truncate, and genitalia as in fig. 6.....*serratoides*
 Abdominal sterna without such black dots; tubercle between bases of forceps rounded, and genitalia not as above (figs. 7-10)..... 6
- 6 (5). Caudal filaments with dark brown annulation at apex of each segment..... 7
 Caudal filaments unicolorous, without annulations..... 8
- 7 (6). Abdominal segments light brown; penes with small, lateral spines (fig. 7).....*serrata*

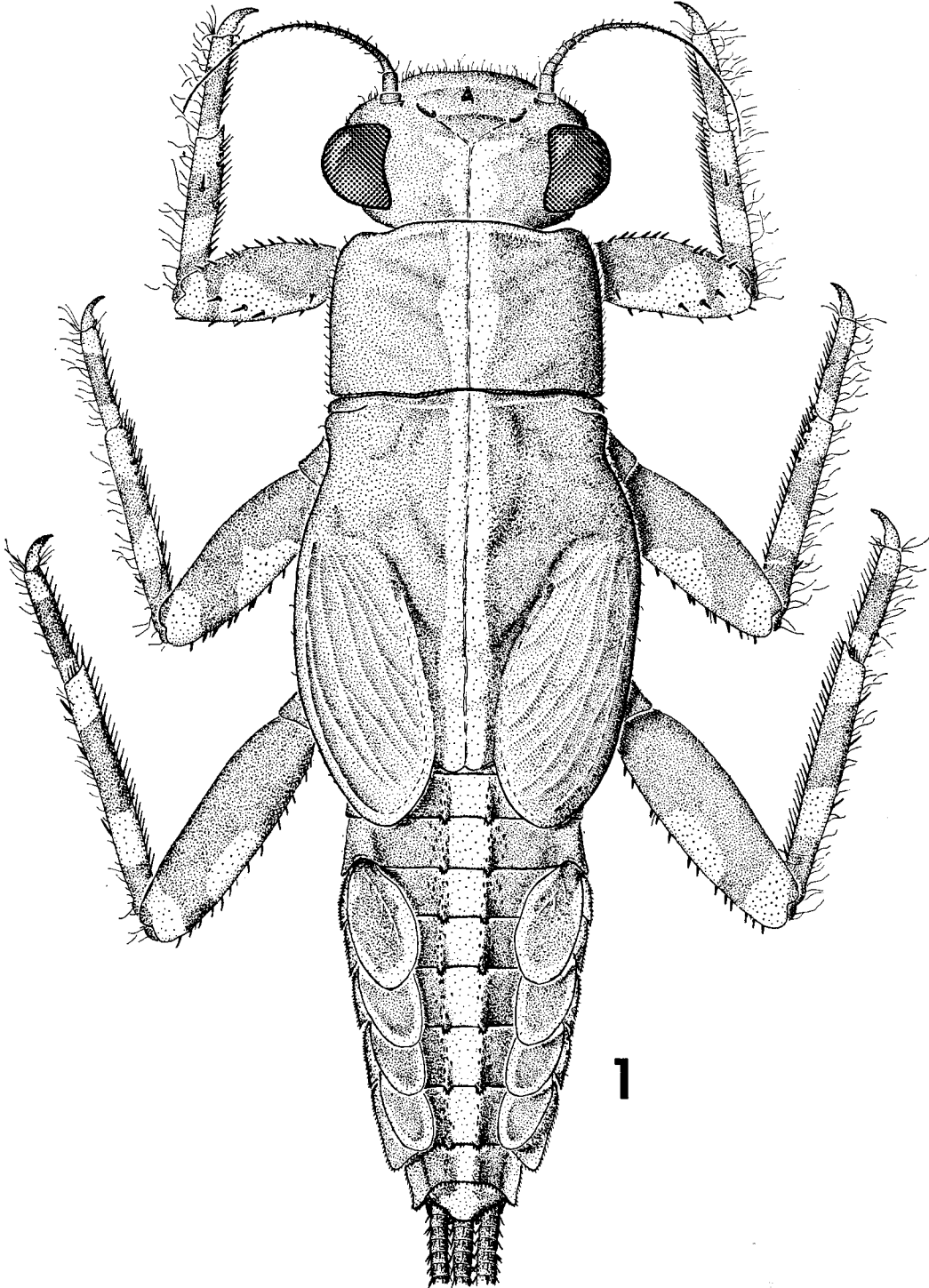


PLATE I

FIG. 1.—*Ephemera tibialis*, mature female nymph, dorsal view.

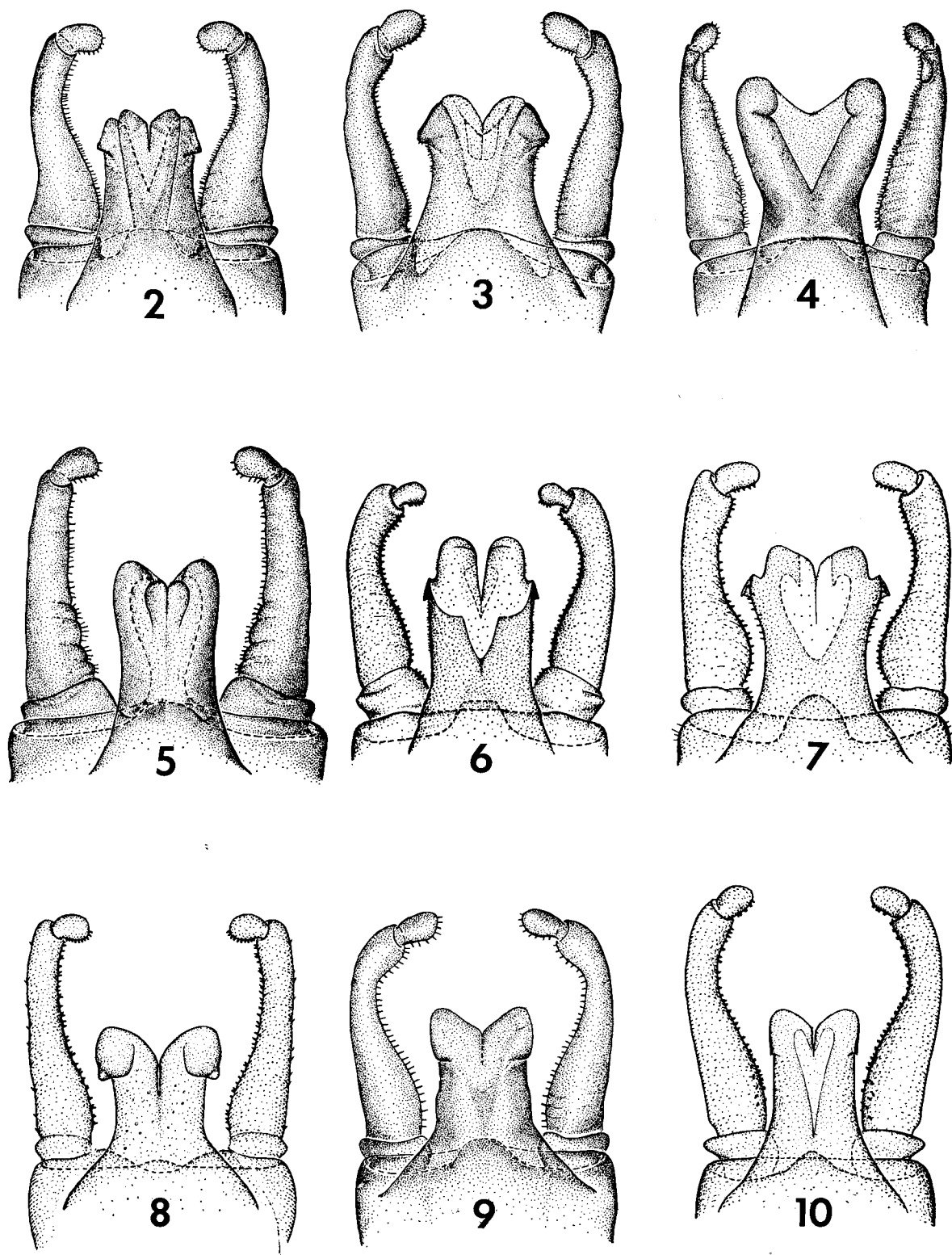
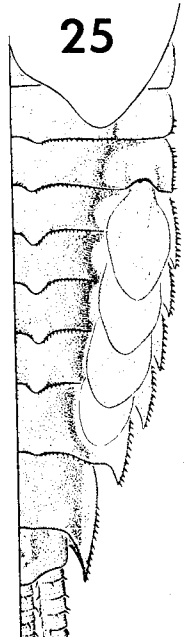
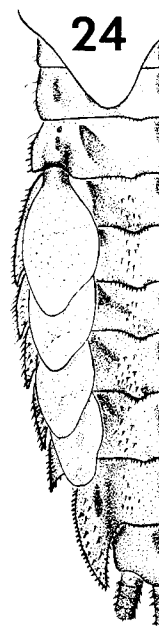
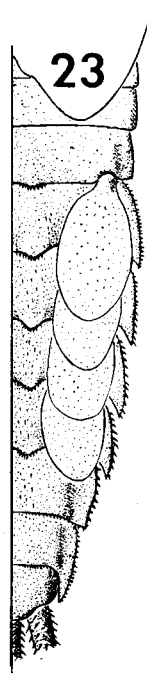
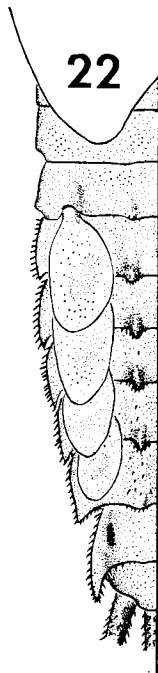
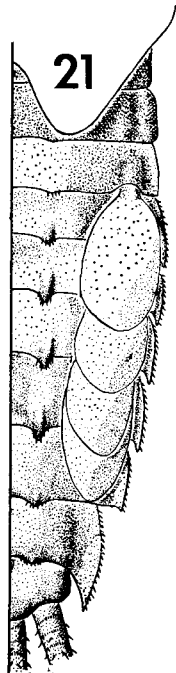
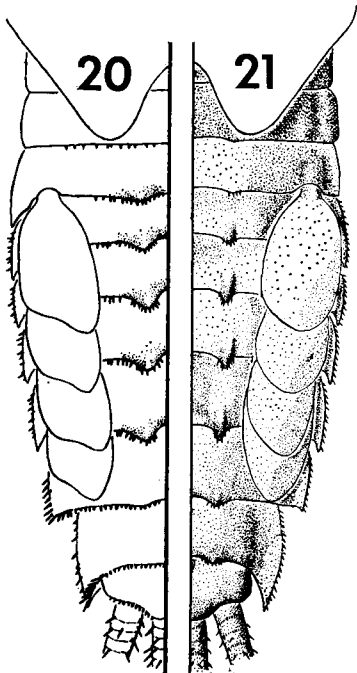
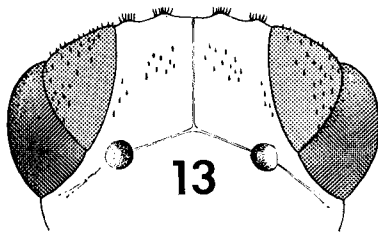
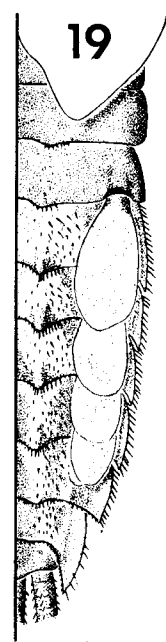
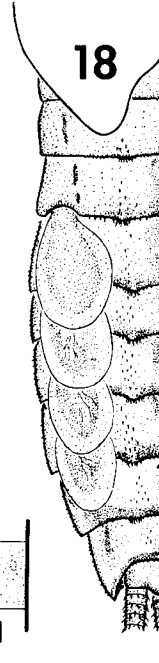
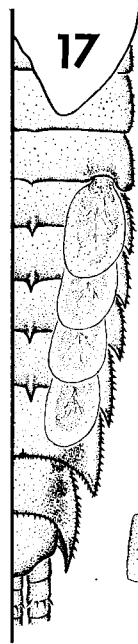
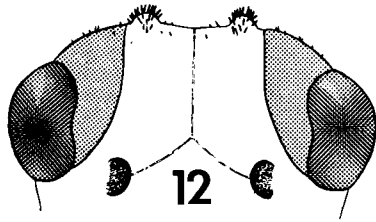
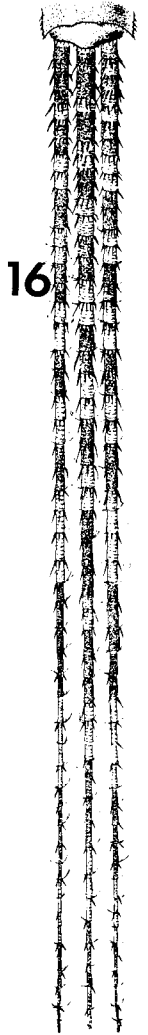
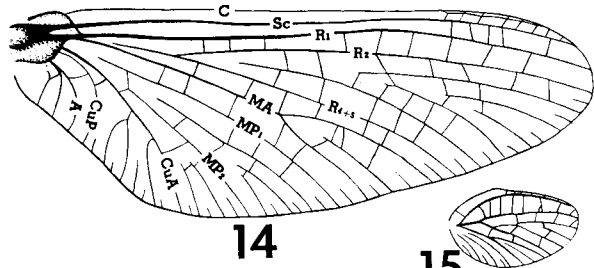
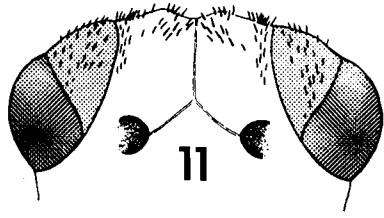


PLATE II

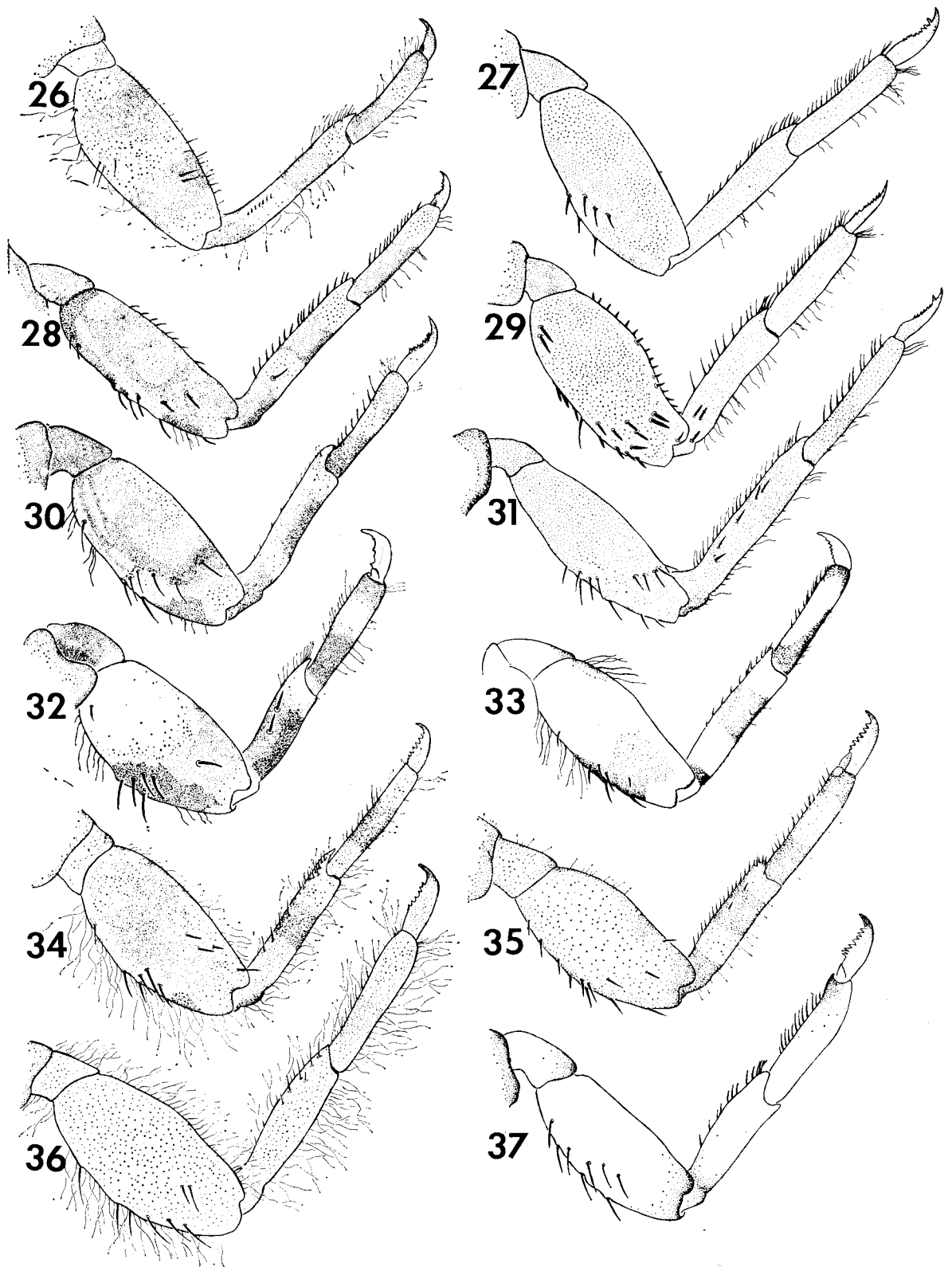
FIGS. 2-10.—Subgenus *Serratella*, male genitalia, dorsal view. FIG. 2.—*E. micheneri*; FIG. 3.—*E. levis*; FIG. 4.—*E. tibialis*; FIG. 5.—*E. teresa*; FIG. 6.—*E. serratoides*; FIG. 7.—*E. serrata*; FIG. 8.—*E. deficiens*; FIG. 9.—*E. frisoni*; FIG. 10.—*E. sordida*.



- Abdominal segments dark chocolate brown; penes without such small spines (fig. 8).....*deficiens*
- 8 (6). Abdominal terga 2 to 7 of dried specimens white with small, paired, light brown, lateral maculae; abdominal terga 2 to 7 of alcohol specimen translucent white, without maculae; genitalia as in fig. 9.....*frisoni*
- Abdominal terga 2 to 7 of dried specimen dark brown, with darker brown sublateral maculae; abdominal terga of alcohol specimen white, with brown sublateral maculae; genitalia as in fig. 10.....*sordida*
- NYMPHS
1. Western North American species; eastern limits in New Mexico, Colorado, Wyoming, Montana, and Alberta.....2
- Eastern North American species; western limits in Mississippi, Missouri, Michigan, Illinois, and Ontario.....6
- 2 (1). Abdominal terga without paired, submedian tubercles, posterior margins of terga with only slight undulations; legs yellowish brown with dark brown bands (fig. 26); tarsal claws with 4 to 7 denticles (fig. 54).....*levis*
- Abdominal terga with paired, submedian tubercles (figs. 17-25); legs and tarsal claws variable.....3
- 3 (2). Paired, submedian tubercles on abdominal segments 4 to 7 only (fig. 17); legs unicolorous brown (fig. 27); maxillary palpi very small (figs. 43-46); tarsal claws with 9 or 10 denticles (fig. 55).....*teresa*
- Paired, submedian tubercles on abdominal terga 2 to 8, sometimes small on segments 2 and 8 (figs. 1, 18, 19); maxillary palpi moderately long (figs. 47, 53); legs and tarsal claws variable.....4
- 4 (3). Abdominal tubercles narrow and acute, posterior margins of middle abdominal terga straight (fig. 1); legs purple-brown, red, or fuscous with pale markings (fig. 28); tarsal claws with 5 to 7 denticles (fig. 56).....*tibialis*
- Abdominal tubercles broadly rounded, posterior margins of middle abdominal terga sinuate (figs. 18, 19); legs and tarsal claws variable.....5
- 5 (4). Abdominal tubercles poorly developed (fig. 18); tarsal claws long and narrow, with 9 to 11 denticles (fig. 57); maxillary palpi two- or three-segmented (fig. 47); legs unicolorous brown (fig. 29).....*velmae*
- Abdominal tubercles well developed (fig. 19); tarsal claws rather blunt, with 6 to 8 denticles (fig. 58); maxillary palpi three-segmented (fig. 48); legs yellow with variable brown markings (fig. 30).....*micheneri*
- 6 (1). Abdominal terga without paired, submedian tubercles; maxillary palpi absent; legs brown with darker brown tibial and tarsal bands (fig. 31); tarsal claws long and narrow, with 8 to 10 denticles (fig. 59).....*deficiens*
- Abdominal terga with paired, submedian tubercles (figs. 20-25); maxillary palpi present; legs and tarsal claws variable.....7
- 7 (6). Pronotum with paired, submedian tubercles; vertex of head with fine spicules (figs. 11-13).....8
- Pronotum without paired, submedian tubercles; head without fine spicules.....10
- 8 (7). Head with paired, submedian, occipital tubercles (fig. 11); abdominal terga with tubercles on segments 3 to 9 (fig. 21); legs brown with dark brown markings (fig. 32); tarsal claws with 5 to 7 denticles (fig. 60).....*carolina*
- Head without tubercles (fig. 12) or only roughened (fig. 13); abdominal terga with tubercles on segments 3 to 7 or 3 to 8; legs and tarsal claws variable.....9
- 9 (8). Head without tubercles, covered with numerous fine spicules (fig. 12); abdominal terga with tubercles on segments 3 to 7 (fig. 20); maxillary palpi with a single segment (fig. 49); legs pale with brown markings (fig. 33); tarsal claws with 6 to 8 denticles (fig. 61).....*spiculosa*
- Head roughened and with only scattered spicules (fig. 13); abdominal terga with tubercles on segments 3 to 8 (fig. 22); maxillary palpi three-segmented (fig. 50); legs brown with dark brown markings (fig. 34); tarsal claws with 3 to 5 denticles (fig. 62).....*serrata*
- 10 (7). Abdominal sterna each with four black dots; posterolateral projections on segment 9 not extending beyond posterolateral margin of segment 10 (fig. 23); maxillary palpi three-segmented (fig. 51); legs brown with dark brown markings (fig. 35); tarsal claws with 5 to 8 denticles (fig. 63).....*serratoides*
- Abdominal sterna without such black dots; posterolateral projections on segment 9 extending beyond posterolateral margin of segment 10 (figs. 24, 25); maxillary palpi one- or two-segmented (figs. 52, 53); legs and tarsal claws variable.....11
- 11 (10). Head, thorax, and legs (fig. 36) with long hairs; abdominal terga with tubercles on segments 3 to 8 (fig. 24); maxillary palpi two-segmented (fig. 52); tarsal claws with 5 to 7 denticles (fig. 64).....*sordida*
- Head, thorax, and legs (fig. 37) without long hairs; abdominal terga with tubercles on segments 2 to 8 (fig. 25); maxillary palpi with a single segment (fig. 53); tarsal claws with 6 to 8 denticles (fig. 65).....*frisoni*
- Ephemerella deficiens* Morgan
- Ephemerella deficiens* Morgan 1911, 111, 4 figs.; Morgan 1913, fig. 42; Ulmer 1920, 119; McDunnough 1929, 170 (= *atrescens*); Ide 1930, 211; McDunnough 1931b, 205; Steger 1931, 30; Traver 1932, 146, 148, 177; Ide 1935, 13, 44; Traver 1935, 590, 1 fig.; Traver 1937, 73; Sprules 1947, 44; Leonard 1950, 19; Burks 1953, 67, 2

PLATE III

FIGS. 11-13.—Subgenus *Serratella*, vertex of heads, frontal view. FIG. 11.—*E. carolina*; FIG. 12.—*E. spiculosa*; FIG. 13.—*E. serrata*. FIGS. 14-16.—*Ephemerella tibialis*. FIG. 14.—Forewing; FIG. 15.—Hindwing; FIG. 16.—Caudal filaments of mature nymph. FIGS. 17-25.—Subgenus *Serratella*, half of abdominal terga of mature nymphs. FIG. 17.—*E. teresa*; FIG. 18.—*E. velmae*; FIG. 18a.—*E. velmae*, half of abdominal sternum 4 of mature nymph; FIG. 19.—*E. micheneri*; FIG. 20.—*E. spiculosa*; FIG. 21.—*E. carolina*; FIG. 22.—*E. serrata*; FIG. 23.—*E. serratoides*; FIG. 24.—*E. sordida*; FIG. 25.—*E. frisoni*.



figs.; Pugh 1956, 26; Berner and Allen 1961, 156; Leonard and Leonard 1962, 47, 3 figs.

Ephemerella atrescens McDunnough 1925a, 43; McDunnough 1925b, 212, 2 figs.

Ephemerella sp. A. Berner 1950, 160, 1 fig.; Berner 1958, 30.

E. deficiens was described from mature nymphs and male imagoes.

Male Imago (in alcohol). Length: body 6.5-7.5; forewing 6-7 mm. Head chocolate brown. Thorax chocolate brown; wings hyaline, basal portion tinted with brown and costal and stigmatic areas opaque, primary longitudinal veins brown, crossveins and intercalaries pale; legs pale, each femur with a light brown apical macula. Abdominal segments dark chocolate brown, anterior half of segment lighter brown than posterior half; abdominal sterna without maculae. Genitalia as in fig. 8. Caudal filaments light brown with dark brown annulations at apex of each segment.

Mature Nymph. Length: body 5-6; caudal filaments 2.5-3.5 mm. General color dark brown, often with a wide pale median stripe on head, thorax and abdomen. Without occipital, thoracic or abdominal tubercles; maxillae without palpi; legs brown with dark brown tibial and tarsal bands, foreleg as in fig. 31; tarsal claws with 8 to 10 denticles (fig. 59). Abdominal terga often with a dark brown median stripe; abdominal sterna brown, without maculae. Caudal filaments brown and without setae.

Type Locality. Fall Creek, Ithaca, New York.

Type. No. 1112, Cornell University Collection, Ithaca, New York.

DISTRIBUTION.—*E. deficiens* is a boreal eastern North American species with a wide latitudinal distribution. It is known from Nova Scotia to Michigan and austrad to Mississippi and Florida (fig. 68). The distribution of this species is discussed and detailed locality records are included for the southeastern states by Berner and Allen (1961). We have examined specimens from the following localities:

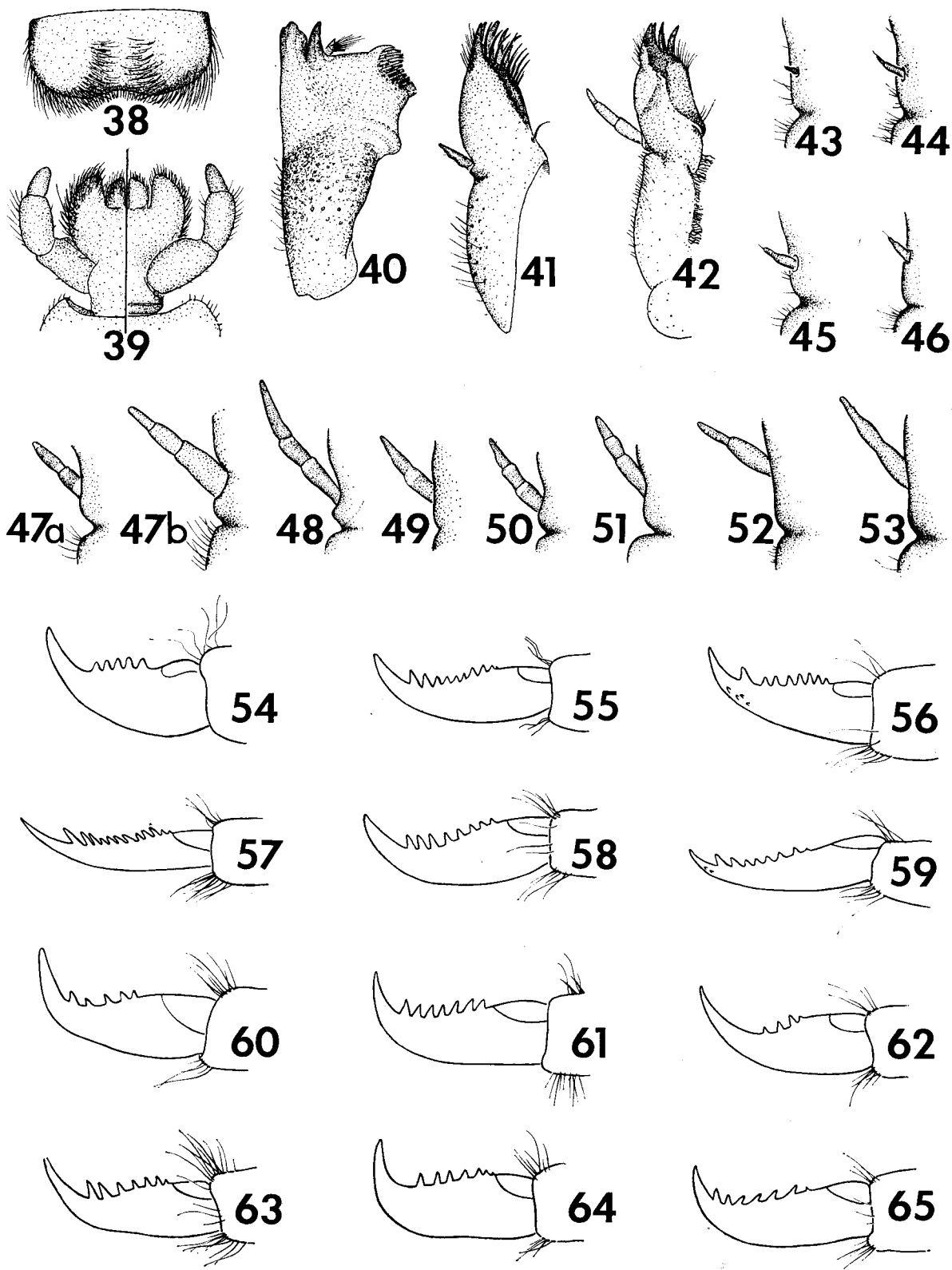
FLORIDA: Liberty Co., Sweetwater Creek, 2-V-41, L. Berner; Rock Bluff, 19-VII-30, H. T. Spieth (AMNH). GEORGIA: Flint River, Flat Shoals, 5.6 mi. W. Concord, 21-VI-39, P. W. Fattig (INHS). MASSACHUSETTS: Bachelor Brook, South Hadley, 14-V-49, T. Dolan and J. R. Traver (JRT). MICHIGAN: Maple River nr. Douglas Lake, 19-VI-48, GFE; Sturgeon River nr. Rondo, 3-VIII-48, GFE; Great Sable River, Peacock, 28-V-39, T. H. Frison and H. H. Ross (INHS); Little Manistee River nr. Irons, 28-V-39, T. H. Frison and H. H. Ross (INHS); Cold Water River, Freeport, 27-VII-29, H. T. Spieth (AMNH); Platte River, Honor, 27-V-39, T. H. Frison and H. H. Ross (INHS); Pere

Marquette River nr. Baldwin, 5-VIII-47, J. W. and F. A. Leonard (JRT); Kalamazoo River, Ceresco, 8-VI-29, H. T. Spieth (AMNH). NEW BRUNSWICK: Miramichi River, 6-VII-50, E. L. Bousefield; Annapolis River, 25-VI-50, R. Story; Cocagne River, 17-VII-51, E. L. Bousefield; Boiestown, 13-VI-28, W. J. Brown (CNC). NEW HAMPSHIRE: Moose Creek, Gorham, 19-VI-29, G. S. Walley (CNC). NEW YORK: Fall Creek, date?, A. H. Morgan (Holotype) (CU); E. Islip, 16-VII-30, H. T. Spieth (AMNH); Route 11 d, Mt. Champlain, 17-VI-52, E. I. Coher. NORTH CAROLINA: Davidson River, 20-VI-30, J. R. Traver (JRT); Wayah Creek, 28-VII-30, J. R. Traver (JRT); Stream 0.5 mi. N. Marble, 20-VII-57, S. and D. Mulaik; Bryson City, 8-VII-30, H. T. Spieth (AMNH); Wilkesboro, 2-VII-30, H. T. Spieth (AMNH); Murphy, 29-VII-30, H. T. Spieth (AMNH); Almond, 4-VIII-30, H. T. Spieth (AMNH); Marion, 6-VII-30, H. T. Spieth (AMNH); Jefferson, 4-VII-28, H. T. Spieth (AMNH); Smokemont, 20-VIII-30, H. T. Spieth (AMNH). NOVA SCOTIA: Annapolis River, 25-VI-50, R. Story; Stream nr. Springhill, 9-VII-50, E. L. Bousefield; Baddeck, 13-VI-36, J. McDunnough (CNC); Tory Creek, Guysboro, 4-VIII-36, J. McDunnough (CNC). ONTARIO: Rideau River, Ottawa, 16-VI-24, J. McDunnough (holotype *atrescens*) (CNC). PENNSYLVANIA: Scranton, summer, 1945, H. K. Townes (JRT); Bedford, summer, 1925, Herman Wright (AMNH). QUEBEC: Montreal, 21-VII-56, GFE; Knowlton, 11-VII-30, L. J. Milne (CNC); Cascades Point, 24-VI-30, G. S. Walley (CNC); Fulford, 5-VI-29, G. S. Walley (CNC); Sweetsburg, 16-VI-29, J. McDunnough (CNC); Waterloo, 27-VI-29, J. McDunnough (CNC); Covey Hill, 13/23-VI-27, G. S. Walley (CNC); Vaudreuil, 24-VI-30, G. S. Walley (CNC). SOUTH CAROLINA: Greenville Co., Highway 14, 1.5 mi. N. junction with Highway 29, 3-VIII-55, C. D. Hynes (UF). TENNESSEE: Stream 17 mi. W. Headquarters Great Smokey Natl. Park, 9-VII-57, S. and D. Mulaik; Cades Cove, 13-VI-40, T. H. Frison (INHS); Laconte Creek, Gatlinburg, 14-V-39, T. H. Frison and H. H. Ross (INHS); Sevierville, 29-VIII-30, H. T. Spieth (AMNH). VIRGINIA: Shenandoah River, Berryville, 12-V-38, E. Surber (JRT). WEST VIRGINIA: Morris Creek, Wardensville, 13-VIII-30, J. R. Traver (JRT).

BIOLOGY.—This species was discussed by Berner (1950) and Leonard and Leonard (1962). In the Southeastern States the nymphs are found primarily in moss and other vegetation in rocky, swiftly-flowing streams. In Michigan they were found in detritus and marginal vegetation of streams. The adults emerge from mid-May to July in the Southeast and from June to August in Michigan.

PLATE IV

FIGS. 26-37.—Subgenus *Serratella*, right nymphal forelegs. FIG. 26.—*E. levis*; FIG. 27.—*E. teresa*; FIG. 28.—*E. tibialis*; FIG. 29.—*E. velmae*; FIG. 30.—*E. micheneri*; FIG. 31.—*E. deficiens*; FIG. 32.—*E. carolina*; FIG. 33.—*E. spiculosa*; FIG. 34.—*E. serrata*; FIG. 35.—*E. serratoides*; FIG. 36.—*E. sordida*; FIG. 37.—*E. frisoni*.



Ephemerella levis Day

Ephemerella species No. 2 Mayo 1952, 185, 2 figs.
Ephemerella levis Day 1954, 15, 3 figs.; Day 1956, 96.

This species was described from nymphs and reared male imagoes from central California.

The specimens which Mayo (1952) called *Ephemerella* species Number 2 are apparently *E. levis* Day. Color characters presented in the descriptions by Mayo and by Day (1954) do not agree in every detail, but the male genitalia figured by Mayo (op. cit.) approximates that of *E. levis* (fig. 3) very closely.

Male Imago (in alcohol). Length: body 7-8; forewing 7-8 mm. Head, thorax, and abdomen yellow. Wings hyaline, venation pale except costal and subcostal veins with a dark brown mark at base; legs yellow. Abdominal terga 2 to 7 each with an anteriorly situated transverse brown macula; abdominal sterna 5 to 9 with sublateral dark brown streaks. Genitalia as in fig. 3. Caudal filaments pale with dark brown annulations at apex of each segment.

Mature Nymph. Length: body 7.5-8.5; caudal filaments 3-4 mm. General color yellowish brown. Without occipital, thoracic or abdominal tubercles; maxillary palpi with three well defined segments; legs yellowish brown with dark brown bands, foreleg as in fig. 26; tarsal claws with 4 to 7 denticles (fig. 54). Abdominal terga without tubercles, terga 3 to 7 with slight undulations on posterior margins; terga 3 to 8 with scattered spicules medially to the gills; abdominal sterna 1 to 9 with sublateral dark brown streaks. Caudal filaments pale with alternating brown bands and without hair.

Type Locality. Capell Creek, Napa Co., California.

Type. California Academy of Sciences, San Francisco, California.

DISTRIBUTION.—*E. levis* is known only from the following two localities in central California (fig. 66).

CALIFORNIA: Napa Co., Capell Creek, 14-VI-52, W. C. Day (paratypes); Nevada Co., Sagehen Creek, 19-XI-54, S. Penoyer (UCSC).

Ephemerella velmae, new species

Mature Nymph. Length: body 6-7; caudal filaments 4-5 mm. Head dark brown, without occipital tubercles; maxillary palpi two- or three-segmented (fig. 47a-b). Thorax dark brown; pronotum with two small submedian tubercles; legs unicolorous

brown, foreleg as in fig. 29; tarsal claws with 9 to 11 denticles (fig. 57). Abdominal terga brown with a dark brown median stripe, terga 2 to 8 with two submarginal dark brown maculae on each side; terga 2 to 8 with short, blunt paired submedian tubercles, tubercles barely discernible on segment 2, very small on segments 3 and 8, moderately developed on segments 4 to 7 (fig. 18); abdominal sterna brown with sublateral dark brown dashes on sterna 2 to 8; paired brown submedian dots on sterna 1 to 4 and larger diffuse dark patches anterolateral to these, obsolescent indications of these markings on segments 5 to 8 (fig. 18a). Caudal filaments brown and without setae.

Holotype. Mature female nymph, Branch of Still Creek on road to Timberline Lodge, Clackamas Co., Oregon, 30-VIII-58, Richard K. Allen and George F. Edmunds, Jr., in collection of University of Utah, Salt Lake City. Paratypes. Mature male nymph, North Fork Bishop Creek, Inyo Co., California, 31-VII-50, Velma Knox Mayo, in collection of the California Academy of Sciences, San Francisco, California; young male nymph, Still Creek, Clackamas Co., Oregon, 27-VIII-54, RKA and GFE, in collection of University of Utah, Salt Lake City.

TAXONOMY.—*E. velmae* appears to be most closely related to *E. tibialis* McDunnough. It may be distinguished from *E. tibialis* and other western species of *Serratella* by the size and shape of the paired dorsal abdominal tubercles (fig. 18), by the dentition of the tarsal claws (fig. 57), and by the maxillary palpi (fig. 47). The authors take pleasure in naming this species in honor of Dr. Velma Knox Mayo, who has contributed extensively to the knowledge of the western North American Ephemeroptera.

Ephemerella sordida McDunnough

Ephemerella sordida McDunnough 1925a, 42; McDunnough 1930, 55; McDunnough 1931b, 205, 2 figs. (nymph); Traver 1935, 621, 1 fig.; Burks 1953, 66, 1 fig.; Berner and Allen 1961, 153.

Ephemerella sordida ? Ide 1930, 212.

Ephemerella deficiens Edmunds 1959, fig. 8 nec Morgan 1911, 111.

McDunnough described this species from a male imago, and in 1931 published a description of the nymphal stage.

Male Imago (in alcohol). Length: body 5.5-6.5; forewing 6-7 mm. Head light brown. Thorax brown; wings hyaline; costal veins and wing base brown, other venation pale; legs light brown. Ab-

PLATE V

FIGS. 38-41.—*Ephemerella carolina*, nymphal mouthparts. FIG. 38.—Labrum; FIG. 39.—Labium, dorsal and ventral; FIG. 40.—Left mandible; FIG. 41.—Maxilla. FIG. 42.—*E. (Ephemerella) rotunda*, maxilla. FIGS. 43-46.—*E. teresa*, maxillary palpi. FIG. 43.—From Los Angeles Co., California; FIG. 44.—From Humboldt Co., California; FIG. 45.—From Lincoln Co., Oregon; FIG. 46.—From Stevens Co., Washington. FIGS. 47-53.—Subgenus *Serratella*, maxillary palpi. FIG. 47a-b.—*E. velmae*; FIG. 48.—*E. micheneri*; FIG. 49.—*E. spiculosa*; FIG. 50.—*E. serrata*; FIG. 51.—*E. serratoides*; FIG. 52.—*E. sordida*; FIG. 53.—*E. frisoni*. FIGS. 54-65.—Subgenus *Serratella*, tarsal claws. FIG. 54.—*E. levis*; FIG. 55.—*E. teresa*; FIG. 56.—*E. tibialis*; FIG. 57.—*E. velmae*; FIG. 58.—*E. micheneri*; FIG. 59.—*E. deficiens*; FIG. 60.—*E. carolina*; FIG. 61.—*E. spiculosa*; FIG. 62.—*E. serrata*; FIG. 63.—*E. serratoides*; FIG. 64.—*E. sordida*; FIG. 65.—*E. frisoni*.

dominal segments pale, segments 8 to 10 light brown; abdominal terga 2 to 9 with submedian dark brown maculae (pinned specimens are darker brown than alcoholic specimens); abdominal sterna 1 to 8 pale and without maculae, sterna nine brown with dark brown sublateral streaks. Genitalia as in fig. 10. Caudal filaments pale, without annulations or bands.

Mature Nymph. Length: body 4.5-5.5; caudal filaments 2.5-3.5 mm. General color light brown. Without occipital or thoracic tubercles, head and thorax with long hair; maxillary palpi with two distinct segments (fig. 52); legs brown with dark brown tarsal bands and with long hair, foreleg as in fig. 36; tarsal claws with 5 to 7 denticles (fig. 64). Abdomen light brown, terga 2 to 9 with a single median and paired sublateral dark brown maculae; terga with paired submedian tubercles on segments 3 to 8, tubercles very small, often barely discernible on segments 3 and 8 (fig. 24); abdominal sterna pale. Caudal filaments brown with a single dark brown basal band and without setae.

Type Locality. Lachine, Quebec.

Type. No. 1280, Canadian National Collection, Ottawa, Ontario.

DISTRIBUTION.—*E. sordida* is a boreal eastern North American species known from Quebec and Ontario to Indiana and austrad to Alabama (fig. 68). The distribution of this species is discussed and detailed locality records are included for the southeastern states by Berner and Allen (1961). We have examined specimens from the following localities:

INDIANA: Pigeon River, Scott, 1-VII-28, H. T. Spieth (AMNH). NORTH CAROLINA: Wilkesboro, 3-VII-30, H. T. Spieth (AMNH); Ocono Lufty River, Bryson City, 8-VII-30, H. T. Spieth (AMNH). ONTARIO: Cornwall, 16-VIII-56, GFE. PENNSYLVANIA: 1 mi. E. Bedford, summer-28, H. Wright (AMNH). QUEBEC: Foster Power Plant, Yamaska River, Foster, 5-VII-29, J. McDunnough (CNC); Lachine, 6-VIII-24, G. S. Walley (Holotype) (CNC); Ottawa Golf Club, 13/14-VIII-24, F. P. Ide (CNC); Montreal, 21-VI-56, GFE; Kirks Ferry, 4-VIII-25, G. S. Walley (CNC).

BIOLOGY.—Berner and Allen (1961) discussed the biology of this species. The nymphs live in the crevices of rocks or other protected places in moderately sized streams to large rivers. The adults emerge primarily in July.

Ephemerella frisoni McDunnough

Ephemerella frisoni McDunnough 1927, 10; McDunnough 1931b, 206; Traver 1935, 599; Burks 1953, 65, 3 figs. (nymph); Berner and Allen 1961, 154.

E. frisoni was originally described from the male imago only, but is now known from all stages.

Male Imago (in alcohol). Length: body 5.0-6.5; forewing 5.0-6.5 mm. Head brown. Thorax brown; wings hyaline, brown at the base; venation pale, except costal and subcostal veins light brown; legs

pale. Abdominal segments pale and translucent, except posterior half of tergum 8 and terga 9 and 10 opaque (pinned specimens have white abdominal segments with small paired light brown lateral maculae). Genitalia as in fig. 9. Caudal filaments white, without annulations or bands.

Mature Nymph. Length: body 5.0-6.5; caudal filaments 2.5-3.5 mm. General color light yellowish brown with variable darker brown markings. Head without occipital tubercles; maxillary palpi with a single long segment (fig. 53). Thorax without tubercles; legs yellowish brown, foreleg as in fig. 37; tarsal claws with 6 to 8 denticles (fig. 65). Abdominal terga with paired submedian tubercles on segments 2 to 8, tubercles small on segments 2 and 8 (fig. 25); abdominal sterna light brown with sublateral dark brown streaks. Caudal filaments unicolorous brown, and with sparse setae on segments in apical half.

Type Locality. Oakwood, Illinois.

Type. Illinois State Natural History Survey, Urbana, Illinois.

DISTRIBUTION.—*E. frisoni* is a subboreal eastern North American species known from Illinois and Missouri austrad to Alabama (fig. 68). Detailed locality records for the southeastern states are recorded by Berner and Allen (1961). We have examined specimens from the following localities:

ILLINOIS: Oakwood, 26-VI-29, T. H. Frison (INHS); Oakwood, 8-VI-36, T. H. Frison and "Auden" (Paratype) (CNC); Trib. Sangamon River nr. Mahomet, 30-IV-40, T. H. Frison (INHS); Salt Forks River, Oakwood, 22-V-42, H. H. Ross and B. D. Burks (INHS); Muncie, 8-VI-27, T. H. Frison (INHS). MISSOURI: Mammoth Springs, 6-VI-37, H. H. Ross (INHS).

BIOLOGY.—The biology of this species was discussed by Berner and Allen (1961). The nymphs are found crawling in the vegetation in large, swiftly-flowing streams. Adults are known to emerge in June.

Ephemerella micheneri Traver

Ephemerella micheneri Traver 1934, 227, 1 fig.; Traver 1935, 611, 1 fig.; Day 1956, 96, 1 fig.
Ephemerella sp., an undescribed species Allen and Edmunds 1956, 87.

This species was described from nymphs and adults collected in southern California.

Male Imago (in alcohol). Length: body 6-7; forewing 6-7 mm. Head yellow with brown markings at bases of antennae. Thorax yellow with brownish black markings; wings hyaline; venation pale; legs yellow. Abdominal terga brown, terga 2 to 8 with dark brown maculae near the pleural fold; abdominal sterna yellow. Genitalia as in fig. 2. Caudal filaments pale with purplish black annulations at apex of each segment.

Mature Nymph. Length: body 6-7; caudal filaments 2-3 mm. General color yellowish brown with variable dark brown markings. Without occipital or thoracic tubercles; maxillary palpi with three distinct

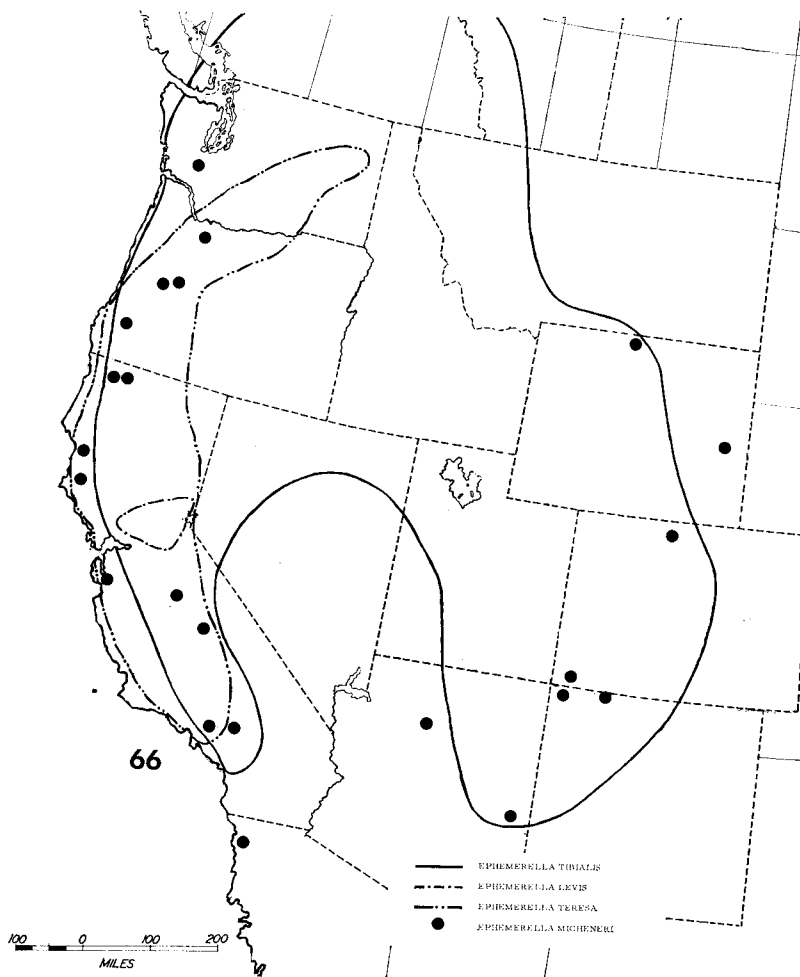


PLATE VI

FIG. 66.—Distribution map of *Ephemerella tibialis*, *E. levis*, *E. teresa* and *E. micheneri*.

segments (fig. 48); legs yellow with variable dark bands and markings, foreleg as in fig. 30; tarsal claws with 6 to 8 denticles (fig. 58). Abdominal terga with paired submedian tubercles on segments 2 to 8, tubercles may be small or barely discernible on segment 2, and often small on segments 3 and 8 (fig. 19); abdominal sterna 1 to 9 with sublateral dark brown longitudinal streaks. Caudal filaments pale with several dark bands, and with sparse setae on segments in apical half.

Type Locality. San Gabriel Canyon, San Gabriel Mountains, California.

Type. No. 1283.1, Cornell University Collection, Ithaca, New York.

DISTRIBUTION.—*E. micheneri* is a boreal western North American species with an unusual distribution. It is known from central Washington austrad to Baja California and from several disjunct records in Arizona, Colorado, Wyoming and New Mexico (fig. 66). The distribution and ecology of the species suggest that it would be expected to occur

in western Wyoming, Utah and Idaho; however, extensive collections from these areas have failed to detect it. It may have dispersed eastward through Arizona and New Mexico with a subsequent northward dispersal along the eastern edge of the Rocky Mountain system to northern Wyoming. Specimens examined by the authors are from the following localities:

ARIZONA: White River, 4 mi. N. White River, 25-VI-51, S. J. Preece, Jr.; Coconino Co., Oak Creek, Sedona, 23-VI-51, S. J. Preece, Jr. BAJA CALIFORNIA: Santa Domingo River, nr. mouth, 19-V-36, P. R. Needham (JRT). CALIFORNIA: Siskiyou Co., Klamath River, 1 mi. W. Seiad Valley, 3-VII-59, RKA; Scott River at Hamburg, 2-VII-59, RKA; Mendocino Co., Eel River at Bell Glen nr. Leggett, 2-VII-59, RKA; Broaddus Creek, 3 mi. W. Willits, 2-VII-59, RKA; Stanislaus Co., Riverbank, 10-VI-50, W. C. Day; Nevada Co., Highway 40, first stream E. Donner Summit, 2-VIII-52, R. B. Selander; Prosser Creek, 3 mi. N. Truckee, 6-VIII-59,

RKA; Los Angeles Co., San Gabriel Canyon, San Gabriel Mountains, 25-VI-32, C. D. Michener (Holotype) (CU); East Fk. San Gabriel River at Camp Bonita, 16-VI-59, RKA and E. E. Ruzicka; East Fk. San Gabriel River, Sandy Oaks Camp, 16-VI-59, RKA and E. E. Ruzicka; Tulare Co., Kaweah River, 4 mi. S. Three Rivers, 18-VI-59, RKA; San Bernardino Co., Warm Springs Creek nr. San Bernardino, 24-IX-46, H. G. Nelson. COLORADO: LaPlata Co., Los Pinos River, 6-VII-60, W. L. Peters; Los Pinos River, LaBoca City, 15-VII-60, L. D. Jensen; Archuleta Co., Piedra River, 5 mi. N. Arboles, 14-VII-60, W. L. Peters; Larimer Co., Fort Collins, 12-VIII-35, R. Swain (CNC). NEW MEXICO: Rio Appiba Co., San Juan River, mile 165, 7-VII-60, L. D. Jensen; San Juan Co., San Juan River, 29-VI/16-VII-60, W. L. Peters. OREGON: Clackamas Co., Molalla River, 3 mi. E. Molalla, 26-VIII-54, GFE and RKA; Benton Co., Willamette River at Corvallis, 26-VIII-54, GFE and RKA; Linn Co., Santiam River, 8 mi. N. Albany, 26-VIII-54, GFE and RKA; Douglas Co., Umpqua River, Sawyer Rapids, 26 mi. E. Reedsport, 17-VI-58, M. L. Johnson; South Umpqua River, 3 mi. S. Canyonville, 24-VIII-54, GFE and RKA; Lane Co., Tributary of Row River, 25-VII-57, M. L. Johnson; Willamette River, Walker, 25-VI-57, M. L. Johnson. WASHINGTON: Lewis Co., 26-VII-36, H. H. Ross (INHS). WYOMING: Sheridan Co., Piney Creek, Jeffers (4,400'), 10 mi. SE. Story, 4-VIII-59, A. G. Dumont (SC); Platte Co., North Platte River, Guernsey, 7-VI-61, GFE and W. L. Peters.

TAXONOMY.—The nymphs of *E. micheneri* are variable in the development of the paired dorsal abdominal tubercles. These tubercles are rather uniform in development (fig. 19) in populations from the Sierra Nevada Mountains and the Coast Ranges; however, nymphs from isolated southwestern populations have longer more acute abdominal tubercles. Populations from Baja California and Arizona have better developed and sharper tubercles on terga 4 to 7 and have well developed tubercles on terga 2 to 3 and 8.

BIOLOGY.—*E. micheneri* nymphs have been collected in moderately cool (55°–62° F. in June and July) streams with a rock and gravel bottom type. The nuptial flight of the adults has not been observed by the authors.

Ephemerella tibialis McDunnough

Ephemerella tibialis McDunnough 1924, 224; McDunnough 1926, 186; McDunnough 1928, 8; McDunnough 1929, 170, 1 fig.; Walley 1930, 18, 7 figs. (nymph); Traver 1935, 624; Edmunds 1954, 66 (= *angusta*); Day 1956, 96, 1 fig.; Allen and Edmunds 1956, 87.

Ephemerella angusta Traver 1934, 211; Traver 1935, 581.

Ephemerella angustata Berner 1950, 153.

This species was described from a single male imago collected in Banff, Alberta, and Walley (1930) described the nymph from specimens collected in Montana.

In 1934 Traver described this species as *Ephemerella angusta* from nymphs collected in Utah. Edmunds (1954) synonymized *angusta* with *E. tibialis*.

Male Imago (in alcohol). Length: body 7–8; forewing 7–8 mm. Head, thorax and abdomen purple-brown, red or fuscus. Wings hyaline, longitudinal veins brown, intercalaries and crossveins pale; legs smoky. Abdomen with a pale semitranslucent ring on anterior margin of segments 3 to 8. Genitalia as in figure 4. Caudal filaments pale with dark annulations at apex of each segment.

Female Imago (in alcohol). Length: body 7.5–9.0; forewing 8–9. General color as in male, but lacking pale rings on segments 3 to 8 and posterior margins of abdominal segments often margined with black. Other characters as in male except for usual sexual differences.

Mature Nymph. Length: body 7–9; caudal filaments 6–7 mm. General color purple-brown, red or fuscus, and often with a wide pale median stripe on head, thorax and abdomen (fig. 1). Without occipital or thoracic tubercles; maxillary palpi with three distinct segments; legs dark with pale markings, femora with variable pale markings, tibiae pale with apical and median dark bands, and tarsi pale with a median dark band (figs. 1 and 28); tarsal claws with 5 to 7 denticles (fig. 56). Abdominal terga with paired submedian tubercles on segments 2 to 8, tubercles may be small, barely discernible or absent on terga 2 and 8 (fig. 1). Caudal filaments with alternating pale and dark bands and without setae (fig. 16).

Type Locality. Banff, Alberta, Canada.

Type. No. 780, Canadian National Collection, Ottawa, Ontario.

DISTRIBUTION.—*E. tibialis* is a boreal western North American species. It has been reported from Alberta and British Columbia austrad to northern New Mexico, southern Arizona and southern California (fig. 66). Marginal and representative state records are as follows:

ALBERTA: Banff, 19-IX-22, G. B. D. Garrett (CNC); Blairmore, 15-VIII-30, J. H. Pepper (CNC); Lake Minewanka, 1-IX-28, J. McDunnough (CNC). ARIZONA: Gila Co., Horton Creek, Tonto Natl. Forest, 20-VII-36, C. M. Tarzwell. BRITISH COLUMBIA: Shingle Creek, Penticton, 3-X-34, A. N. Gartrell (CNC); Mosquito Creek nr. Vancouver, 3-VII-40, H. H. and J. A. Ross (INHS); Cook Creek nr. Bowser, Vancouver Island, 29-VI-33, J. McDunnough (CNC); Wilson Creek nr. New Denver, 11-VIII-40, V. K. Mayo (VKM). CALIFORNIA: Sequoia Natl. Park, Dorst Camp, 30-VI-46, S. and D. Mulaik; Nevada Co., South Fork San Joaquin River, Blaney Meadows, VII-48, W. C. Day; Plumas Co., North Fork Deer Creek, 5 mi. N. Fire Mountain, 3-VII-59, RKA; Humboldt Co., 5 mi. W. Willow Creek, 2-VII-59, RKA; Sierra Co., Lincoln Creek, Tahoe Natl. Forest 20-IX-46, H. G. Nelson (INHS). COLORADO: El Paso Co., Cascade Creek, 12-VIII-43, H. H. and J. A. Ross (INHS); Rocky

Mountain Natl. Park, Glacier Creek, 17-VIII-40, T. H. Frison (INHS). IDAHO: Boise Co., South Fork Payette River, 5 mi. W. Crouch, 6-IX-58, GFE and RKA; Lemhi Co., North Fork Salmon River, North Fork, 2-VIII-58, GFE. MONTANA: Rock Creek, Bozeman, 10-VIII-28, J. McDunnough (CNC); Mineral Co., Clearwater River, 12 mi. W. St. Regis, 30-VI-59, GFE; Flathead Co., Middle Fork Flathead River, Jct. with Bear Creek, 10-VIII-49, L. T. Nielsen. NEVADA: Elko Co., Franklin River, 12 mi. SW. Arthur, 19-IX-57, GFE and RKA. NEW MEXICO: Taos Co., Red River, Carson Natl. Forest, 9-VII-36, C. M. Tarzwell. OREGON: Benton Co., Siletz River nr. Corvallis, 5-III-47, E. P. Hughes; Lane Co., Cape Creek nr. Sealion Point, 25-VIII-54, GFE and RKA; Jackson Co., Rogue River, Oregon Highway Jct. 230-62, 24-VIII-54, GFE and RKA; Clackamas Co., Polallie Creek, Oregon Highway 35, Mt. Hood, 31-VIII-58, GFE and RKA; Grant Co., John Day River, John Day, 13-VI-54, GFE; Wallowa Co., Lostine River, French Camp, 18-VIII-52, GFE. UTAH: Uintah Co., Little Elk Creek, 28-VIII-53, C. E. Pitt; Wasatch Co., Provo River, Heber, 30-VI-46, GFE; Summit Co., Weber River, Glendale Ranch, 19-VIII-45, GFE. WASHINGTON: Spokane Co., Peone Creek, Bruce Road, Spokane, 19-VI-55, RKA; Ferry Co., 6 mi. E. Republic, Washington Highway 3P, 29-VII-58, GFE; Kittitas Co., Little Naches River, Little Naches Forest Camp, 5-IX-58, GFE and RKA; Clallam Co., Ennis Creek nr. Port Angeles, 4-IX-58, GFE and RKA. WYOMING: Uinta Co., Bear River, 16-VII-48, L. T. Nielsen; Sheridan Co., Porcupine Creek, 15-VIII-59, A. G. Dumont (SC); Yellowstone Natl. Park, Soda Butte Creek, 2-VIII-40, T. H. Frison and T. H. Frison, Jr. (INHS).

TAXONOMY.—Nymphs and adults of *E. tibialis* show little morphological variability, but both stages exhibit a wide range of color variation. They vary from red to purple-brown to fuscus. Many nymphs possess a dorsal, median white stripe, while in others this white stripe is lacking. The stripe, when present, may run the entire length of the nymph (fig. 1). In some specimens it is lacking on the occiput, while in others it is restricted to the abdomen. These color variations occur throughout the range of the species and are of no taxonomic importance.

Female imagoes of *E. tibialis* collected at Brightwood, Oregon, were of two different colors; some were fuscus and some were red. Nymphs collected from the Salmon River at this same point showed this same variation. This interesting example of color dimorphism also occurs very commonly in the Utah and Idaho populations.

BIOLOGY.—*E. tibialis* nymphs are found in cool (47°-58° F., July to September samples), moderately flowing streams from sea level along the Pacific Coast to over 10,000 feet elevation in the interior mountains. The nymphs are often found clinging to vegetation or exposed roots along stream margins,

but may be found in vegetation and on rocks in the riffles of streams.

The nuptial flight occurs at sundown. A swarm observed over a highway near Brightwood, Oregon at dusk, consisted of two separate groups, one at about 15 to 20 feet above the road and one some 20 to 30 feet higher. The lower swarm consisted of females only and it is supposed that the higher swarm were the males of this same species.

Nymphs have been collected from May 5 to September 15, and the adults are known to emerge from July 2 to September 19.

Ephemerella teresa Traver

Ephemerella teresa Traver 1934, 230; Traver 1935, 624; Day 1956, 96, 1 fig.; Allen and Edmunds 1956, 87. *Ephemerella cognata* Traver 1934, 231; Traver 1935, 585; Day 1952, 37, 1 fig. (adult). **New Synonymy.**

E. teresa was described from the nymphal stage only, but is now known from all stages.

Traver (1934) named *E. teresa* from nymphs collected in San Antonio Canyon in southern California, and *E. cognata* from nymphs collected in Waddell Creek in Santa Cruz County, California. She also referred a single female nymph from the San Antonio Canyon collection to *E. cognata*. These species supposedly differ in that the maxillary palpi are wanting in *E. teresa* and vestigial in *E. cognata*. All of the type specimens of *E. teresa* have some vestige of a maxillary palp. One paratype has a palp on one maxilla, while on the opposite member the palp is absent. A thorough study of nymphs collected from the San Gabriel Mountains in southern California north to western Washington shows a continuous variation in the development of the maxillary palpi encompassing all forms found in the types of *E. cognata* and *E. teresa*. *Ephemerella cognata* is clearly a synonym of *E. teresa*. Day (1952) described the male imago (as *E. cognata*) from specimens reared from nymphs collected in central California.

Male Imago (in alcohol). Length: body 7-8; forewing 8-9 mm. Head brown. Thorax chocolate brown; wings hyaline; longitudinal veins light brown, intercalaries and crossveins pale; legs light brown. Abdominal terga brown except posterior margins of each tergum dark brown; abdominal sterna light brown. Genitalia as in fig. 5. Caudal filaments pale with dark brown intersegmental annulations.

Female Imago (in alcohol). Length: body 7-8; forewing 8-9 mm. Head, thorax and abdomen lighter brown than in male. Other characters as in male except for usual sexual differences.

Mature Nymph. Length: body 7-9; caudal filaments 3.5-4.5. General color brown. Without occipital tubercles; maxillary palpi extremely small, often barely discernible (figs. 43-46). Thorax without tubercles; legs brown and without distinctive color markings, foreleg as in fig. 27; tarsal claws with 9 or 10 denticles (fig. 55). Abdominal terga with

paired submedian tubercles on segments 4 to 7 (fig. 17); abdominal sterna light brown with paired sublateral dark brown streaks. Caudal filaments with alternating light and dark bands and without setae.

Type Locality. San Antonio Canyon, California.

Type. No. 1289.1, Cornell University Collection, Ithaca, New York.

DISTRIBUTION.—*E. teresa* is known from only the west coastal states. It has been collected from eastern Washington austrad to southern California (fig. 66). The authors have examined specimens of this species from the following localities:

CALIFORNIA: San Antonio Canyon (Holotype) 29-V-23, T. R. Seemann (CU); Waddell Creek, Sta. 1.1000-3 (Holotype, *cognata*), D. Sheperd (CU); Trinity Co. Stream on Hoopa Valley Indian Reservation, 2-VII-59, RKA; Siskiyou Co., Swillup Creek (Bridge 2-40), 2-VII-59, RKA; Stream at Cottage Grove, 2-VII-59, RKA; Scott River, Hamburg, 3-VII-59, RKA; Madera Co., Chilacoot Creek, above Bass Lake, 19-VI-59, RKA; Willow Creek, 12-VII-51, W. C. Day; Humboldt Co., Mad River at Blue Lake, 2-VII-59, RKA; Stream, 5 mi. W. Willow Creek, 2-VII-59, RKA; Boers Ranch, 9-VI-03, H. S. Barber (JRT); Tehama Co., Mill Creek, 5 mi. N. Childs Meadows, 3-VII-59, RKA; Nevada Co., Sagehen Creek, 26-VII-54, S. Pennoyer (UCSC);

Los Angeles Co., E. Fk. San Gabriel River at Shady Oaks Public Camp, 16-VI-59, RKA and E. E. Ruzicka; San Mateo Co., San Gregorio Creek, 17-VI-50, W. C. Day; El Dorado Co., 4 mi. W. Kyburz, 29-VIII-53, R. B. Selander. **OREGON:** Lane Co., Willamette River nr. Walker, 26-VI-57, M. L. Johnson; Douglas Co., Umpqua River, 26 mi. E. Reedsport, 17-VI-58, M. L. Johnson; Benton Co., Muddy Creek, 12-IV-38, S. G. Jewett (OSU). **WASHINGTON:** Stevens Co., Stream nr. Springdale, 19-VI-55, GFE and RKA.

TAXONOMY.—The morphological variability within the nymphs of *E. teresa* is minor. The only structures showing extreme variation are the maxillary palpi which exhibit a rather wide range of development (figs. 43 to 46). Specimens from northern California and Oregon show a greater development of the palpi than do those in southern California, with the degree of development following a somewhat clinal pattern. Specimens collected in eastern Washington, however, have a lesser development of the palpi than do those collected in northern California and Oregon. It also has been noted that many specimens show an inconsistent degree of development of the palpi on the right and left maxillae. One paratype of *E. teresa* has a minute palpus on the right maxilla, whereas the left maxillary palpus is absent.

BIOLOGY.—*E. teresa* has been collected with *E. tibialis* and *E. micheneri* in cool to moderately cool (50°-63° F. in June and July) fast flowing streams with rocky bottom types. The mating flight of this species has not been observed by the authors.

Ephemerella serratoides McDunnough

Ephemerella serrata McDunnough 1930, 55 nec Morgan 1911.

Ephemerella serratoides McDunnough 1931a, 83; McDunnough 1931b, 207, 3 figs. (nymph); Traver 1932, 146; Traver 1935, 619, 1 fig.; Burks 1953, 67, 1 fig.; Pugh 1956, 26; Berner and Allen 1961, 154.

This species was described from male and female imagoes reared from nymphs collected in southern Quebec; however, McDunnough did not describe the nymph until 1931.

Male Imago (dry). Length: body 5-6; forewing 5-6 mm. Head light brown. Thorax light brown; wings hyaline, venation pale; legs yellow. Abdominal terga 1 to 3 reddish brown, terga 4 to 6 yellow with reddish brown submedian maculae, terga 7 to 10 yellow; abdominal sterna yellow, each sternum with a transverse row of four black dots. Genitalia as in figure 6. Caudal filaments pale with dark brown annulations at apex of each segment.

Mature Nymph. Length: body 6-7; caudal filaments 2-3 mm. General color brown, often sprinkled with small pale dots. Head without occipital tubercles; maxillary palpi three-segmented (fig. 51). Prothorax without tubercles; legs brown with darker brown tibial and tarsal bands, forelegs as in fig. 35; tarsal claws with 5 to 8 denticles (fig. 63). Abdominal terga with paired submedian tubercles on seg-

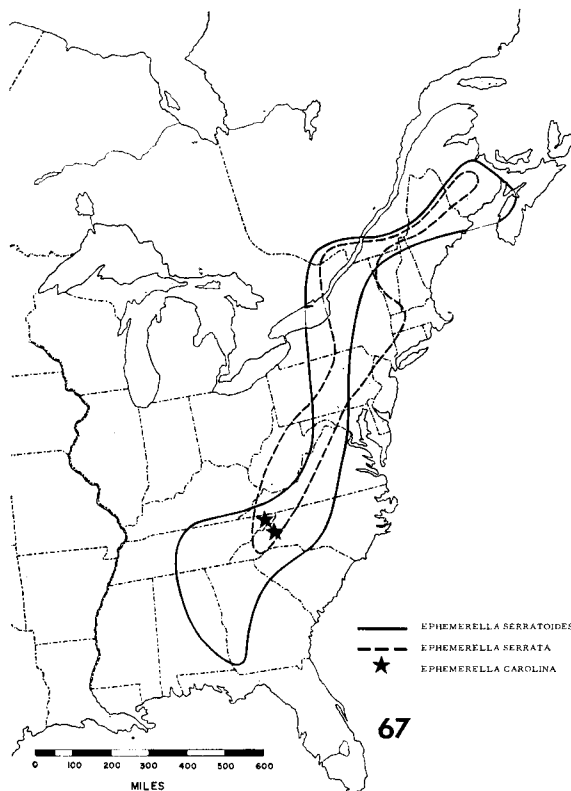


PLATE VII

FIG. 67.—Distribution map of *Ephemerella serratoides*, *E. serrata* and *E. carolina*.

ments 3 to 7, tubercles often small on segment 3 (fig. 23); abdominal sterna light brown, each sternum with a transverse row of four black dots. Caudal filaments brown often with pale tips and/or bands, and without setae.

Type Locality. Knowlton, Quebec.

Type. No. 3274, Canadian National Collection, Ottawa, Ontario.

DISTRIBUTION.—*E. serratoides* is a boreal eastern North American species. It is known from Ontario to Nova Scotia and New Brunswick austrad to southern Georgia and Alabama (fig. 67). Berner and Allen (1961) have recorded detailed locality records of this species in the Southeastern States. We have examined specimens from the following localities:

NEW BRUNSWICK: NW. Miramichi River nr. New-castle, 7/13-VII-61, T. Dolan; Tetagouche Falls, 3-VIII-50, E. L. Bousefield; Charlo River, 2-VIII-50, E. L. Bousefield. **NORTH CAROLINA:** Bryson City, 8-VII-30, H. T. Spieth (AMNH); Marion, 6-VII-30, H. T. Spieth (AMNH); Almond, 4-VII-30, H. T. Spieth (AMNH); Nantahala River, 16-VIII-54, L. Berner (UF); Murphy, 27/28-VII-30, H. T. Spieth (AMNH); Yadkin River, Wilkesboro, 2-VII-30, H. T. Spieth (AMNH). **NOVA SCOTIA:** Annapolis Royal, 21-VII-28, W. J. Brown (CNC); Margee River, 6-VII-58, E. L. Bousefield; Ingramport, 22-VIII-39, T. H. Frison and T. H. Frison, Jr. (INHS). **QUEBEC:** Knowlton, 13-VIII-30, L. J. Milne (Holotype) (CNC); Lake Kazubazua, 18-VIII-27, G. S. Walley (CNC); Ottawa Golf Club, 23-VIII-24, J. McDunnough (CNC); Trinity Bay, 17-VIII-29, W. J. Brown (CNC); Wakefield, 8-VII-31, L. J. Milne (CNC). **TENNESSEE:** Franklin Co., Winchester, 13-IV-54, J. Pugh (UF); Sevier-ville, 29-VIII-30, H. T. Spieth (AMNH). **WEST VIRGINIA:** Cacapon River, 13-VIII-30, J. G. Needham (CU).

BIOLOGY.—Berner and Allen (1961) have notes on the biology of *E. serratoides*. The nymphs are found in swiftly-flowing streams on moss and other vegetation. The adults emerge from May in the southeast to mid-August and possibly later in the north.

Ephemerella serrata Morgan

Ephemerella serrata Morgan 1911, 109, 4 figs.; Morgan 1913, fig. 40; Ulmer 1920, 119; Lestage 1925, 285, 1 fig.; McDunnough 1931b, 207, 1 fig.; Traver 1932, 146; Traver 1935, 619; Ide 1935, 44; Burks 1953, 67, 1 fig.; Berner and Allen 1961, 154.

E. serrata was described from all stages collected in New York.

Male Imago (in alcohol). Length: body 7-8; forewing 7-8 mm. Head brown. Thorax brown; wings hyaline; wing base and primary longitudinal veins light brown, intercalaries and crossveins pale; legs pale, each femur with a brown apical band. Abdominal terga light brown, middle abdominal segments translucent, abdominal sterna pale, without maculae. Genitalia as in fig. 7. Caudal filaments

pale with dark brown annulations at apex of each segment.

Female Imago (in alcohol). Length: body 7.5-8.5; forewing 8-9 mm. Abdomen darker brown than in male. Other characters as in male except for usual sexual differences.

Mature Nymph. Length: body 5-6; caudal filaments 1.5-2.0 mm. General color brown with variable pale and dark brown markings. Head roughened but without distinct occipital tubercles (fig. 13); maxillary palpi three-segmented (fig. 50). Thorax brown, often with variable dark brown markings; prothorax with paired submedian tubercles; legs brown with femoral, tibial, and tarsal bands, foreleg as in fig. 34; tarsal claws with 3 to 5 denticles (fig. 62). Abdominal terga dark brown, segments 4 to 6 often pale; segment 9 with paired dark brown sublateral maculae; terga with paired submedian tubercles on segments 3 to 8, tubercles may be small, barely discernible or absent on segments 3 and 8 (fig. 22); abdominal sterna pale, segments 2 to 9 with sublateral dark brown maculae. Caudal filaments brown often with a wide dark brown median band and without setae.

Type Locality. Fall Creek, New York.

Type. Cornell University Collection, Ithaca, New York.

DISTRIBUTION.—*E. serrata* is a boreal eastern

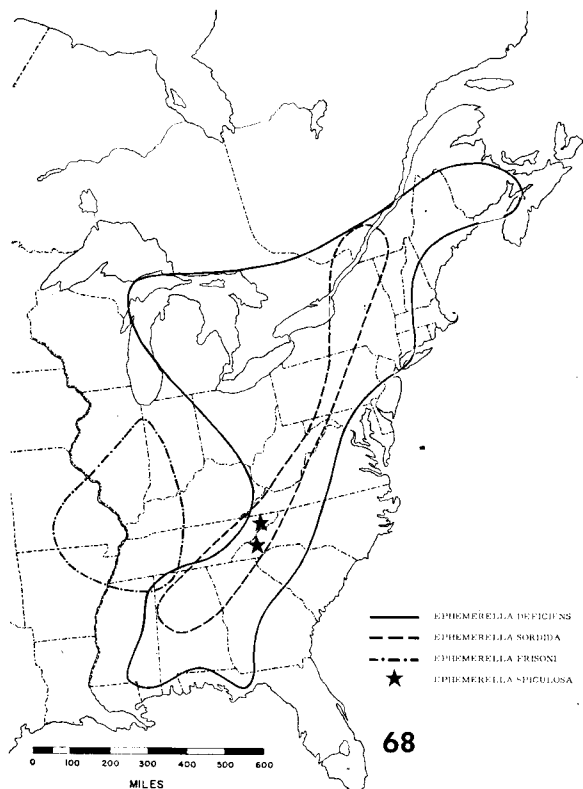


PLATE VIII

FIG. 68.—Distribution map of *Ephemerella deficiens*, *E. sordida*, *E. frisoni* and *E. spiculosa*.

North American species known from Quebec and New Brunswick austrad to the Appalachian region of North Carolina (fig. 67). The distribution of this species in the southeastern states has been discussed by Berner and Allen (1961). Specimens from the following localities have been examined by the authors:

MARYLAND: Catoctin Creek, 17/19-VI-24, V. Argo (CU). NEW YORK: Wilmington, 6-VIII-28, P. R. Needham (CU); Fall Creek, 13-VI-10, A. H. Morgan (Holotype) (CU). NEW BRUNSWICK: Miramichi River, 2-IX-50, E. L. Bousefield. NORTH CAROLINA: Bryson City, 5-VIII-30, H. T. Spieth (AMNH); Smokemont, 3-VIII-30, H. T. Spieth (AMNH); Wayah Creek, 27-VII-30, J. R. Traver (JRT); Trib. Pigeon River, Waynesville, 20-VII-30, J. R. Traver (JRT). QUEBEC: Wakefield, 8-VII-31, L. J. Milne (CNC); Foster Power Plant, 21-VII-30, L. J. Milne (CNC); Yamaska River, 6-VIII-30, L. J. Milne (CNC); Fulford, 29-VI-29, L. J. Milne (CNC); Knowlton, 22-VI/12-VIII-30, L. J. Milne (CNC). WEST VIRGINIA: Lost River, 12-VIII-30, J. G. Needham (CU).

BIOLOGY.—Little has been recorded of the biology of *E. serrata*, but it is known to occur in cool swiftly-flowing streams. The adults are known to emerge from early July to mid-August.

Ephemerella spiculosa Berner and Allen

Ephemerella spiculosa Berner and Allen 1961, 152, 5 figs.

This species was described from nymphs collected in the Southeastern United States. The taxonomy of this species was discussed by Berner and Allen (1961).

Mature Nymph. Length: body 4.0–4.6; caudal filaments 1.7–2.0 mm. General color brown with variable dark brown and pale markings. Head without occipital tubercles, but covered with numerous fine spicules (fig. 12); maxillary palpi with a single segment and with fine apical spicules (fig. 49). Thorax covered with numerous fine spicules; prothorax with small paired submedian tubercles; legs pale with brown markings on femora and tibial and tarsal bands, foreleg as in fig. 33; tarsal claws with 6 to 8 denticles (fig. 61). Abdominal terga light brown, terga 1 to 3 with two wide submedian dark brown stripes; terga with paired submedian tubercles on segments 3 to 7 covered with fine spicules, segments 2, 8, and 9 with slight undulations (fig. 20); abdominal sterna pale with brown posterior margins, sterna 3 to 7 with dark sublateral maculae; sternum 9 with scattered fine spicules. Caudal filaments pale with alternating dark brown bands and without setae.

Type Locality. Horse Creek Recreation Area, Green Co., Tennessee.

Type. No. 3829.6, University of Florida Collection, Gainesville, Florida.

DISTRIBUTION.—*E. spiculosa* is known from the type locality in Tennessee (fig. 68) and the following locality in North Carolina: Macon Co., Skittles Creek, 16-VII-57, C. D. Hynes (UF).

BIOLOGY.—The nymphs of this species occur on the vegetated surfaces of rocks in swiftly-flowing streams. The biology of this species is discussed in detail by Berner and Allen (1961).

Ephemerella carolina Berner and Allen

Ephemerella sp?, No. 2 Traver 1932, 178.

Ephemerella carolina Berner and Allen 1961, 149, 5 figs.

This species was described from nymphs only, collected in Southeastern United States. The taxonomy of *E. carolina* was discussed in Berner and Allen (1961).

Mature Nymph. Length: body 4.5–5.0; caudal filaments 1.5–2.0 mm. General color brown with variable dark brown and pale markings. Head with well-developed occipital tubercles covered with fine spicules (fig. 11); mouthparts as in figs. 28–31; maxillary palpi unsegmented (fig. 41). Thorax brown with variable dark brown and pale markings; prothorax with paired submedian tubercles covered with fine spicules; legs brown with dark brown femoral, tibial and tarsal bands, foreleg as in fig. 32; tarsal claws with 5 to 7 denticles (fig. 60). Abdominal terga brown, terga 4 to 6 usually pale while terga 7 to 9 are usually dark brown to black; terga with paired submedian tubercles on segments 3 to 9, tubercles may be small on segments 3 and 9 (fig. 21); abdominal sterna unicolorous dark brown, often reddish brown with darker brown lateral margins. Caudal filaments pale with variable dark brown bands, and without setae.

Type Locality. Buck Creek, Macon Co., North Carolina.

Type. No. 3184.5, University of Florida Collection, Gainesville, Florida.

DISTRIBUTION.—This species is known from only the Appalachian region of North Carolina and Tennessee (fig. 67). Detailed locality records are listed by Berner and Allen (1961).

BIOLOGY.—The nymphs of *E. carolina* occur on and among rocks in swiftly-flowing streams in the Great Smoky Mountains of North Carolina and Tennessee. Berner and Allen (1961) estimate that adults emerge in late August or early September.

Ephemerella molita McDunnough

Ephemerella molita McDunnough 1930, 57; McDunnough 1931b, 206; Traver 1935, 613.

McDunnough (1930) named *E. molita* from two female imagoes collected in Quebec and Nova Scotia and placed the species in the *simplex* group (=subgenus *Dannella*). In 1931, without explanation, he removed *E. molita* from this group and included it in his section II, the *serrata* group. The holotype female from Trinity Bay, Quebec, was found to have characters common to the female imagoes of other eastern species of the *Serratella*. The basal portion of the forewings is tinted with light brown as are the forewings of *E. serrata*, *E. sordida* and *E. deficiens*. The abdominal segments were collapsed in both the holotype and the paratype, but the middle segments have four black dots as in *E. serratoides*,

the legs have femoral markings as in *E. serratoides* and *E. serrata*, and the caudal filaments are unicolorous as in *E. sordida*. The inclusion of this species in the *Serratella* is tentative, and if it is properly placed, we are still not able to determine whether or not it is conspecific with other species in the subgenus. The status of *E. molita* can be determined only when reared topotypical material is available for study. The male imago and the nymph of this species remain unknown.

Female Imago (dry). Length: body 6-7; forewing 6-7 mm. Head yellowish with brown markings. Thorax dark brown; wings hyaline; wing base shaded with brown; venation pale; legs yellow, each femur with a brown apical band. Abdominal terga dark brown; abdominal sterna pale, each sternum with a transverse row of four black dots. Caudal filaments pale.

Type Locality. Trinity Bay, Quebec.

Type. No. 3129, Canadian National Collection, Ottawa, Ontario.

DISTRIBUTION.—This species is known from only the type and paratype which we have examined.

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