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REEXAMINATION OF SOME NEARCTIC SPECIES OF THE GENUS CALLIBAETIS EATON, WITH THE DESCRIPTION OF A NEW SPECIES (EPHEMEROPTERA; BAETIDAE)

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The genus *Callibaetis* Eaton is confined to the new world and is particularly abundant in the western portions of North America. At the present time twenty-three nearctic species have been described, one of which, *C. hageni* Eaton, has been declared a *nomen dubium* by Edmunds and Allen (1957)—an action with which I am in entire accord. In the remaining forms there are two major problems—the inadequate descriptions of the earlier authors and the lack of good morphological criteria for the species. This paper is an attempt to resolve both of these difficulties in part.

First, redescriptions of two species, *C. doddsi* Traver and *C. fuscus* Dodds, are given. The original descriptions by Dodds (1923) were so nebulous that Traver had to treat these species in a most cursory manner in the systematic section of The Biology of Mayflies (1935). Since that time they have remained one of the major obstacles in the study of the western fauna. I am particularly indebted to Harold J. Grant, Jr. of the Academy of Natural Sciences of Philadelphia for the loan of the types of these two forms.

Secondly, I have tried to deal with the problem of good morphological criteria for some of the species; those previously used have been the coloration and the venation of the forewing. It has been found, however, that these characters are especially prone to wide variation. In my study of the genus I have come to the conclusion that the male genitalia and the venation of the hindwing of both sexes offer good characters for the separation of the species. Consequently, I have figured these structures whenever the identification of a species was certain.

In this study I have utilized not only the material in my own collections (T.B.T.) and the types previously mentioned from the Academy of Natural Sciences of Philadelphia (A.N.S.P.), but also the large collection of the genus from the Illinois Natural History Survey (I.N.H.S.). I would like to thank Dr. H. H. Ross for the loan of the latter specimens.

Callibaetis doddsi Traver

C. vitreus Dodds 1923, *nec* Navas 1918.
C. Doddsi Traver 1935, new name proposed.

This species is closely related to *C. traverae* Upholt, *C. floridanus* Banks, *C. montanus* Eaton, and *C. fluctuans* (Walsh). All have the male forewing unpigmented, few crossveins in the forewing behind vein R_2, and, where the females are known, an absence of dark clouds on the longitudinal veins of this sex. The male genitalia, the venation of the hindwing, and the paired marginal intercalaries are distinctive of the species *doddsi*.

The type, a single male (A.N.S.P. Type number 9027) preserved in alcohol, is represented and is in a rather poor state of preservation. The color pattern is still distinct, however. As it was impossible to make slides of the male genitalia and hindwing, these structures were difficult to observe, but they appeared to be well represented by the figures given orginally by Dodds.

Type locality.—Tolland, Colorado (July, 1921, G. F. Dodds).

Measurements.—Length of body 6.5 mm.; forewing 6.3 mm.; caudal filaments 13.0 mm.

Head.—Yellow-tan. Antennal scape and pedicel very light brown; flagellum yellow-white, with small white bulb at base marked with brown. Ocelli white, ringed with black at base. Venter and vestigial mouthparts yellow-white, marked with light brown. Vertex between eyes and frontal shelf dark red-brown.

Thorax.—Dark red-brown on dorsum of all segments, broken only by very narrow streaks of white at anterior edge of mesoscutum; mesoscutellum dark, with light anterior and posterior margins. Propleura medium brown; meso- and metapleura light brown, very broad brown band extending from wing base to tip of mesoscutellum and also continued onto the venter. All sternites light brown.

Wings.—Forewings without pigment; veins Sc and R tan, others yellowish hyaline; no alteration of light and dark in longitudinal veins; crossveins and wing margin uniformly hyaline; marginal intercalaries occurring in pairs, usually even in length; about 14 crossveins behind vein R_2. Hind-

wings without pigment and as in the figure given by Dodds.

Legs.—Forecoxae and trochanters light brown, other segments missing. Mid- and hindlegs loose in vial and very similar to one another; femora yellow-tan, tibia and tarsi lighter; tarsal joints narrowly marked with brown distally.

Abdomen.—First segment with dorsum uniform dark brown, venter light brown. Tergites of remaining segments medium brown, light narrow median stripe. Venter light brown, submedian and lateral dark oval spots on each side.

Caudal filaments.—Only the stubs remain; these are uniform light brown.

Callibaetis fuscus Dodds Fig. 1.

C. fuscus Dodds 1923.

The original material upon which Dodds based his description consisted of a series of one male, one female, and one nymph. The author (1958) designated the male of this series as lectotype (A.N.S.P. Type no. 9026). In addition, other males and females collected and determined by Dodds, but not included in the type series, are in the collections of the Illinois Natural History Survey. They agree exactly with the type material and have been utilized in the redescription. Fig. 1 is drawn from these specimens. *C. fuscus* is closely related to *Callibaetis evergreenensis* sp. n. (described below) but is separable by the characters cited in the description of the latter.

Type locality.—Tolland, Colorado (July, 1915, G. F. Dodds).

Lectoholotype.— ♂.

Measurements.—Length of body 8.0 mm.; forewing 10.0 mm.; caudal filaments 16.0 mm.

Head.—Medium brown. Vertex between eyes and frontal shelf dark brown; venter and vestigial mouthparts light brown with dark brown markings. Antennal scape and pedicel dark brown; flagellum missing on type, in other material light brown. Upper facet of compound eye medium brown, lower black. Ocelli white, with black basal ring.

Thorax.—Pronotum dark brown, areas immediately lateral to median line lighter; propleura and venter light brown, heavily stippled with fine brown dots; meso- and metapleura and venters similar. Mesonotum dark brown with two submedian and one median cream stripes anteriorly, fading in middle of segment; posterior uniform black-brown with narrow light stripe leading onto and including tip. Metanotum dark brown margined in black.

Wings.—Longitudinal veins alternately dark and light in the anterior region, uniformly brown in posterior; crossveins yellow-hyaline, about 37

behind vein R_2; marginal intercalaries paired, anterior vein longer than posterior one; wing margin uniformly yellow-brown. Vitta extending to radius; continuous basal two-thirds, with 13 roundish hyaline areas; larger hyaline area in the upper two cells; distally and beneath with few more small hyaline cells. Hindwings pigmented with brown proximally; venation as in figure presented by Dodds.

Legs.—All legs light brown, tibiae yellowish and margined in dark brown; tarsal joints narrowly margined with brown distally.

Abdomen.—Light brown, stippled with fine dark brown dots. Tergites with lighter median area and lateral light spot on each side. Sternites with median light stripe, margined on each side by dark stripe, lateral areas lighter. Each segment, dorsum and venter, finely margined with dark brown on posterior.

Genitalia.—Yellow-white, as in fig. 1.

Caudal filaments.—Uniformly light brown.

Lectoallotype.— ♀.

As in the male, but with lighter coloration and the following exceptions.

Compound eyes black. Mesonotum not margined with black on posterior; venter of thorax lighter cream color. Abdomen medium brown, very dense, uniform, and dark stippling; very small lateral light spots on tergites. Wing margin alternately dark and light. Light stigmatic dots on abdomen.

Nymph (not reared).

This specimen is in very poor condition and, as a result, little can be added to the original description except for the following items.

Wing pads black, indicating specimen was ready to emerge. Caudal filaments uniformly pale, not banded with black. Femur without apical band. No distinctive markings visible on the abdomen.

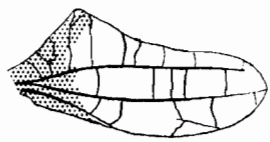
Other specimens identifiable as this species have been taken at the following locality.

COLORADO: Beaver ponds, Kokomo, 9,000 ft. July 23, 1938. H. H. and J. A. Ross, collectors (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.).

Callibaetis evergreenensis sp. nov. Figs. 2-3.

This species is separable from all of the nearctic species of *Callibaetis,* except *C. coloradensis* Banks, *C. nigritus* Banks, and *C. fuscus* Dodds, by the absence of dark clouds around the veins in the disc of the forewing of the female, and the presence of pigment and the alternately dark and light coloration of the longi-

1



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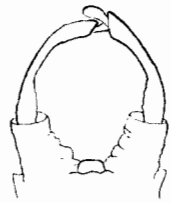

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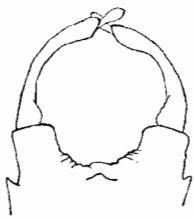

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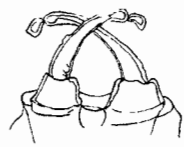

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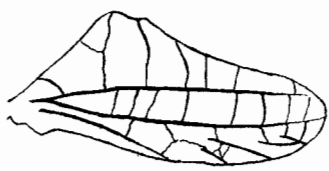

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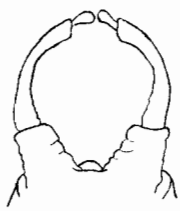

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Fig. 1, male genitalia of *Callibaetis fuscus* Dodds; Fig. 2, hindwing of *C. evergreenensis* sp. nov.; Fig. 3, male genitalia of *C. evergreenensis* sp. nov.; Fig. 4, the same of *C. ferrugineus* (Walsh); Fig. 5, the same of *C. fluctuans* (Walsh); Fig. 6, the same of the subimago of *C. montanus* Eaton; Fig. 7, hindwing of *C. pretiosus* Banks; Fig. 8, male genitalia of *C. pretiosus* Banks. All figures greatly enlarged.

tudinal veins of the forewing of the male. It can be distinguished from *coloradensis* by the brown pigment present in the basal costal space of the female and also by the venation of the hindwing; from *nigritus,* by the light brown (not black) thorax and vitta, and the abdominal maculation; from *fuscus,* to which it is most closely related, by the male genitalia, the venation of the hindwing, and the coloration of the thoracic notum of the female.

Holotype.— ♂ ; Evergreen, Jefferson County, Colorado; Aug. 24, 1956 (A. L. Baily; specimen in alcohol) [Academy of Natural Sciences of Philadelphia, Type no. 9363].

Measurements.—Length of body 6.5 mm.; forewing 6.5 mm.; caudal filaments 16.3 mm.

Head.—Black-brown. Vertex between compound eyes black-brown; frontal shelf same but with two submedian yellow spots; face brown, vestigial mouthparts white; genae brown, marked with yellowish white ventrally; venter of head white. Antennal scape dark brown, pedicel and flagellum white. Turbinate portion of compound eyes light brown, lower portion black. Ocelli white, ringed with black at base.

Thorax.—Pronotum dark red-brown, median cream colored streak and two posterior, submedian cream colored dots on each side; pleura lighter red-brown, marked with cream, this merging into white prosternum, having basisternum set off anteriorly and posteriorly with dark brown sutures. Mesoscutum dark brown anteriorly, fading to light brown posteriorly, with light tan median stripe running entire length; anterior edges of scutum plus prescutum cream; scutellum brown with wide white median stripe; postscutellum deep brown, cream tip; mesopleura cream, broadly stippled and marked with light brown; mesosternum uniformly light brown, except for basisternum, which is cream mottled with dark brown, and around the coxae, where it is light tan. Metanotum brown with blackish brown posterior margin; metapleura cream, heavily marked with brown; metasternum cream, mottled with dark brown dots.

Wings.—Forewing with longitudinal veins alternately light and dark; crossveins white, about 30-40 behind vein R_2; marginal intercalaries paired, those placed anteriorly longer than the posterior ones; wing margin uniformly light brown. Vitta light brown, more or less continuous in the costal space, except hyaline basal costal space and about 12-14 hyaline spots around crossveins; vitta broken into four distinct lobes in subcostal and radial interspaces—one basal, two median, and one apical—all widely separated. Hindwings (fig. 2) with relatively numerous crossveins; longitudinal and crossveins pale brown proximally, hyaline distally; light brown pigmentation in basal and costal areas of wing.

Legs.—Forecoxae and trochanters white, with dark brown sutures, stippled with very fine brown dots; forefemora yellow with a few brown dots and

two fine black lines on each edge. Foretibiae and tarsi uniformly light brown, distal ends of tarsal segments margined with black. Mid- and hindlegs yellowish white; coxae, trochanters, and femora marked as in foreleg, but with heavier stippling; tibiae yellow-white, lateral edges finely margined in black, stippled with very fine brown dots, with distinct dark brown ring proximally; first tarsal joint yellow-white proximally, grey distally; remainder dark grey.

Abdomen.—Cream colored, densely mottled with brown dots; dots on tergites more dense than on sternites. Tergites with median cream colored stripe, which is bisected on posterior segments by narrow brown stripe, all tergites bordered on each side by a wide brown band; apical segments with distinct, less densely mottled spots becoming diffuse posteriorly; last tergite uniform light brown, lighter median stripe and two light submedian dots. Sternites with two submedian stripes, somewhat indistinct posteriorly; stippling concentrated into narrow band at posterior of each segment; segments 1-9 with apicolateral dark brown spot on each side; last sternite with only two submedian dark brown spots.

Genitalia.—Forceps light brown proximally, fading to white distally. Penis lobes as in fig. 3.

Caudal filaments.—Pale brown, narrowly and lightly marked with dark brown at joints.

Allotype.— ♀ ; same data as holotype. [Academy of Natural Sciences of Philadelphia.]

Measurements.—Length of body 6.2 mm.; forewing 7.0 mm.; caudal filaments 10.0 mm.

Head.—Cream colored, with dark brown markings; vertex between eyes and frontal shelf cream, two submedian dark brown stripes, stippled with brown dots which are especially heavy medially but extremely fine around the compound eyes and ocelli; two white dashes anterio-medially; face, vestigial mouthparts, genae and venter of head all cream colored, sutures dark brown, with fine dark brown stippling. Antennal scape white proximally with narrow black ring distally; pedicel white proximally, black distally. Compound eyes white distally, blackish shading proximally.

Thorax.—Pronotum with cream colored median stripe, flanked on each side by a very wide brown band, with anterior submedian white spot; remainder cream with dark brown dots; pleura cream stippled with dark brown, large dark brown spot medio-laterally; prosternum cream colored, sutures broadly marked in dark brown; posterior edges and tip of scutum cream; prescutum white; postscutum brown, tip and posterior edges broadly white; mesopleura cream, with heavy brown stippling, sutures broadly marked with dark brown; mesosternum cream, with heavy dark brown stippling, except pleurotrochantin which is uniformly cream. Metanotum deep brown, posterior margins black; metapleura and sternum cream, with heavy dark brown dots and sutures.

Wings.—As in the male, except for the following: vitta black-brown; forewing margin alternately light and dark; basal costal space whitish hyaline proximally, brown distally. Pigmentation in basal area of hindwing more extensive than in male.

Legs.—All similar, as follows: coxae and trochanters cream colored, with dark brown stippling and sutures; femora light tan, lightly stippled with brown, with two faint black lines on each edge; tibiae white, with narrow dark ring apically; tarsi white, distal end of each joint tinged with black.

Abdomen.—Cream colored, heavily stippled with dark black-brown. Tergites with median, less densely stippled stripe; lateral margins heavily stippled, thereby making a long streak of dark brown. Sternites uniformly stippled with dark brown, with only a narrow median and two extreme lateral dark stripes.

Caudal filaments.—White, joints narrowly margined with brown; every other segment margined with dark brown, others with light brown.

Paratypes.—3 ♂♂, 5 ♀♀; same data as holotype; 1 ♂, 2 ♀♀ in the collections of the Academy of Natural Sciences of Philadelphia, and 2 ♂♂, 3 ♀♀ in the collection of the author.

Variation in the male paratypes.—Length of body 6.0-6.3 mm.; forewing 5.5-6.0 mm.; caudal filaments 10.0-11.5 mm. (broken). Compound eyes of one specimen more yellow-tan than brown; coloration of thorax constant, except for the median stripe on mesoscutum, which may be of heavier or lighter intensity; forelegs more yellowish and mid- and hindlegs more whitish than in holotype; vitta of forewing more reduced in two specimens, having the proximal half of the costal space hyaline, except for a few dark brown spots.

Variation in the female paratypes.—Length of body 6.0-7.5 mm.; forewing 6.0-8.0 mm. Thorax often lighter than in allotype, being a uniform light tan, with the median dark area almost obscured. Abdomen sometimes lighter on the venter than on the dorsum.

In addition, there are eight subimagos, none of which were designated as types, in the collection of the author. I have also seen specimens in the Illinois Natural History Survey collections which are referable to this species. They were not included in the type series because of slight color variations. These specimens were taken at the following locality.

WYOMING: L. Slide Lake, Gros Ventre Mts., Moose. Aug. 11, 1940. T. H. Frison and T. H. Frison, Jr., collectors (many ♂♂ and ♀♀, I.N.H.S.).

Callibaetis brevicostatus Daggy

C. brevicostatus Daggy 1945.

Burks (1953) reported this species from Saskatchewan (no other data), the only locality other than the type locality in Minnesota from which it is known. I have examined the specimen, a single male, and am convinced that it represents this species. The full data are SASKATCHEWAN, Indian Head, Aug. 18, 1947 (I.N.H.S.).

Callibaetis ferrugineus (Walsh) Fig. 4.

Cloe ferruginea Walsh 1862.

An excellent redescription of this species, as well as figures of the fore- and hindwings, was given by Burks in 1953. I am presenting a drawing of the male genitalia (fig. 4) of specimens from Lake Geneva, Wisconsin. On the basis of the different configurations of this structure in the species *ferrugineus* and *skokianus*, I cannot agree with Burks that they might be synonymous. They appear to be distinct and easily separable.

I have examined specimens of this species from the following localities. (The Minnesota specimens represent a new state record.)

MICHIGAN: Paw Paw. Aug. 19, 1940. At light. Lucy M. Ayars, collector (many ♂♂ and ♀♀, I.N.H.S.); Sept. 11, 1950. James S. Ayars, collector (4 ♂♂, I.N.H.S.).

MINNESOTA: Willmar. July, 1941. James H. Mohr and W. P. Mohr, collectors (3 ♂♂, I.N.H.S.).

WISCONSIN: Lake Geneva. June 5, 1938. H. H. Ross and B. D. Burks, collectors (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.); Mukwonagan. June 5, 1938. H. H. Ross and B. D. Burks, collectors (many ♂♂ and ♀♀, I.N.H.S.).

Callibaetis fluctuans (Walsh) Fig. 5.

Cloe fluctuans Walsh 1862.

This species was redescribed by Burks (1953) and figures of the wings were presented. I am giving a figure of the male genitalia (fig. 5) from a topotypical specimen from Moline, Illinois, in my personal collection. The following specimens represent a new state record.

KANSAS: Junction City. July 29, 1938. H. H. Ross, collector (many ♂♂ and ♀♀, I.N.H.S.).

Callibaetis montanus Eaton Fig. 6.

C. montanus Eaton 1883-1888.

This species is known from Central America, Mexico, and southwestern United States. The original description by Eaton (1883-1888) gave figures of the wings. Spieth (1941) presented additional notes on the type series. Fig. 6 shows the subimagal male genitalia and is taken from the following specimens.

TEXAS: Hidalgo. Nov. 29, 1945. R. H. Beamer, collector (many ♂♂ and ♀♀, I.N.H.S. and T.B.T.).

Callibaetis pretiosus Banks Figs. 7-8.

C. pretiosus Banks 1914.

I am holding under this name specimens which agree quite well with the incomplete description of the species given by Banks. Berner (1950) reported a variant of this species from Florida, the only state from which it is known other than its type locality in Virginia. The main variation of the specimens cited below lies in size. In the female type, the length of the forewing is about 6.5 mm., while in the northern form it is often from 7.5-9.0 mm. The latter may well represent another subspecies. As the male has never been fully described, I am taking this opportunity to present the following notes based on a specimen from Paw Paw, Michigan.

Measurements.—Length of body 8.0 mm.; forewing 6.5 mm.; caudal filaments 12.0 mm.

Head.—White; face marked with dusky yellow. Antennae white, scape shaded with grey distally. Turbinate portion of compound eyes yellow-white, lower portion black. Ocelli white, ringed with black at base.

Thorax.—Dusky yellow; tip of mesonotum shaded with grey; metanotum yellow-grey. Sternites and pleura yellowish white, sutures lightly shaded with brownish yellow.

Legs.—Yellow-white; forelegs missing; mid- and hindfemora lightly shaded with brown distally; tarsi narrowly marked with brown on distal margin of each segment.

Wings.—Forewing hyaline, without pigmentation or vitta; stigmatic area milky-white; longitudinal veins yellowish hyaline, crossveins whitish hyaline; about 40 crossveins behind vein R_2; marginal intercalaries double anteriorly, single posteriorly. Hindwing hyaline, as in fig. 7.

Abdomen.—Yellow-white. Tergites finely stippled with light brown; median area lighter, bordered on each side with darker stripe, light spot on each side of these, somewhat anterior; segments 8-10 darker yellow. Ster-

nites with a pair of median brown streaks on each segment. All segments with grey-black stigmatic dots.

Genitalia.—Yellow-white, as in fig. 8.

Caudal filaments.—White, joints narrowly and faintly marked with grey.

The specimens cited below represent new state records.

CONNECTICUT: Mt. Carmel. Sept. 27, 1943. Sweeping dry grass. Katherine Sommerman, collector (1 ♀, I.N.H.S.).

MICHIGAN: north fork of Au Sable River, near Lorell. May 24, 1936. Justin W. Leonard, collector (1 ♀, I.N.H.S.); Paw Paw. July 12, 1950. At light. Lucy and James Ayars, collectors (4 ♀♀ and 1 ♂, I.N.H.S. and 1 ♀, T.B.T.).

MINNESOTA: Basswood Lake, Winton. Aug. 19, 1941. At light. T. H. Frison, collector (1 ♀, I.N.H.S.); Ely. Aug. 20, 1940. W. D. Balduf, collector (1 ♀, 1 ♀ subimago, I.N.H.S.); Lake Hubert. Aug. 11, 1941. At light. H. H. Braucher, collector (1 ♀, I.N.H.S.).

ONTARIO: Sinicoe Lake, Swansea. Sept. 1, 1937. H. S. Parish, collector (1 ♀, I.N.H.S.).

WISCONSIN: Totogatio River, Minong. Sept. 3, 1939. B. D. Burks, collector (1 ♀, I.N.H.S.).

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