

THE NORTH AMERICAN EPHEMEROPTERAN SPECIES OF FRANCIS WALKER

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In his work, *List of the Specimens of Neuropterous Insects in the Collection of the British Museum, Part III, Termitidae-Ephemeridae*, Walker considered thirty-two species of ephemerids from North America. Twenty-two of these were believed to be new to science, while the other ten were species that had been described by Say, Pictet, and Burmeister. Walker had specimens which he assigned to two of these ten species. The other eight, which he discussed although he had no material to represent them, are: PALINGENIA PUELLA PICTET = *Campsurus puella* (Pictet), PALINGENIA LIMBATA GUERIN = *Hexagenia limbata* (Guerin), BAËTIS INTERPUNCTATA SAY = *Stenonema interpunctatum* (Say), BAËTIS ARIDA SAY = *Isonychia arida* (Say), BAËTIS VERTICIS SAY = *Potamanthus verticis* (Say), BAËTIS OBESA SAY = *Baetisca obesa* (Say), *Caenis hilaris* Say, and *Ephemera guttulata* Pictet. These eight species are not considered further in the present paper.

Later students of the Ephemeroptera, especially Eaton (1871 and 1883-1888), have synonymized many of Walker's species. During the last two decades, however, intensive research on the North American Ephemeroptera has resulted not only in the description of many new species but also in the revival of some of Walker's names that had previously been synonymized. In order to determine whether or not the present concepts of Walker's species are correct, it seemed advisable to compare recently collected material with his original specimens. Through the kindness of the authorities at the British Museum (Natural History), it was possible to do this during the summer of 1939. I wish particularly to thank Messrs. N. D. Riley, D. E. Kimmins, and Martin E. Mosely for their courtesy and helpfulness in connection with my visit to England and the British Museum (Natural History). Mr. Kimmins kindly made invaluable study preparations of several ephemerid genitalia.

As stated in the introduction to Walker's *List*, "the different individuals of each species contained in the collection are indicated by letters a, b, c, etc." Eaton, when he studied the various specimens, put a label on each pin giving Walker's determination and the letter which Walker had allotted each specimen. Thus, regardless of the subsequent disposition of the specimens by Eaton or other students, it is still easily possible to locate and recognize the actual individuals that Walker considered. In addition the original locality labels are on the pins as well as distinctively colored type labels which have recently been added by the British Museum (Natural History).

In order to present a comprehensive and clear picture of Walker's material, each of his species is discussed individually. The disposition of the species which appears correct in the light of present knowledge is given, as well as any other pertinent information. The synonymy that accompanies each species is not complete, but merely consists of that which is considered important to the present discussion.

***Ephemera decora* Walker = *Ephemera simulans* Walker**

Ephemera decora Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 537, 1853.

Ephemera simulans Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 536, 1853.

Eaton, Revisional Mono. Rec. Ephemeridae, part 1, p. 67, 1883.

Walker based his species upon a single individual from "Canada" that had been "presented by Dr. Barnston." In the Brit. Mus. Nat. Hist. there is a male imago that is labeled "Canada" and, in Eaton's handwriting, "*Ephemera decora* (Type) Walker." There is no doubt that Eaton's synonymizing of the species is correct. The specimen agrees in all respects with the present concept of *E. simulans*.

***Ephemera hebes* Walker = *Blasturus cupidus* (Say)**

Ephemera hebes Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 538, 1853. Hagen, Syn. Neuropt. No. Amer., p. 39, 1861.

Baëtis ignava Hagen, Syn. Neuropt. No. Amer., p. 47, 1861.

Leptophlebia cupida (Say). Eaton, Trans. Ent. Soc., Lond., part 1, p. 89, 1871.

Blasturus cupidus (Say). Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 101, 1884.

Walker based his species upon a female subimago from "Newfoundland" that had been "presented by W. C. St. John, Esq." No specimen meeting all of these qualifications could be found in the Brit. Mus. Nat. Hist. Some person has written the word "unrepresented" under the name *E. hebes* in the Museum's copy of Walker's *List*. Hagen (1861), who visited the Museum in 1857 and studied the ephemerids, did not see any specimens of *hebes* Walker and his description of the species is taken from Walker. Eaton (1871 and 1884) questionably placed *E. hebes* in *cupidus* but did not say that he saw the specimen.

In the entire ephemerid collection at Walker's disposal, there was only one specimen recorded from Newfoundland. There is in the Brit. Mus. Nat. Hist. a *female subimago* that bears three labels: (1) "N-f-d-land," (2) "45 Baetis," and (3) in Eaton's handwriting, "*B. ignava* (Type) Hagen." Walker (p. 571) listed his forty-fifth species of the genus *Baëtis* as *Baëtis?* —, subimago. He considered *Ephemerangustipennis* Rambur as a synonym of this partially named species! Comparison of Walker's description with that of Rambur (1842, *Hist. Nat. Ins. Neuropt.*, p. 295) clearly shows that Walker's description and distributional data were derived from Rambur. Thus we can safely conclude that Walker did not have any specimens to represent his *Baëtis?* — subimago. This is all the more apparent when it is noted that Walker listed all of his specimens by letter. Somebody mistakenly put the label "45 Baëtis" on the true type of *E. hebes* Walker. Hagen (1861, p. 47), doubtfully described *B. ignava*, utilizing the specimen from Newfoundland. This individual is clearly a female subimago of *Blasturus cupidus* (Say). *Ephemerahebes* Walker and *Baëtis ignava* are therefore, as Eaton (1884) indicated, synonyms of *B. cupidus* (Say).

***Ephemerasimulans* Walker**

Ephemerasimulans Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 536, 1853.
Needham, Traver, Hsu, etc., *Biology of Mayflies*, p. 252, 1935.

The species was based upon a single specimen that had been collected on the "River St. Lawrence" and "presented by the Entomological Club." Walker did not indicate the sex or whether the specimen was a subimago or imago. The Brit. Mus. Nat. Hist. has a male subimago labeled "R. Foster, River St. Lawrence," and, in Eaton's handwriting, "*Ephemerasimulans* (Type) Walker." The specimen fits Walker's description and unquestionably agrees with the present concept of the species. *E. simulans* is so distinctive and well known that a redescription of the type is unnecessary.

***Palingenia bicolor* Walker = *Isonychia bicolor* (Walker)**

Palingenia bicolor Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 552, 1853.
Siphylurus bicolor (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 128, 1871.
Revisional Mono. Rec. Ephemeridae, part 3, p. 221, 1885.
Chirotonetes albomanicatus Needham, N. Y. State Mus. Bull. 86, p. 31, 1905.
Isonychia bicolor (Walker). McDunnough, Canad. Ent., vol. 63, p. 161, 1931.

Walker based his species upon a single subimago but did not mention the sex. The specimen had been collected at "St. Martin's Falls, Albany River, Hudson's Bay," and "presented by Dr. Barnston." In the Brit. Mus. Nat. Hist. there is a female subimago labeled "Hudson's Bay" and, in Eaton's handwriting, "*Palingenia bicolor* (Type) Walker." Subimagoes, especially old specimens, are usually difficult to study. Comparison of the type with recently collected subimagoes and imagoes leaves no doubt, however, that the present concept of the species as given by McDunnough is correct. The type also substantiates McDunnough's conclusion that *I. albomanicata* (Needham) is a synonym of *I. bicolor* (Walker).

***Palingenia concinna* Walker = *Blasturus cupidus* (Say)**

Palingenia concinna Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 553, 1853.

Leptophlebia cupida (Say). Eaton, Trans. Ent. Soc. Lond., part 1, p. 89, 1871.

Blasturus cupidus (Say). Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 101, 1884.

Walker based his species upon a single specimen, a male imago from "Nova Scotia" that was in "Lieut. Redman's collection." There is in the Brit. Mus. Nat. Hist. a male imago labeled "N. Scotia Redman" and, in Eaton's handwriting, "*Palingenia concinna* (Type) Walker." Mr. Kimmins has prepared a study mount of the genitalia. A careful comparison of the specimen and especially its genitalia with recently collected individuals of *B. cupidus* confirms Eaton's conclusion that *P. concinna* Walker is a synonym of *B. cupidus* (Say).

***Palingenia natata* Walker = *Ephemera simulans* (Walker)**

Palingenia natata Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 551, 1853.

Ephemera simulans Walker. Eaton, Revisional Mono. Rec. Ephemeridae, part 1, p. 67, 1883.

The species was based upon two female subimagos which had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." Two female subimagos in the Brit. Mus. Nat. Hist. are labeled "St. Martin's Falls" and, in Eaton's handwriting, "*Ephemera natata* (Type) Walker." Careful study confirms Eaton's conclusion that the species is a synonym of *Ephemera simulans* Walker.

***Palingenia nebulosa* Walker = *Blasturus nebulosus* (Walker)**

Palingenia nebulosa Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 554, 1853.

Leptophlebia nebulosa (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 89, 1871.

Blasturus nebulosa (Walker). Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 103, 1884. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 538, 1935.

Walker based the species upon two individuals which had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and had been "presented by Dr. Barnston." The original description was of a male. There are in the Brit. Mus. Nat. Hist. two male imagos which are labeled "Hudson's Bay, St. Martin's Falls" and, in Eaton's handwriting, "*Palingenia nebulosa* (Type) Walker." Traver's description of the species agrees with the types. The present concept of the species seems adequate. Since the second specimen of the original pair is in better condition than the first, I have designated it as the lectotype.

***Palingenia occulta* Walker = *Hexagenia limbata occulta* (Walker)**

Palingenia occulta Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 551, 1853.

Hexagenia occulta (Walker). McDunnough, Canad. Ent., vol. 59, p. 119, 1927.

Needham, Traver, Hsu, etc., Biology of Mayflies, p. 269, 1935.

Walker had three individuals which he considered as belonging to the species. Apparently he utilized all three in the construction of his description. They had been collected in "Arctic America, between Lake Winnipeg and Lake Superior" and "presented by Sir John Richardson."

In the Brit. Mus. Nat. Hist. there are three subimagos, a male and two females, which are labeled "Arctic America" and, in Eaton's handwriting, "*Palingenia occulta* (Type) Walker." The male was Walker's "a" specimen and the two females the "b" and "c" individuals.

Color and distinctness of the color pattern are the most important criteria available for the separation of the various geographical subspecies of the genus *Hexagenia*. Unfortunately, the colors of pinned subimagos fade. The color pattern is also usually obscured by the fading and by the shriveling that take place. To some extent this has happened to the three subimagos in question. Thus the venter of the male's abdomen is faded and discolored so that the color pattern as well as the original colors can not be determined. There are, however, certain salient features of this type specimen that can be distinguished. They are as follows: The genitalia are clearly of the *limbata* type. The clear cut color pattern with a large amount of yellow maculation which is typical of the true *limbata* is lacking. Instead there is a general tendency, especially on the dorsum of the abdomen, for the yellow areas to be suffused with ruddy brown. The lightly colored subdorsal areas of the abdominal tergites are relatively small. They are lacking in tergite one. In tergites two to seven they are present as slender elongated areas that progressively increase in size in the distal segments. All of these areas are completely surrounded by the ruddy ground color. In segments eight and nine the areas are more elongately triangular, being based on the anterior edge of the tergites. The posterolateral angles of the tergites are occupied by lightly colored areas. There are no dark spots in the disks of the meta- and mesothoracic wings. The metathoracic wings lack dark outer margins. I have designated the male as the lectotype.

Except for the usual sexual differences, the two female subimagos agree closely with the male subimago. They were apparently collected on the same date and at the same place as the male. All unquestionably belong to the same subspecies.

Comparison of the type series with recently collected material clearly indicates that the present concept of *occulta* as set forth by McDunnough (1927) and Traver (1935), the latter giving *occulta* specific rank, is adequate and correct. As indicated by McDunnough the subspecies displays a considerable amount of variation, especially in the amount and intensity of the ruddy infuscation, the size of the lightly colored subdorsal areas of the abdomen, and the presence or absence of the dark outer margin of the metathoracic wing. The subspecies is found in immense numbers in the Great Lakes and their tributaries and in the St. Lawrence valley.

***Palingenia pallipes* Walker = *Blasturus cupidus* (Say)**

Palingenia pallipes Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 553, 1853.

Leptophlebia cupida (Say). Eaton, Trans. Ent. Soc. Lond., part 1, p. 89, 1871.

Blasturus cupidus (Say). Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 101, 1884.

Walker, in his original description of the species, described the female and also the subimago. He had available three specimens that

had been collected in "Nova Scotia" and which came "from Lieut. Redman's collection." There is in the Brit. Mus. Nat. Hist. a female imago whose three labels bear the following information: (1) "R," (2) "N. Scotia Redman," and (3) in Eaton's handwriting, "*Palingenia pallipes* (Type) Walker." A second female imago bears similar data except that it lacks the second label. A male subimago also lacks the second label. Careful study of the three specimens and also comparison with recently collected material confirm Walker's conclusion that they all belong to the same species, and also Eaton's decision that *Palingenia pallipes* Walker is a synonym of *Blasturus cupidus* (Say).

***Palingenia viridescens* Walker = *Hexagenia limbata*
viridescens (Walker)**

Palingenia viridescens Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 551, 1853.

Hexagenia viridescens (Walker). McDunnough, Canad. Ent., vol. 59, p. 118, 1927.

Needham, Traver, Hsu, etc., Biology of Mayflies, p. 275, 1935.

Walker described his species from a single individual, stating neither the sex nor stage of development. The specimen had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." There is in the Brit. Mus. Nat. Hist. a female subimago labeled "St. Martin's Falls" and, in Eaton's handwriting, "*Palingenia viridescens* (Type) Walker."

Eaton considered the species to be a synonym of what is now known as *Hexagenia limbata* Guerin. McDunnough (1927) withdrew the name from synonymy and applied it to a darkly colored, northern population of the genus *Hexagenia*. Since it is so closely related to *occulta* and other subspecies of *limbata*, a complete redescription of the type follows.

In general appearance the specimen is darkly colored, especially so for a female and despite the fading due to time.

Fronto-clypeal area yellow; basal segment of antennae slightly darker; second antennal segment medium brown, shading to yellowish brown at the tip; flagellum brown. Vertex black, except for a small posteromedial area where head meets thorax and regions posterior to lateral ocelli, all of which are yellow. Pronotum blackish brown except posterolateral yellowish areas. Fore coxa yellow with distal posterior surface darker; fore trochanter brown; fore femur brown; fore tibia light brown; first, second, and third fore tarsal segments yellowish brown but darker distally; distal tarsal segment and claws black. Prosternum yellow except for brown colored ridge between coxae. Mesonotum brown with yellow lateral areas anterior to scutellum; posterolateral membrane between meso- and metanotum yellow. Mesopleura yellow with a brown streak of color from wing root to sternum. The brown diffuses laterally. Mesosternum blackish brown. Mesocoxa brown; trochanter and femur lighter. Tibia yellow tinged with brown; tarsal segments one, two, and three yellow but slightly darker at tips; distal tarsal segment and claws brown. Metanotum brown; metathoracic legs missing; metapleura yellow with streaks of brown color from wing roots. Metasternum blackish brown.

All longitudinal veins of mesothoracic wing, except A_1 and A_2 , are brown shading to yellow at wing base; A_1 and A_2 entirely yellow; cross

veins purplish except in anal region. Wing membrane tinged with yellow in costal and subcostal areas; slight infuscations on cross veins in costa and subcostal areas, but lacking elsewhere. Metathoracic wings similar to mesothoracic wings except that they have a broad distal border of purplish black.

Abdomen darkly colored; color pattern obscured. Subdorsal, lightly colored, paired areas lacking on tergites one and two, scarcely visible on three and four, but distinct on five to nine inclusive. Except on tergite nine, where they are based on the anterior margin, these areas are completely surrounded by the dark ground color. Posterolateral yellow areas present on tergites one to eight inclusive; on segment nine lateral yellow area extends entire length of the tergite. Abdominal sternites yellow except that the anterior sternites are infuscated with the dark color of the metathoracic sternum and except that sternites eight and nine each has a dark medial streak. Length exclusive of cerci, 21.5 mm.; length of mesothoracic wing, 25 mm.; length of metathoracic wing, 11 mm.

McDunnough's concept of the species seems to be correct. The dark coloration and the almost complete absence of subdorsal, lightly colored abdominal areas, especially in the males, serve to separate the subspecies from all of its American relatives. Typical individuals of *occulta* can be separated easily from *viridescens*, but dark individuals are distinguished with great difficulty. Further study will probably show that these two subspecies hybridize freely where their ranges overlap.

***Palingenia vitrea* Walker = *Iron vitrea* (Walker)**

Palingenia vitrea Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 555, 1853.

Heptagenia vitrea (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 143, 1871.

McDunnough, Canad. Ent., vol. 56, p. 117, 1924. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 365, 1935.

Rhithrogena vitrea (Walker). Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 254, 1885.

Epeorus humeralis Morgan, Ann. Ent. Soc. Amer., vol. 4, no. 2, p. 105, 1911.

Iron humeralis (Morgan). McDunnough, Canad. Ent., vol. 56, p. 129, 1924. Canad. Ent., vol. 57, p. 189, 1925.

Walker based the species upon a single subimago that had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." In the Brit. Mus. Nat. Hist. there is a female subimago labeled "Hudson's Bay" and, in Eaton's handwriting, "*Palingenia vitrea* (Type) Walker."

Walker's description is inadequate and unfortunately Eaton's redescription (1885) is also insufficient for accurate placement of the species. Subsequent workers have therefore been confused. Traver (1935) considers *vitrea* as "an undetermined species." A complete description is therefore presented.

The type lacks all legs on the right side of the body, and the abdomen, which has been broken from the thorax, is glued to a piece of cardboard.

Clypeus yellow; antenna (left one missing) and entire frontal area pale brown; a black line runs from base of eye to antennal base and

continues over antennal base; vertex yellow with central area slightly darker. Pronotum brown with an indentation on medial portion of posterior edge; prosternum yellow; a thin brown streak between pro- and mesosternum. Fore coxa yellow; a black streak extending from edge of pronotum along side of coxa; remainder of fore leg yellow except tarsi which are light brown; also dark medial and apical bands on fore femur; tarsal segment five longest, two and three subequal to one and about three-fourths as long as five; segment four shortest, about one-half of segment one.

Synthorax yellow with black spots on pleurae, especially above coxae. Meso- and metathoracic legs yellow; coxae with black spots; femora with dark medial and distal areas, the terminal areas being less intense; tarsi slightly darker than remainder of legs; tarsal joinings dark; two tarsal claws on each foot asymmetrical. Wings light grey, venation slightly darker; humeral cross vein black in posterior half; cross veins in pterostigmal space straight and not anastomosed; those before the bulla weak. Had the specimen reached the imaginal state, the venation would have been almost hyaline.

Abdomen shriveled and discolored, especially dorsally, due mostly to the presence of eggs. All sternites clear yellow with no markings. Medially the tergites are brownish black with darker, transverse, laterally extending bars on the posterior margins. These laterally extending bars swing forward slightly and almost reach the lateral margins of the tergites. Lateral regions of tergites yellow. These yellow areas are divided by the transverse posterior bars into a small posterolateral area and a large anterolateral area. Cerci missing. Length undeterminable; mesothoracic wing length, 11 mm.

The posteromedial indentation of the pronotum, the pigmentation of the humeral cross vein, the condition of the cross veins in the subcostal area, the tarsal claws, and the relative lengths of the fore tarsal segments all indicate that *vitrea* is a member of the genus *Iron*. In connection with the relative length of the fore tarsal segments, it should be remembered that the specimen is a subimago. The published relative lengths are for imagoes which are considerably different from those of the subimagoes.

A comparison of the type with recently collected material leaves no doubt that *Iron humeralis* (Morgan) is a synonym of *Iron vitrea* (Walker). Each of Morgan's specimens, collected at Ithaca, N. Y., has a lighter colored abdomen than the type. McDunnough (1925) has shown that the northern specimens of the species have darker abdomens than do more southern representatives. It is therefore to be expected that the type which was taken near Hudson's Bay should be dark. The light colored thorax of the type eliminates *I. suffusus* McD. from consideration as a synonym of *I. vitrea* (Walker). Likewise the large size (mesothoracic wing, 11 mm.) eliminates *I. rubidus* Traver and *I. punctatus* McD., both of which are smaller, as possible synonyms of *I. vitrea* (Walker).

Baëtis angulata Walker = *Hexagenia limbata viridescens* (Walker)*Baëtis angulata* Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 564, 1853.*Hexagenia bilineata* (Say). Eaton, Trans. Ent. Soc. Lond., part 1, p. 66 (partim).
Revisional Mono. Rec. Ephemeridae, part 1, p. 50 (partim).*Hexagenia occulta* (Walker). McDunnough, Canad. Ent., vol. 59, p. 120, 1927 (partim).
Needham, Traver, Hsu, etc., Biology of Mayflies, p. 269, 1935 (partim).

Walker based this species upon a single male collected in "Canada" and "presented by Dr. Barnston." In the Brit. Mus. Nat. Hist. there is a small male labeled "Canada" and, in Eaton's handwriting, "*Baëtis angulata* (Type) Walker." The specimen is well preserved except that in the abdomen the pigment bearing layer which lies immediately under the chitin has flaked away to some extent. A careful study of the eye size, the remaining abdominal color pattern and the coloration of the head, cerci and wings indicates that *angulata* Walker is a synonym of *viridescens* Walker instead of *bilineata* Say as indicated by Eaton, or *occulta* Walker as McDunnough and Traver have held.

Baëtis annulata Walker = *Siphonurus alternatus* (Say)*Baëtis annulata* Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 567, 1853.*Siphonurus alternatus* (Say). Eaton, Trans. Ent. Soc. Lond., part 1, p. 17, 1871.
Revisional Mono. Rec. Ephemeridae, part 3, p. 219, 1885.*Siphonurus alternatus* (Say). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 466, 1935.

Walker had a single male specimen from "Trenton Falls, New York" that was "presented by the Entomological Club." In the Brit. Mus. Nat. Hist. there is a male imago which is labeled "R. Foster, Trenton Falls, New York" and, in Eaton's handwriting, "*Baëtis annulata* (Type) Walker." The specimen is in excellent condition. Study of Walker's type, especially of the genitalia, confirms Eaton's opinion that *B. annulata* Walker is a synonym of *S. alternatus* (Say).

Baëtis basalis Walker = *Siphloplecton basale* (Walker)*Baëtis basalis* Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 565, 1853.*Heptagenia basalis* (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 139, 1871.
Revisional Mono. Rec. Ephemeridae, part 5, p. 298, 1887.*Siphloplecton basalis* (Walker). McDunnough, Canad. Ent., vol. 56, p. 128, 1924.*Siphloplecton basale* (Walker). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 441, 1935.

Walker described the species from a single individual collected at "Lake Winnipeg" and "presented by Sir John Richardson." There is in the Brit. Mus. Nat. Hist. a single male imago labeled "S. of L. Winnipeg" and, in Eaton's handwriting, "*Baëtis basalis* (Type) Walker." Eaton's redescription as given in his *Revisional Mono.* is as good as can be derived from the type since it is in a poor state of preservation. All the legs are lost and the abdomen, although intact, was badly smashed at the time the specimen was collected. The present concept of the species as set forth by McDunnough (1924) and Traver (1935) is correct.

Baëtis canadensis Walker = *Stenonema canadense* (Walker)

- Baëtis canadensis* Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 569, 1853.
Heptagenia canadensis (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 138, 1871.
Ecdyurus canadensis (Walker). Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 278, 1885.
Ecdyonurus canadensis (Walker). McDunnough, Trans. Royal Soc. Canad., vol. 19, sec. 5, p. 222, 1925.
Stenonema canadensis (Walker). Traver, Jour. Eli. Mitch. Sci. Soc., vol. 48, no. 2, p. 175, 1933.
Stenonema canadense (Walker). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 307, 1935.

Walker described the species from a male that had been collected in "Canada" and "presented by Dr. Barnston." The Brit. Mus. Nat. Hist. has a male imago labeled "Canada" and, in Eaton's handwriting, "*Baëtis canadensis* (Type) Walker." The specimen is in good condition. The present concept of the species is correct. As indicated by McDunnough the individuals show considerable variation in the amount of dark infuscation particularly on the abdomen. Specimens from the southern part of the range of the species, especially those captured in the late summer, are often much lighter in coloration than are the more northern representatives. The type which was collected in Canada is dark and compares closely with material from Ottawa, Canada.

Walker also described a variety of *canadense*, which he based upon a single specimen from an unknown locality. The specimen is present in the Brit. Mus. Nat. Hist. and has been labeled "*Baëtis canadensis* var. (Type) Walker" by Eaton. It is in a very fragmentary condition, consisting only of the head and part of the thorax. The latter bears the pro- and mesothoracic legs, a complete meso- and metathoracic wing and a part of another mesothoracic wing. The coloration is much lighter than that of the true *canadense*. The black clypeal band of *canadense* is replaced by two dots. The specimen does not belong to *S. canadense* Walker, but probably is a representative of *S. frontale* Banks. Because of the condition of Walker's specimen, accurate identification can not be made.

Baëtis debilis Walker = *Paraleptophlebia debilis* (Walker)

- Baëtis debilis* Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 569, 1853.
Leptophlebia debilis (Walker). Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 98, 1884. McDunnough, Canad. Ent., vol. 57, p. 169, 1925.
Paraleptophlebia debilis (Walker). Needham, Traver, Hsu, etc., Biology of Mayflies, p. 519, 1935.

Walker's brief description of the species was based upon a single female that had been collected in "Nova Scotia" and was in "Lieut. Redman's collection." A single female imago, still retaining her eggs and labeled according to the data given above, is in the Brit. Mus. Nat. Hist. McDunnough (1925), with the aid of Mr. Blair, has associated this type with the correct male. The present concept of the species as set forth by McDunnough (1925) and Traver (1935) is adequate and correct.

Baëtis fusca Walker = *Rhithrogena jejuna* Eaton

Baëtis fusca Walker (partim), List Neuropt. Ins. Brit. Mus., part 3, p. 568, 1853.
Heptagenia fusca (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 138, 1871.
 (Non) *Baëtis fusca* Burmeister, Hand. Ent. Band 2, p. 800, 1839.
Rhithrogena jejuna Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 252, 1885. McDunnough, Canad. Ent., vol. 58, p. 195, 1926. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 380, 1935.

Walker based his species upon three specimens. Two of these, "a" and "b," had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." The third individual came from "Nova Scotia" and belonged to "Lieut. Redman's collection." There are in the Brit. Mus. Nat. Hist. two specimens, a male imago and a female imago, which are labeled "Hudson's Bay" and, in Eaton's handwriting, "*Baëtis fusca* (Type) Walker." There is also a male imago which is labeled "Nova Scotia" and, in Eaton's handwriting, "*Baëtis fusca* (c) Type Walker." This must be Walker's third specimen. Eaton, in 1871, recognized that the "c" individual does not belong to the same species as the other two. It is clearly a representative of *Blasturus cupidus* (Say).

Walker's name *Baëtis fusca* (1853) was preoccupied by *Baëtis fusca* Burmeister (1839). Eaton (1885) therefore renamed and redescribed the species, utilizing only the two specimens from St. Martin's Falls. Since he did not judicate a type, the male is hereby designated as the lectotype.

The description of the species as given by Traver (1935) fits the type well except that the legs are bistre instead of "sooty" and the wing membrane is slightly darkened in the pterostigmal area.

Mr. Kimmins prepared a study mount of the type's genitalia, and it shows clearly that the penes do not narrow at the tip as indicated by Traver (1935, fig. 102) but are broad as in *Rhithrogena undulata* Banks (*ibid.*). The distal outcurving of the penes is quite distinct and separates this species from *R. impersonata* McD. *R. undulata* Banks from the southwestern part of North America will probably prove to be a geographical subspecies of *jejuna* which is northeastern in its distribution.

Baëtis fuscata Walker = *Ephemerella walkeri* Eaton

Baëtis fuscata Walker (partim), List Neuropt. Ins. Brit. Mus., part 3, p. 570, 1853.
 Hagen, Syn. Neuropt. No. Amer., p. 47, 1861.
 (Non) *Baëtis fuscata* Stephens, Illust. Brit. Ent., Mandib., vol. 6, p. 66, 1835.
Ephemerella walkeri Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 129, 1884.
Ephemerella bispina Needham (partim, imago non nymph), New York State Mus. Bull. 86, p. 43, 1905.
Ephemerella fuscata (Walker). McDunnough, Canad. Ent., vol. 63, p. 214, 1931.
 Needham, Traver, Hsu, etc., Biology of Mayflies, p. 600, 1935.

Walker based his species upon two specimens, an imago and a subimago. He gave a short and inadequate description of each. The material had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." There are in the Brit. Mus. Nat. Hist. a male imago and a male subimago which are labeled "Hudson's Bay" and, in Eaton's handwriting, "*Baëtis fuscata* (Type)

Walker." The subimago, specimen "b" of Walker, is shriveled and distorted so that accurate placement is impossible. Eaton (1884) thought it belonged to Rhithrogena. He was probably correct.

The imago, specimen "a" of Walker, was designated by McDunnough (1931) as the lectotype. It is in a fragmentary condition, consisting of a small part of the head, mainly the dorsal part and the compound eyes; the thorax which still bears the left mesothoracic wing, the metathoracic wings, the right mesothoracic leg, the metathoracic legs, both of which are broken at the distal termination of the tibia; and the first two abdominal segments. McDunnough (1931), with the aid of Dr. K. G. Blair, correlated the type with recently collected material. Comparison of the type with specimens from North America confirms McDunnough's conclusions. The present concept of the species as given by McDunnough (1931) and Traver (1935) seems adequate.

As indicated by Eaton (1884), *Baëtis fuscata* Walker (1853) is a homonym of *Baëtis fuscata* Stephens (1835) and is therefore invalid in entirety. Hence *Ephemerella walkerii* Eaton becomes the valid name for the species.

***Baëtis invaria* Walker = *Ephemerella invaria* (Walker)**

Baëtis invaria Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 568, 1853.

Ephemerella invaria (Walker). Eaton, Ent. Month. Mag., vol. 5, p. 87, 1868. Revisional Mono. Rec. Ephemeridae, part 2, p. 129, 1884. McDunnough, Trans. Roy. Soc. Canada, vol. 19, sec. 5, p. 213, 1925 (partim). Canad. Ent., vol. 63, p. 196, 1931. Canad. Ent., vol. 70, p. 24, 1938. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 607, 1935.

Walker based the species upon three specimens collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." The Brit. Mus. Nat. Hist. has three male specimens labeled "Hudson's Bay" and, in Eaton's handwriting, "*Baëtis invaria* (Type) Walker." McDunnough (1925) designated the "a" individual as the lectotype of which Dr. Blair made a balsam mount of the genitalia and the last eight abdominal segments. The second specimen agrees with the type in coloration and size. The third is lighter in color than are the other two. Unfortunately it is in a poorly preserved condition and can not be identified with certainty.

E. invaria (Walker) belongs to a closely related group of highly variable species. The chief criteria utilized for the separation of the imagoes of these species have been the genitalia, the coloration, and to a lesser extent the size. Although the concept of the species as outlined by Traver and especially by McDunnough is correct, the following characteristics of the lectotype seem sufficiently important to be re-emphasized.

The general color is reddish brown rather than brown. The fore femur and tibia are reddish golden brown; fore tarsi yellowish white. Meso- and metathoracic legs light yellowish white; wing transparent, with the longitudinal veins of both the meso- and metathoracic wings light brown. Cross veins colorless or almost so, and not dark as in *E. subvaria*. Tergites much more intensely and brightly colored than the sternites, but of same hue. Each of the first segments of the forceps

of the genitalia has an expanded distal end; the penes (fig. 1) have the typical shape of the entire invaria complex of species; the penes of the type have mediodorsally a number of spines that are *bilaterally unequal*, two distoventral spines, and *no medioventral* spines.

The lack of medioventral spines is, as McDunnough (1938) stated, the best criterion for distinguishing *invaria* from the closely related *rotunda*.

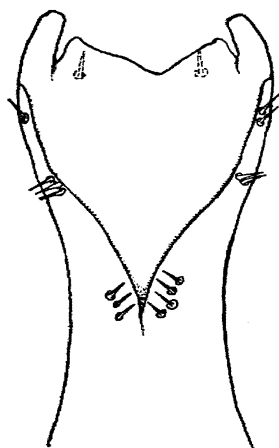


Fig. 1. Genitalia of *Ephemerella invaria*.

Baëtis tessellata Walker = *Stenonema vicarium* (Walker)

Baëtis tessellata Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 566, 1853.

Heptagenia vicaria (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 150, 1871.

Ecdyurus vicarius (Walker) (partim). Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 280, 1885.

Stenonema vicarium (Walker). Traver, Jour. Eli. Mitch. Sci. Soc., vol. 48, No. 2, p. 174, 1933.

Walker based his species upon a subimago from "Nova Scotia" that was in "Lieut. Redman's collection." In the Brit. Mus. Nat. Hist. there is a female subimago labeled "N. Scotia Redman" and, in Eaton's handwriting, "*Baëtis tessellata* (Type) Walker." As Eaton (1871) indicated, the species is a synonym of *S. vicarium* (Walker).

Baëtis vicaria Walker = *Stenonema vicarium* (Walker)

Baëtis vicaria Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 565, 1853.

Heptagenia vicaria (Walker). Eaton, Trans. Ent. Soc. Lond., part 1, p. 150, 1871.

Ecdyurus vicarius (Walker) (partim). Eaton, Revisional Mono. Rec. Ephemeridae, part 4, p. 280, 1885.

Ecdyonurus vicarius (Walker). McDunnough, Trans. Royal Soc. Canada, vol. 19, sec. 5, p. 222, 1925.

Stenonema vicarium (Walker). Traver, Jour. Eli. Mitch. Sci. Soc., vol. 48, no. 2, p. 174, 1933. Needham, Traver, Hsu, etc., Biology of Mayflies, p. 334, 1935.

Walker based his species upon a single male from "North America?" which had been "presented by the Entomological Club." In the Brit. Mus. Nat. Hist. there is a male imago which bears no locality label but has a printed label "Ent. Club. 44-12" and another, in Eaton's handwriting, "*Baëtis vicaria* (Type) Walker." The concept of the species as

given by McDunnough (1925) and Traver (1935) is correct. The lectotype agrees with Traver's description of the species except for the following points: The meso- and metathoracic tarsi are brownish black instead of "yellowish red" and the fore tarsi are sepia brown. The costoapical area of the mesothoracic wing is tinged with red, especially in the proximal part. As McDunnough (1925) indicates, it is a "decidedly ruddier tinge" than that found in *S. fuscum* Clemens. The sternites are not "creamy yellow" but rather purplish brown with translucent diagonal dashes and submedial spots.

The species is closely related to *S. pudicum* (Hagen) from which it can be distinguished by the light colored scutellum, by the lack of dark pigmentation on the metathoracic wing margin and by the moderate ruddiness of the pterostigmal area of the mesothoracic wing.

Ulmer (1921, *Archiv. f. Natur.*, Band 87, Abt. A, Hft. 6, p. 252) mistakenly describes as the type of this species a specimen in Selys' collection that had been collected in Canada in 1859. The specimen that Ulmer saw does belong to *S. vicarium* Walker, but is not the type.

Caenis diminuta Walker

Caenis diminuta Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 584, 1853. Eaton, Revisional Mono. Rec. Ephemeridae, part 2, p. 147, 1885 (partim). McDunnough, Canad. Ent., vol. 63, pp. 257-58, 1931. Needham, Traver, Hsu, etc., Biology of Mayflies, pp. 648-9, 1935.

Walker described his species from a single male specimen collected at "St. John's Bluff, E. Florida" and "presented by E. Doubleday, Esq." There is in the Brit. Mus. Nat. Hist. a male imago labeled "St. John's Bluff—E. Fla.," and, in Eaton's handwriting, "*Caenis diminuta* (Type) Walker." The type is preserved perfectly. The present concept of the species as set forth by McDunnough (1931) and Traver (1935) is correct. McDunnough (1931) has redescribed the species. His description, and also that of Traver which was taken from McDunnough, does not completely agree with the type. The following differences and additions to their descriptions should be noted:

Tergites seven, eight, and nine uniformly light yellow with black stigmatic dots; tergite ten light yellow with black shading; all sternites uniformly light yellow; meso- and metathoracic femora with dark apical bands.

In addition to the new species which he described, Walker also redescribed two previously known North American species, but instead of utilizing the original descriptions of the authors or their type material, he based his descriptions upon material in the British Museum. Because of the subsequent history of these species, it seems advisable to touch upon them briefly.

Siphonurus luridipennis Burmeister

Baëtis luridipennis Burmeister, Handbuch der Ent., Band 2, p. 801, 1839. Pictet, Hist. Nat. Ins. Neuropt., Ephemerines, part 2, p. 192, 1842.
Siphonurus luridipennis Burmeister. Ulmer, Entomolog. Mitteilungen, Band 15, pp. 223-225, 1926. McDunnough, Canad. Ent., vol. 58, p. 190, 1926.
(Non) *Baëtis luridipennis* Burmeister. Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 563, 1853.

- (Non) *Heptagenia luridipennis* (Burmeister). Eaton, Trans. Ent. Soc. Lond., part 1, p. 149, 1871.
 (Non) *Ecdyurus luridipennis* (Burmeister). Eaton, Revisional Mono. Rec. Ephemeridae, part 4, pp. 279–280, 1885.

Burmeister based his species upon a male and a female that had been collected by Zimmerman in "Carolina." Following Burmeister, the specimens were never seen by any student of the Ephemeroptera until Ulmer (1926) located the female. Walker (1853) had a male from "St. Martin's Falls, Albany River, Hudson's Bay" that had been "presented by Dr. Barnston." This specimen was questionably placed in *B. luridipennis* Burm. and a description of it given. In the Brit. Mus. Nat. Hist. there is a male imago from "Hudson's Bay" and labeled, in Eaton's handwriting, "*Baëtis? luridipennis? Walker Type.*" This is the male specimen that Eaton (1871) utilized in describing *H. luridipennis* (Burm.) and (1885) *E. luridipennis* (Burm.). It is in reality a representative of *Stenonema fusca* Clemens. Unfortunately all workers subsequent to 1885 attempted to identify Burmeister's species from Eaton's description, hence the resultant confusion and uncertainty that prevailed until Ulmer (1926) discovered Burmeister's type specimen.

***Stenonema interpunctatum* (Say)**

- Baëtis interpunctata* Say, Jour. Acad. Nat. Sci., Phila., vol. 8, p. 41, 1839. Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 562, 1853.
Baëtis flaveola Pictet, Hist. Nat. Ins. Neuropt., Ephemerines, part 2, p. 186, 1843. Walker, List Neuropt. Ins. Brit. Mus., part 3, p. 559, 1853.
Heptagenia interpunctata (Say). Ulmer, Archiv f. Natur., Band 87, Abt. A, Hft. 6, p. 242, 1921.
Stenonema interpunctatum (Say). Traver, Jour. Eli. Mitch. Sci. Soc., vol. 48, no. 2, p. 178, 1933.

Walker doubtfully referred three specimens to *Baëtis flaveola* Pict. They had been collected at "St. Martin's Falls, Albany River, Hudson's Bay" and "presented by Dr. Barnston." Eaton (1871, Trans. Ent. Soc. Lond., part 1, p. 149), who had available Pictet's type specimen of *B. flaveola* which came from Tennessee and also Walker's material, placed them all in *Heptagenia flaveola* (Pictet). Eaton (1885, Revisional Mono. Rec. Ephemeridae, part 4, p. 278) considered *Heptagenia flaveola* (Pictet) as a synonym of *Ecdyurus verticis* (Say). Ulmer (1921) showed that Pictet's *B. flaveola* was really a synonym of *Stenonema interpunctatum* (Say) and McDunnough (1926, Canad. Ent., vol. 58, p. 186) showed that *verticis* Say really belonged to the genus *Potamanthus*.

In the Brit. Mus. Nat. Hist. there are two female subimagos and one female imago which are all labeled "Hudson's Bay" and, in Eaton's handwriting, "*Baëtis flaveola* (Type) Walker." The imago belongs to *Stenonema luteum* Clemens, one subimago to *Stenonema rubromaculatum* Clemens and the other to *Heptagenia hebe* McD.