33 Taxonomy of the eastern Nearctic species of *Choroterpes* Eaton (Ephemeroptera: Leptophlebiidae)

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The present state of the taxonomy of the eastern Nearctic Choroterpes *s.s. is not good. Specifically, this group includes the taxa* Choroterpes *(C.)* basalis *(Banks),* C. *(C.)* ferruginea *Traver,* C. *(C.)* fusca *Spieth and* C. *(C.)* hubbelli *Berner. The accurate determination of these taxa is difficult or impossible using the existing keys and descriptions. To address this problem the taxonomy of these species was reevaluated by studying the type material and specimens from across eastern North America. The results of morphological comparisons of male imagos, nymphal exuviae from reared specimens and final instar nymphs showed previous diagnostic characters were not reliable. New synonymies discovered were:* Choroterpes *(C.)* basalis *(Banks)=* C. *(C.)* ferruginea *Traver n. syn.,* C. *(C.)* fusca *Spieth n. syn. and* C. *(C.)* hubbelli *Berner n. syn. The species* Choroterpes *(C.)* basalis *(Banks) is herein redescribed and illustrated. Ranges of Nearctic* Choroterpes *s.s. are plotted and discussed.*

Introduction

In North America the genus *Choroterpes* Eaton is represented by two subgenera *Choroterpes* s.s. Eaton and *Neochoroterpes* Allen. Taxa of *Neochoroterpes* are mostly restricted to the southwestern United States and Mexico (Allen 1974; Henry 1989). Species of *Choroterpes* s.s., in contrast, are widely distributed (Peters 1988) with most taxa occurring in the northern and eastern parts of the continent (Edmunds et al. 1976). The focus of this paper is on four primarily eastern species: *Choroterpes (C.) basalis* (Banks), *C. (C.) ferruginea* Traver, *C. (C.) fusca* Spieth and *C. (C.) hubbelli* Berner. Taxonomically, these species are weakly defined and only *C. hubbelli* has a reasonably complete description. Descriptions of nymphs of *C. ferruginea* and *C. fusca* have never been published. Because of the poor or incomplete state of the taxonomy of this group existing keys and descriptions are difficult or impossible to use without direct reference to the type material. Perhaps as a result of this situation no detailed ecological or life history studies have been done on any of these taxa. Burian and Gibbs (1992) and Berner and Pescador (1988) have listed or summarized most of the preliminary ecologic and biologic observations published on these species, but much remains to be learned. The purpose of this study was to reevaluate the taxonomy of these species as an important first step leading to future studies on their ecology and systematics.

Materials and Methods

Mature nymphs (i.e., those with dark or well developed wing pads), nymphal exuviae from reared specimens, male and female imagos, comprising some 238 specimens, were examined during this study. Among these were all holotypes and paratypes as well as material from Canada and eight states. All specimens were scored for the characters/states listed in Table 1. Initially, it was the intent to consider only autapomorphic characters as diagnostic of a particular group, but because the systematics of *Choroterpes* s.s. is not well enough understood to define plesiomorphic and apomorphic states for all characters studied this approach was abandoned. Thus, the convention of concordant characters/states indicative of distinct morphological discontinuities was adopted as the criterion for recognizing a diagnostic feature of a group. In addition to Table 1 characters/states, measurements of body length were recorded for final instar nymphs, male and female imagos. Measurements were taken from the anterior edge of the head to the posterior edge of tergite 10. All measurements were made using a calibrated ocular micrometer and given to the nearest 0.1 mm.

In the text, abbreviations used to denote life stage or some combination of life stage are: M - male imago; F - female imago; N - nymph; N: M,F - nymphs specified with regards to sex; S - subimago; S: M,F - subimagos specified with regards to sex. Abbreviations used in the material studied section of the text to denote collections from which specimens were obtained for study are:

AMNH - American Museum of Natural History, New York

CNC - Canadian National Collection, Ottawa

CUIC - Cornell University Insect Collection, Ithaca, New York

FAMU - Florida A&M University, Tallahassee, Florida

INHS - Illinois Natural History Survey, Urbana

MCZ - Museum of Comparative Zoology, Harvard University, Cambridge

PERC - Purdue Entomological Research Collection, West Lafayette, Indiana

SWRC - Stroud Water Research Center, Avondale, Pennsylvania

UME - University of Maine Entomology Reference Collection, Orono

UNH - University of New Hampshire Entomology Collection, Durham

Table 1. List of morphological characters studied for species of eastern Nearctic *Choroterpes* s.s.

Life Stage	Characters/States		
Nymph	Mouthparts	Labrum	- shape of lateral margins
			- shape of anterior margin
			- type of dorsal setae
			- position of dorsal setae
			- type of ventral setae
			- position of ventral setae
		Mandibles	- shape of outer margin
			- incisor shape
			- incisor position
			- setae on incisors
			- shape of protheca
			- position of protheca
		Maxillae	- number of segments of palpi
			- lengths of segments of palpi
			- type of setae on seg. 1 of palpi
			- position & number of setae on seg. 1 of palpi
			- type of setae on seg. 2 of palpi
			- position & number of setae on seg. 2 of palpi
			- type of setae on seg. 3 of palpi
			- position & number of setae on seg. 3 of palpi
			- shape of crown
			- type of frontal setae
			- position of frontal setae
		Superlingua	- shape of outer lobes
			- shape of inner lobes

Table 1. (continued)

		Labium	- number of segments of palpi
			- type of setae on seg. 1 of palpi
			- position & number of setae on seg. 1 of palpi
			- type of setae on seg. 2 of palpi
			- position & number of setae on seg. 2 of palpi
			- type of setae on seg. 3 of palpi
			- position & number of setae on seg. 3 of palpi
Nymph	Mouthparts	Labium	- type of setae on glossa
			- position & number of setae on glossa
			- type of setae on paraglossa
			- position & number of setae on paraglossa
			- shape of glossa
			- shape of paraglossa
	Legs		- banding pattern
			- distinctly banded
			- indistinctly banded
			- unbanded
			- pattern of specialized setae on anterior edge of forefemora
			- armature of femora
			-dorsal/ventral/apical/basal
			-armature of tibiae
			-dorsal/ventral/apical/basal
			- armature of tarsi
			- dorsal/ventral/apical/basal
			- shape of tarsal claws
			- pattern of primary (1°) denticles on foreclaws
			- pattern of secondary (2°) denticles on foreclaws

Table 1. (continued)

	Thorax		- dorsal colour pattern
	Abdomen	Tergites	- surficial armature
			- pattern of spines on posterior margin of seg. 8
			- colour pattern
			- posterior lateral projections
		Sternites	- colour pattern
		Gills	- pattern of tracheation of gill 1
			- shape of dorsal lamella of gill 3
			- shape of ventral lamella of 3
			- shape of dorsal lamella of gill 7
			- shape of ventral lamella of gill 7
		Caudal Filaments	- length of terminal filament compared to cerci
			- colour pattern
			- armature of annuli
Adult		Wings	- cross veins between CuA & CuP
			- cross veins in costal space and stigmatic area
			- colour of fore wings
			- colour of hind wings
	Thorax		- dorsal colour pattern
		Legs	- colour pattern
			- structure of foreclaws
	Abdomen	Tergites	- colour pattern
		Sternites	- colour pattern
		Caudal Filaments	- length of terminal filament compared to cerci
			- colour pattern
(Male only)	Genitalia		- structure of penes (including attached appendages)
			- structure of forceps
			- number of annuli on forceps
			- structure of subgenital plate
(Female only)	Genitalia		- shape of subgenital plate

Results

Character Analysis — Adults

Morphological comparisons of diagnostic characters (i.e., colour of thorax, pigmentation of wings, colour and colour pattern of abdominal tergites, colour of caudal filaments, and shape of the genital forceps and penes given by Needham et al. 1935; Spieth 1938; Berner 1946, 1950) showed them not to be reliable for diagnosing species groups. Among these characters, the structure of the male genitalia was essentially the same. Only slight variations in the shape of genital forceps were observed. Pigmentation of wing membranes was limited to the axial areas and showed little variation (Figs. 1, 8 ,9). Caudal filaments were white or cream coloured in all alcohol specimens with no dark banding at the annuli. Only in a few pinned specimens and one in alcohol, which appears to have dried out at some point, was any banding of annuli observed. In these instances I believe the banding not to be an artifact of cuticle pigmentation, but produced by the overlap of the cuticle in the area of the segments that darkens as the insect dries. The anterior and lateral margins of sternite 9 of males is consistently shaded brown. Among the most variable of adult characters/states was thoracic colour and abdominal colour/ pattern. Thoracic colour ranged from a rusty red-brown to almost black. Three basic abdominal colour pattern variants were observed (Fig. 2-7), however, there was much intergradation between forms. Northern specimens (i.e., those from areas north of Pennsylvania) and a few larger individuals from Indiana exhibited the darker *basalis/fusca* form more frequently than the lighter *ferruginea* form. Specimens of central and southern U.S. tended to be most frequently of the *ferruginea* type. A mixture of all three patterns were observed in some large samples from a single site and among the Algoma, Ontario specimens of the type series of *C. fusca*, which were obtained from a single swarm (Burian 1990). Perhaps indicative of some areas, variation among states of this character were too great to be diagnostic of any of the present groups. No female characters were found to support the present species groups. In addition to the characters discussed above, none of the other characters/states studied met the criterion for diagnostic characters.

Body length statistics for male and female imagos are given in Table 2. Despite distinct size differences observed between male and female nymphs most adults seem to be about the same size.

Character Analysis — Nymphs

Results of morphological comparisons showed that most characters/states were remarkably invariant or varied as much between as within individuals and populations. Mouthparts, legs and thoracic features were relatively invariant among

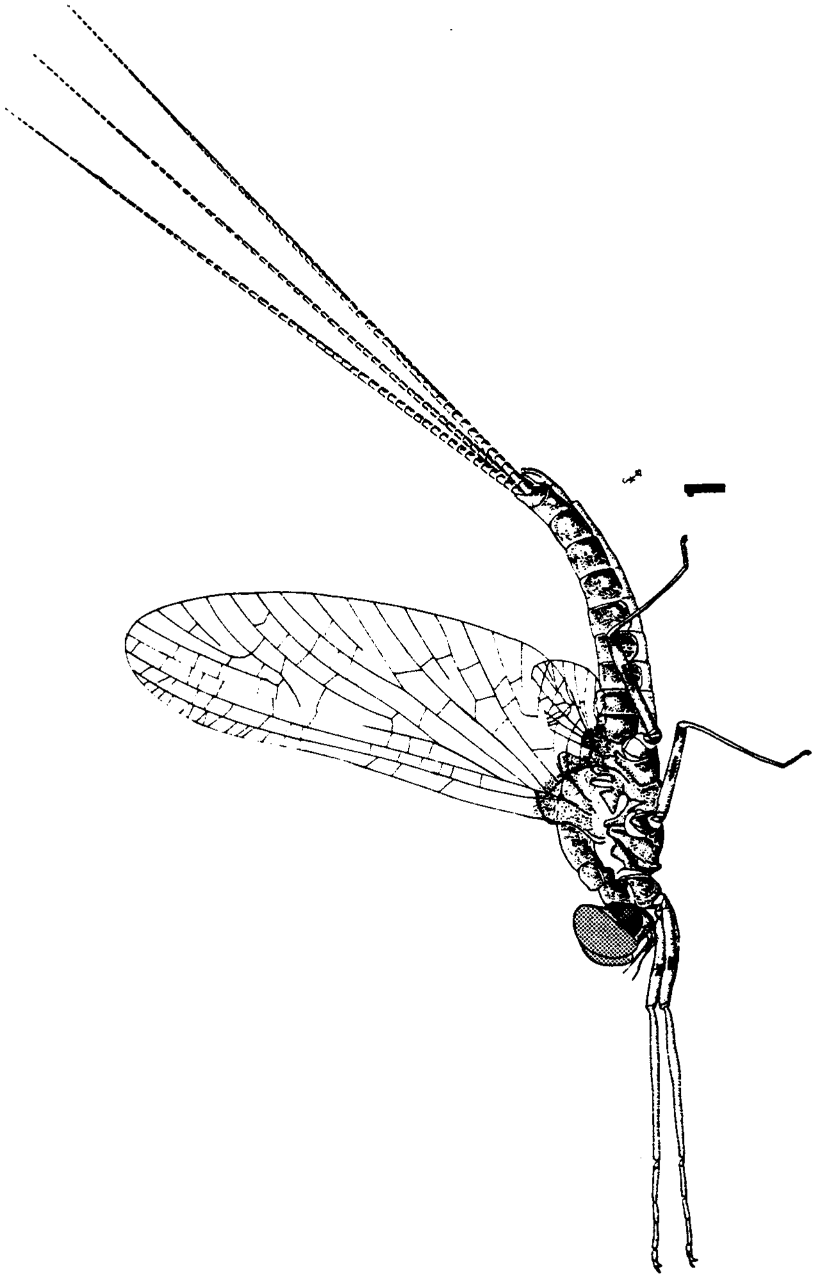


Figure 1. Male imago of *Choroterpes* (*C.*) *basalis*.

Figures 2-7. **Adult abdominal colour patterns of male imagos of *Choroterpes (C.) basalis*. Even numbered figures are dorsal view of segments 5-7; odd numbered figures are lateral view of segments 5-7. 2,3. *basalis/fusca* colour variant. 4,5. *ferruginea* colour variant. 6,7. *hubbelli* colour variant.**

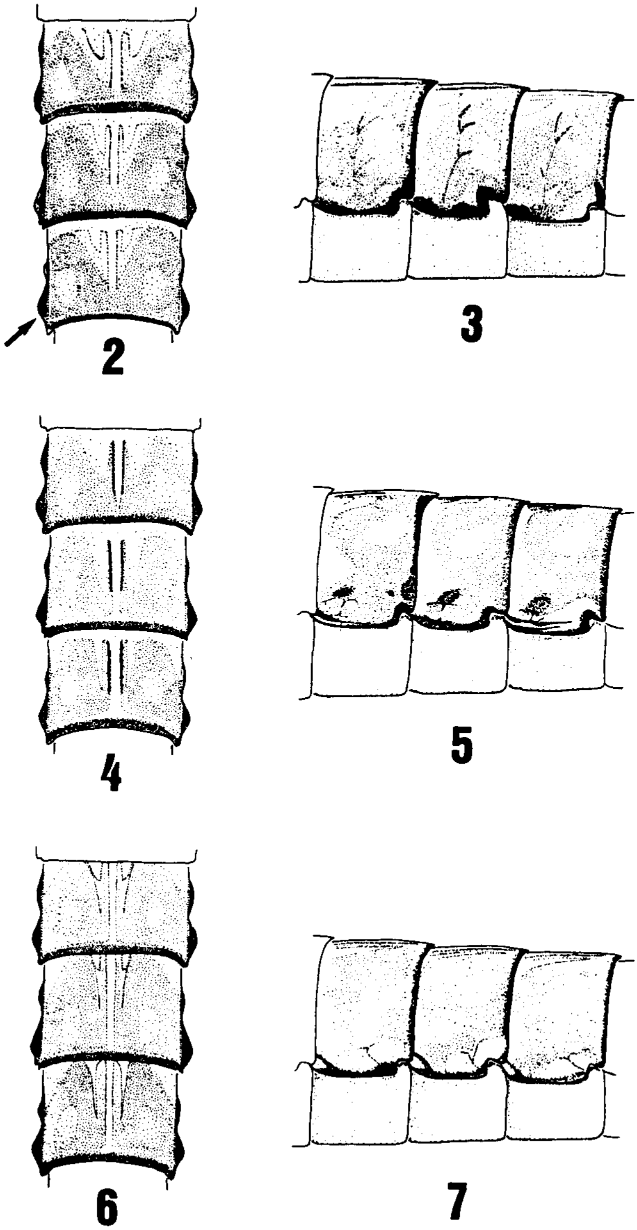


Table 2. Body length measurements of male and female imagos.

Sample Location	Sex	Count (n)	Mean±S.D. (mm)	Range (mm)
Arkansas	M	15	5.11±0.21	4.75-5.41
Indiana	M	5	5.36±0.32	4.83-5.66
Florida	M	4	5.16±0.12	5.08-5.33
New York	M	1	4.50	NA
Maine	M	1	6.66	NA
Pennsylvania	M	4	5.32±0.33	4.91-5.83
Ontario	M	5	4.96±0.44	4.25-5.25
Quebec	M	2	4.66±0.70	4.16-5.16
Arkansas	F	9	5.53±0.26	5.25-5.83
Florida	F	5	5.41±0.24	5.08-5.75
Ontario	F	1	4.83	NA
Quebec	F	2	4.91±0.12	4.83-5.00

all specimens studied. Much variation was observed in colour patterns and pigmentation of abdominal tergites, but was not consistent enough to be considered of diagnostic value. Variation was also evident in the shape of gill lamellae and amount of tracheation. Among differences observed in gill shape, the variation in the terminal filament of the dorsal lamella was most obvious. Specimens from some southern populations had the terminal filament broadly expanded, with the tip almost round (Fig. 11). Other specimens, most notably those of some northern areas, had the terminal filament narrow and acutely pointed (Fig. 12). In addition, specimens with the expanded terminal filament had noticeably more trachea than those with lanceolate filaments. Although somewhat regionally consistent, these features were too variable to be of diagnostic value. Variations in gills are probably related to varying ecologic conditions experienced by nymphs.

Body length statistics for final instar nymphs are given in Table 3. Males tend to be smaller than females for a given region, but generally both sexes are about the same size. There seems to be only one instance of marked difference in size among males. Male nymphs from Arkansas have a smaller mean length than for other areas studied.

Figures 8-12. 8,9. Fore and hind wing of male imago of *Choroterpes (C.) basalis*. 10. Genitalia, ventral view. 11,12. Gill 3, dorsal and ventral lamellae (arrow indicates rounded filament form).

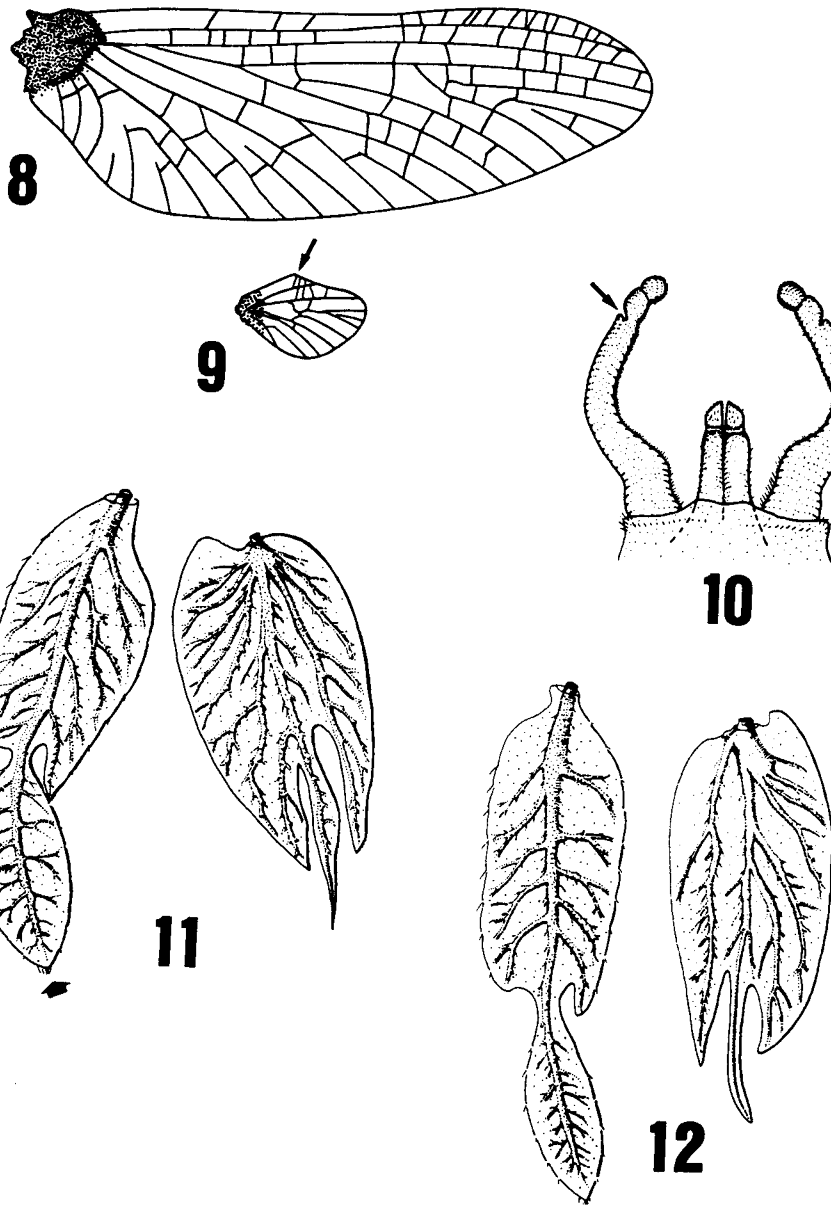


Table 3. Body length measurements of final instar nymphs.

Sample Location	Sex	Count (n)	Mean±S.D. (mm)	Range (mm)
Arkansas	M	6	4.99±0.33	4.50-5.41
Florida	M	2	6.12±0.05	6.08-6.16
Indiana	M	12	5.58±0.46	5.08-6.83
Maine	M	7	6.73±0.23	6.40-7.00
Pennsylvania	M	5	6.61±0.22	6.25-6.83
Quebec	M	5	6.11±0.25	5.83-6.41
Virginia	M	2	5.20±0.64	4.75-5.66
Indiana	F	4	6.05±0.46	5.58-6.66
Maine	F	8	7.15±0.18	6.90-7.40
Quebec	F	5	6.39±0.28	6.08-6.83

Discussion

The variability observed in present diagnostic characters and the absence of any new concordant characters among the specimens studied leads me to conclude that these specimens represent a single, widely distributed species. Thus, I herein designate these species to be synonymous and the names *C. ferruginea* Traver, *C. fusca* Spieth and *C. hubbelli* Berner be placed as junior synonyms of *C. basalis* (Banks).

Choroterpes (Choroterpes) basalis (Banks)

(Figs. 1-21)

Choroterpes (C.) basalis (Banks), 1900: 248. Type locality: Sherbrooke Co., Quebec, Canada [Type 1]. Type deposition: (M) MCZ [# 11433].

Choroterpes (C.) ferruginea Traver, 1934: 205. Type locality: Wintergreen Point, Old Forge, New York, USA. Type deposition: (M) CUIC [#1270.1]. NEW SYNONYMY.

Choroterpes (C.) fusca Spieth, 1938: 4. Type locality: Algoma, Ontario, Canada. Type deposition: (M) AMNH. NEW SYNONYMY.

Choroterpes (C.) hubbelli Berner, 1946: 65. Type locality: Alachua Co., Jerome Sink, Florida, USA. Type deposition: (M) MCZ [#33475]. NEW SYNONYMY.

Male Imago (in alcohol) as in Fig. 1. Body length 4.16-5.83 mm.

Head: eyes semiturbinate and not contiguous dorsally. Head red-brown to a dark brown almost black. Lateral ocelli twice as large as median ocellus and bases of all ocelli ringed with black. Frontal shelf extremely short and margined with a grey-black streak. Antennae three-segmented with the third segment about four times the length of segment two. Thorax: pronotum yellow-brown to a deeper red-brown sometimes almost black. Edges of the pronotum margined with black, only visible on lighter coloured individuals. A median longitudinal ridge is present connecting the anterior and posterior margins. Posterior edge of pronotum with an indentation that accommodates the rounded anterior edge of the mesonotum. Mesonotum may be red-brown, brown or brown-black. On lighter individuals all mesonotal sulci are dark brown. Posterior margin of the mesonotum produced into an upturned hump (Fig. 1). Metanotum similar to mesonotum in colour. Half of the metanotum covered by the posterior portion of the mesonotum. Sclerotized area of pleuron similar in colour to meso and metanotum, but membranous areas streaked with grey or black. Legs: ratio of segments of prothoracic legs, 0.62: 1.00 (1.84 mm): 0.032: 0.26: 0.25: 0.14: 0.09. Prothoracic legs yellow-brown, femora slightly darker with medial grey-black band on dorsal and lateral surfaces (Fig. 1). Apices of femora shaded brown, with the colour extending over onto the tibiae. Meso and metathoracic legs paler yellow-brown with femora and tibiae with similar dark marks as on prothoracic legs. Sclerites of coxa red-brown but margined with black. Coxal membranes also stained with grey or black. Trochanters similar in background colour to legs. Wings: fore wings as in Fig. 8. Crossveins present between veins C and Sc but extremely faint. Veins C, Sc and R_1 may be variably stained brown or lack any colour except near wing base. Dark brown pigmentation of fore wing membrane limited to wing base and axial area, usually not extending much beyond humeral crossvein. Hind wings as in Fig. 9, small rounded costal projection positioned about midway along costal margin. Veins C and Sc stained as in fore wing. Membrane of hind wings may be more extensively pigmented than fore wings, brown colour may extend over one third of the wing. Abdomen: terga of segments 5-7 as in Figs. 2-7, background colour usually a yellow-brown overshaded with grey-black. Segments 8-9 in individuals with the *ferruginea* colour pattern are more red-brown than preceding segments. Lateral margins of tergites flared out as indicated by arrow in Fig. 2. Sternites 1-8 white or cream coloured without distinct maculations; however, ganglia marks may be evident through the cuticle. Sternite 9 shaded brown along anterior and lateral margins. Genitalia as in Fig. 10. Genital forceps with an incomplete annulus near apex of first segment (see arrow Fig. 10).

Bases of forceps not distinctly expanded, bulbous or produced into a shape that approximates a 90° angle in the transition from the forceps base to the linear portion of the appendage. Penes straight and simple, without accessory appendages but with several small, blunt spines clustered around the apex of each penis lobe. Caudal filaments white, cream coloured or tan without any dark bands around annuli. Median terminal filament equal in length to cerci.

Female Imago (in alcohol). Body length 4.83-5.83 mm.

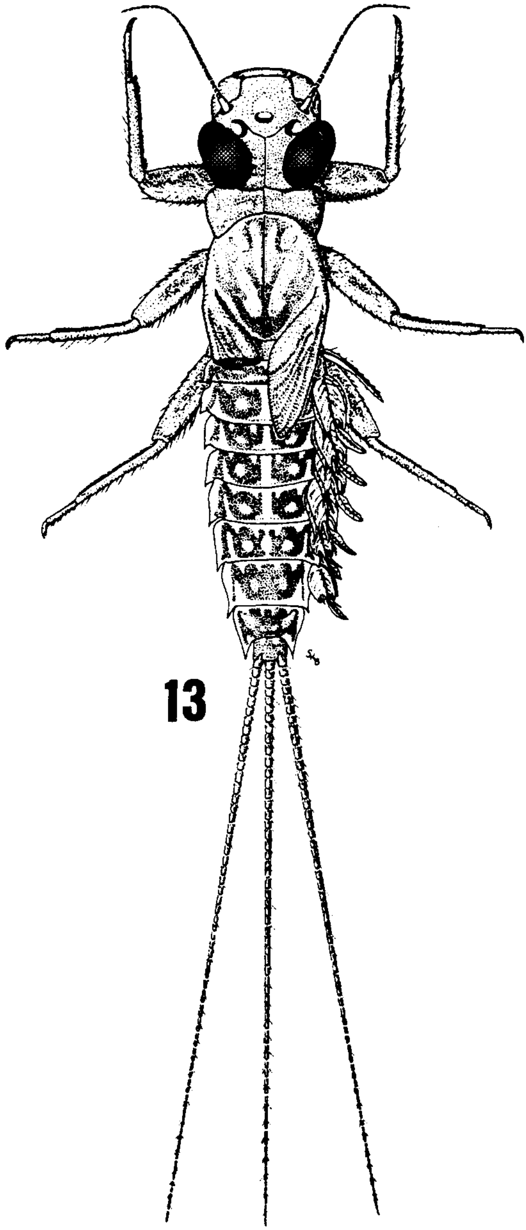
Similar to the male imago in morphology, colour and colour patterns. Sternite 9 is not shaded as in male. The subgenital plate is extended posteriorly to or slightly beyond the tip of the abdomen and has a slight apical notch.

Eggs (in alcohol): eggs subcylindrical with the chorion completely covered with small depressions that are shaped like small volcanos. Needham et al. (1935) present an accurate figure of the eggs and discuss the surficial features of the chorion.

Subimago (in alcohol): similar to imagos in body size, morphology and colour pattern, although colours tend to be darker. Membrane of both wings typically clouded and fringed with setae. The clouded subimaginal membrane obscures adult colouration.

Nymph (with dark wing pads) as in Fig. 13. Body length 4.50-7.40 mm. Head: prognathous, brown with black shading between compound eyes and ocelli, light spots over each ocellus. Antennae tan and shorter than twice the width of the head. Mouthparts (Figs. 14-20): dorsal and ventral aspects of labrum as in Fig. 16, row of short, thin setae present along anterior margin and a second row of longer setae across middle of labrum. Left mandible as in Fig. 18, indentation on dorsal surface margined with fine setae, incisors tridentate apically and protheca forked into sharp spine with a brush of fine setae. Left maxilla as in Fig. 17: palpus three-segmented, fused galea-lacinia quadrate with dense brush of setae along crown, row of 14-15 pectinate setae below crown and one large pectinate spine projecting from subapical margin. Crown area supporting brush of setae may be broadly rounded or somewhat sinuous. Superlingua as in Fig. 19. Labium as in Fig. 20: ventral surface of glossa with many stout peg-like spines. Thorax: brown with black shading on meso- and metathorax, wing pads parallel and narrowly separated (Fig. 13). Shading on prothorax produces a lighter U-shaped pattern laterally. Legs: as in Figs. 14 and 15, yellow-brown with a dark spot on the dorsum of each femur. Tarsi lightly banded with brown (Fig. 14), fore claws with 12 to 15 (primary) denticles and several smaller serrations between apex and first large denticle (Fig. 15). Large denticles of the fore claw distinctly divided into two sections as indicated by arrow in Fig. 15. The denticles of each section begin large and gradually decrease in size. Abdomen: as in Fig. 13, shaded with grey-brown over a lighter background colour of yellow-brown. Some variation in tergal maculations, with paramedial triangular spots

Figure 13. **Mature nymph of *Choroterpes (C.) basalis* with left gills and part of left wing pads removed to expose abdomen.**



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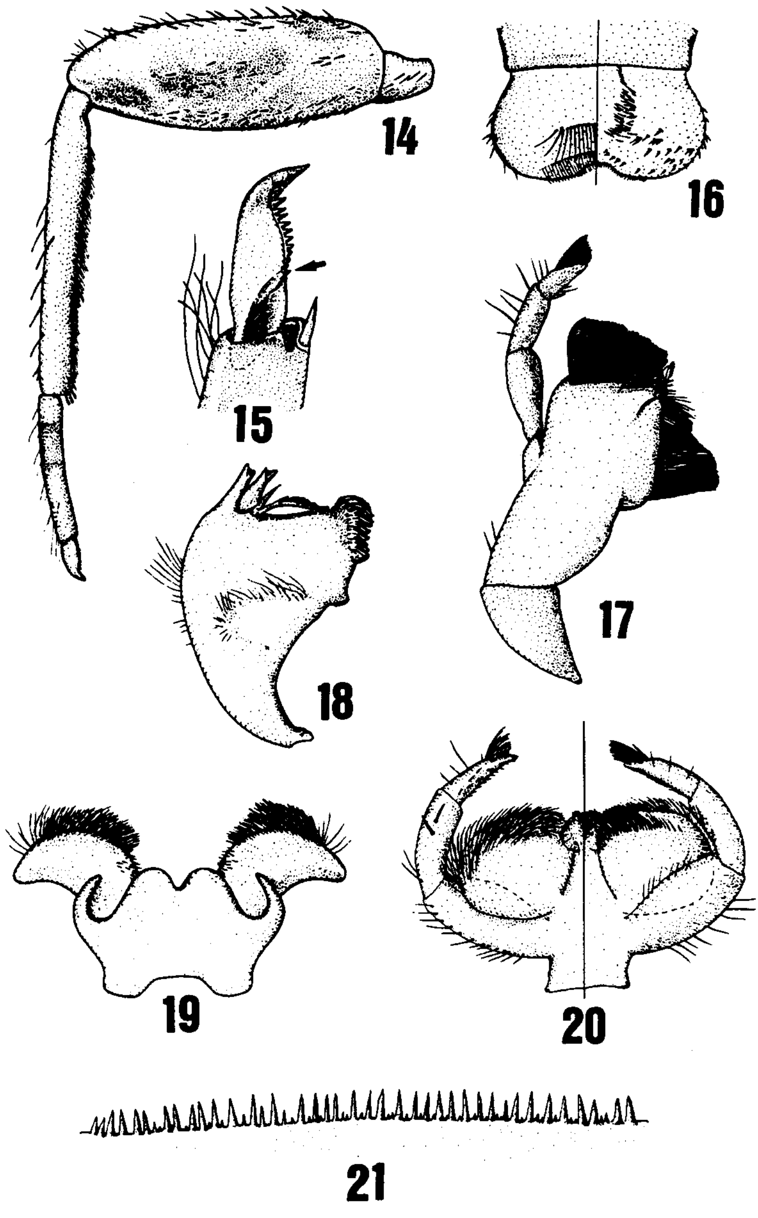
Figures 14-21. Characters of the mature nymph of *Choroterpes (C.) basalis*. 14. Foreleg. 15. Fore claw. 16. Labrum, dorsal (left), ventral (right). 17. Left maxilla. 18. Left mandible. 19. Superlingua. 20. Labium, dorsal (left), ventral (right). 21. Spinulae on posterior margin of tergite 8.



becoming enlarged and connected to medial pale stripe on segments 3-6 or becoming smaller with the medial line being the dominant feature. Except for segment 1, each segment has sharp posterior lateral projections. Spinulae on the posterior margin of tergite 8 as in Fig. 21. Gills as in Figs. 11 and 12, terminal filament of dorsal lamellae on gills 2-7 expanded apically. Outer portion of this filament may be broad and somewhat round apically or lanceolate. Caudal filaments tan, slightly darker near base. Segments with whorls of setae extending from posterior margin of first 15 to 16 segments. Beyond this point setae occur on alternate segments (Fig. 13).

Type Material Examined: Lectotype (1M) *Choroterpes (C.) basalis*, QUEBEC: Sherbrooke Co., [Type 1] 22 VII 1895(?), N. Banks; Paralectotype (1M), PENNSYLVANIA: Montgomery Co., [Type 2] 11 IX 1891(?), N. Banks (MCZ # 11433); (MCZ). Holotype (1M) *Choroterpes (C.) ferruginea*, NEW YORK: Wintergreen Point, Old Forge, ? VIII 1905, J.G. Needham (CUIC); Paratypes (3M), NEW YORK: same as Holotype (CUIC); Paratypes (1M), NEW YORK: Juanita Island, Lake George, 21 VIII 1920, J.G. Needham (CUIC); Paratypes (2M), NEW YORK: Commissioner's Island, Lake George, 25 VIII 1920, J.G. Needham (CUIC). Holotype (1M) *Choroterpes (C.) fusca*, ONTARIO: Algoma, 1 IX 1934, H.T. Spieth (AMNH); Paratypes (5M,5F), ONTARIO: Algoma, same as Holotype (AMNH); Paratypes (2M), CONNECTICUT: Fairfield Co., Redding, 21 VIII 1933, H.T. Spieth (AMNH). Holotype (1M) *Choroterpes (C.) hubbelli*, FLORIDA: Alachua Co., Jerome Sink, 1 III 1940, L. Berner (MCZ # 33475); Allotype (1F), FLORIDA, same as Holotype, 22 IV 1939, L. Berner (MCZ); Paratypes (4M,4F), FLORIDA: Walton Co., Portland, 31 V 1940 (MCZ); Alachua Co., Jerome Sink, 22 IV 1939, L. Berner, (MCZ) & (FAMU); Putnam Co., Red-Water Lake, 26 IV 1939, L. Berner (MCZ) & (FAMU).

Other Material Examined: ONTARIO: (1M) Bala Falls, 14 IX 1925, G.S. Waley (AMNH), (1M) same as last record (UNH); (11M) Orillia, 2/4 VIII 1938, C.H. Currann (AMNH); (2M) Rideau River, Ottawa, 19 VIII 1925, (CNC); (1M) Ottawa, 11 VIII 1925 G.S. Walley (CNC); (1M) Lynn, 10 VIII 1926, G.S. Walley (CNC); (1F) Ottawa, 26 VIII 1924, F.P. Ide (CNC); (1M) Ottawa, 30 VII 1924, F.P. Ide (CNC); (1M) Put-In-Bay, 9 VII 1928, R.C. Ozburn (AMNH); (1M) Kirtland, tributary of Chagrin River, 2 IX 1929, J.R. Traver (CUIC); (N,F) LeRoy, East Creek, 12/24 VIII 1932, J.R. Traver (CUIC); (N,M,F) LeRoy, East Creek, tributary of Big Creek, 14 VIII 1932, J.R. Traver (CUIC); (1M) LeRoy, tributary of Pairre Creek, 16 VIII 1933, J.R. Traver (CUIC). QUEBEC: (1M) Knowlton, 7 VIII 1930, L.J. Milne, (AMNH); (N:7M,10F) Knowlton, Sally's Pond, 27 VII 1929, L.J. Milne (CNC); (N:1M,1F) Foster, Foster Power Creek, 12 VIII 1930, L.J. Milne (CNC); (1M) Knowlton, 27 VII 1929, J. McDunnough (CNC); (1F) Aylmer, 10 VIII 1924, C.H. Curran. ARKANSAS: (2M) Montgomery Co., Little Missouri River at Albert Pike Recreation Area, 30 V 1974, W.P. McCafferty et al. (PERC);

(3M)(N:1M,4F) Montgomery Co., Ouachita River at Rocky Shoals Boat Camp on U.S. highway 270, 1 VI 1974, W.P. McCafferty et al. (PERC); (S:3M,1F) Saline Co., Saline River, North Fork, 7 miles NW of Benton, 15 VIII 1980, H.W. Robinson & S. Winters (PERC); (S:10M,8F) Scott Co., Mill Creek at U.S. highway 71 at Y-City, 29 VI 1980, H.W. Robinson (PERC); (N:2M,1F) Scott Co., Mill Creek at Mill Creek Picnic Area, Ouachita National Forest, 1 VI 1974, W.P. McCafferty et al. (PERC). GEORGIA: (S:4M,10F) Thomasville, Ochlochnee River (5 miles north), 14 VI 1946, P.W. Fattig (INHS). INDIANA: (N:2M,5F) Brown Co., Bean Blossom Creek, 1 mile S of Bean Blossom, 19 VI 1972, W.P. McCafferty et al. (PERC); (N:1F) Crawford Co., Little Blue River above English, 9 IX 1970 (PERC); (N:1M,2F) Crawford Co., Little Blue River at U.S. highway 37, 1 mile N of English, 21 VI 1973, A.V. Provonsha & K. Black (PERC); (N:1F) Fountain Co., East Fork Coal Creek at U.S. highway 41, 13 miles S of Attica, 22 V 1973, W.P. McCafferty et al. (PERC); (N:5M,12F) Lawrence Co., Sugar Creek, 1 mile S of Bono, 20 VI 1972, W.P. McCafferty et al. (PERC); (N:1F) Monroe Co., Stephens Creek, 8 miles E of Bloomington on U.S. highway 46, 19 VI 1972, W.P. McCafferty et al. (PERC); (N:4F) Orange Co., Potoka (?) Creek at bridge 9 miles S of Paoli on highway 37, 29 VIII 1971, W.P. McCafferty et al. (PERC); (10M) Perry Co., Poison Creek, 5 miles NW of Derby, 1 VIII 1975, A.V. Provonsha & M. Minno (PERC); (N:1M,2F) Washington Co., Blue River between and Daisy Hill, 28 VI 1972, W.P. McCafferty et al. (PERC); (N:1F) Washington Co., Blue River, 2 miles E of New Pekins, 28 VII 1977, M. Minno & S. Yocum (PERC); (N:5M,3F) Washington Co., Bear Creek, 9 miles S of Salem , U.S. highway 135, 21 VI 1972, W.P. McCafferty et al. (PERC). MAINE: (1M) Aroostook Co., Allagash Waterway, ? VIII 1985, J. Sobolewski (UME); (N:1M,1F) Aroostook Co., Soldier Pond (Fish River?), 22 VII 1939, B.D. Burks (INHS); (M,F) Hancock Co., Long Pond and Southwest Harbor, ? ? 1934, A.E. Brower (CUIC); (1M) Kennebec Co., West Branch of the Sheepscot River at Route 3, 14 VIII 1986, S.K. Burian (UME); (S:5M,5F) Penobscot Co., Stillwater River below dam at Stillwater Ave., Old Town, 16 VIII 1985, F. Brautigam (UME); (5M,7F) same as last record, 4/6/15 IX 1987, S.K. Burian (UME); (1M) Piscataquis Co., Lazy Tom Stream flowage upstream of spillway on Spencer Bay Road, 26 VIII 1986, S.K. Burian (UME); (N:5M) Somerset Co., Wyman Lake, from sunken logs, 23/25 VII 1981, P. Eiler. MINNESOTA: (1M) Lake Co., Ely, 1-15 VIII 1942, W.V. Baldup (INHS); (1M,2F) St. Louis Co., St. Louis River at Proctor, 20 VII 1936 (AMNH). NEW YORK: (2M) Hamilton Co.(?), Wordworth's Lake, Adirondaks, 11 VIII ?, N. Banks (MCZ); (1M) Hamilton Co., Long Lake, 7/14 VIII 1933, R.C. Tasher (CUIC); (N,M,F) Tompkins Co., Ithaca, Fall Creek, 6/15 VII 1901, (CUIC); (1M) Tompkins Co., Power House, Ithaca, 23 IX 1924, Chapman (CUIC); (1F) Tompkins Co., Ithaca, ? VII 1931, C.N. Hardy (CUIC); (M,F) Tompkins Co., Cascadilla Creek, Ithaca, 16 VII 1931, J.R. Traver (CUIC); (N,M) Tompkins Co., Cascadilla Creek, Ithaca, 9/12/15 VIII 1932, J.R. Traver (CUIC). PENNSYLVANIA: (6M,2F) (S:1F)

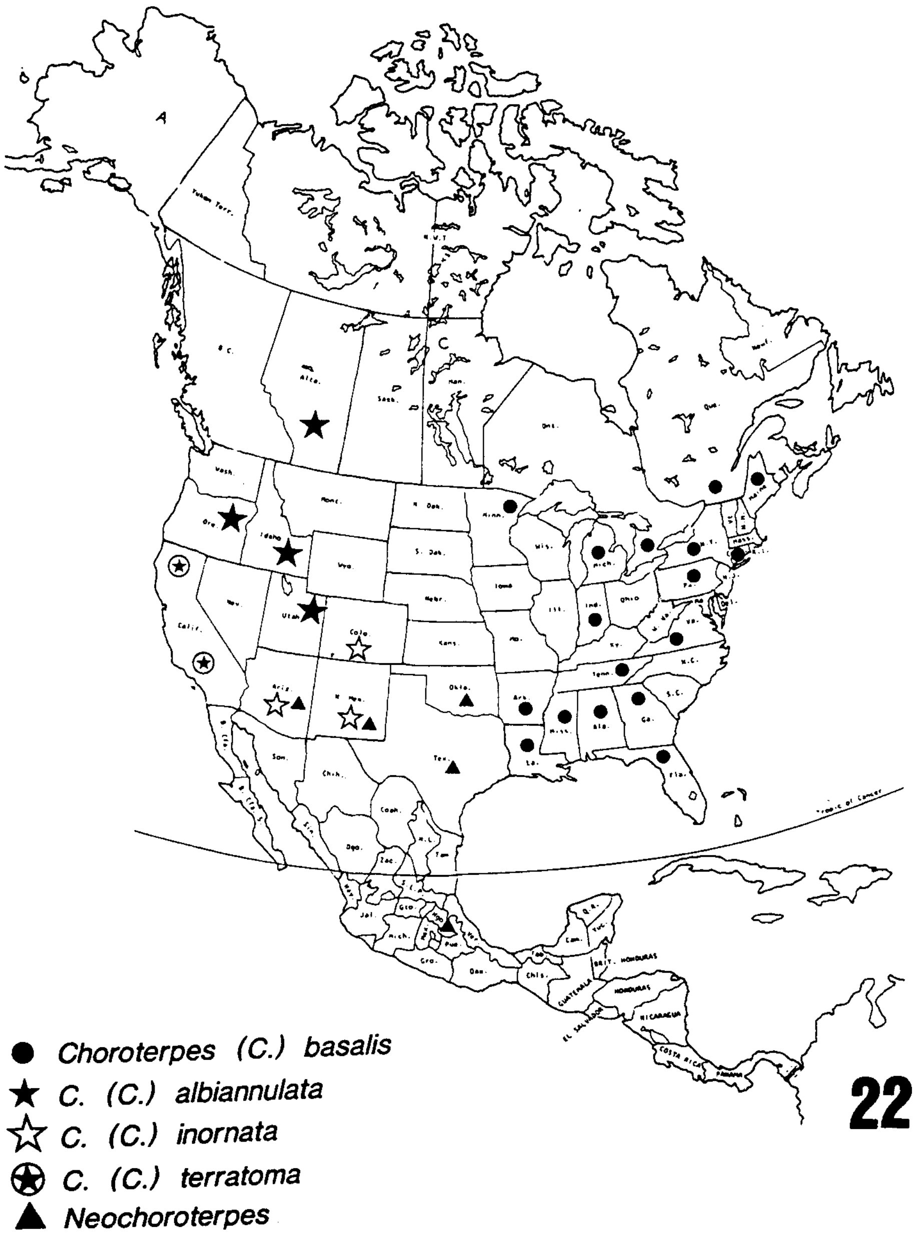
Bradford Co., Susquehanna River, 3 miles ENE of Sayre, 25 VIII 1990, D.I. Rebuck (SWRC); (N:4F) Montour Co., Chillisquaque Creek above Montour Power Plant, 29 VI 1987, D.I. Rebuck (SWRC); (N:1F) Montour Co., same as last record, 27 VI 1987, D.I. Rebuck (SWRC); (N:1F) Montour Co., Chillisquaque Creek below Montour Power Plant, 29 VI 1987, D.I. Rebuck (SWRC); (N:1F) Wayne Co., Delaware River at Dillontown, 27 VII 1983, JWP & DIR (SWRC). VIRGINIA: (N:2M) Craig Co., Sinking Creek at Route 625, 15 VIII 1979, B.W Sweeney et al. (SWRC).

Choroterpes basalis can be distinguished from other Nearctic members of *Choroterpes* s.s. by genital forceps of the male not having an enlarged basal area; caudal filaments being white or cream coloured without bands on annuli; and by the general form of the abdominal colour pattern, which consists of a pale median line flanked by two small triangular spots and two more circular diffuse spots as in Figs. 2-7. Nymphs are more difficult to diagnose because of the brief or incomplete nature of descriptions given for *C. albiannulata* by Jensen (1966); *C. terratoma* by Seeman (1927); and *C. inornata* by Eaton (1892). Tentatively, nymphs of *C. basalis* can be distinguished from those of *C. albiannulata* and *C. terratoma* by having 12-15 denticles on the fore claw. *Choroterpes albiannulata* and *C. terratoma* are reported to have 9-11 and 8-10 denticles, respectively. Currently, I am not able to offer any characters to separate nymphs of *C. basalis* from nymphs of *C. inornata*. Admittedly, nymphs are at best weakly diagnosed. Perhaps after the taxonomy of the western species is better understood a more positive diagnosis will be possible.

The distribution and occurrence of *Choroterpes* s.s. and *Neochoroterpes* in North America is difficult to interpret. Ranges of all species of *Choroterpes* s.s. and the overall ranges of the subgenus *Neochoroterpes* are presented in Fig. 22. Peters (1988) discussed possible dispersal events and systematic relationships, or the visible lack thereof, between the Nearctic, Palearctic and Ethiopian taxa of *Choroterpes*. In his discussion Peters noted that the Nearctic *Choroterpes* s.s. could be of boreal origin, austral origin or both. Based on the study of eastern North American populations I believe that there is evidence to support a Laurasian origin for *Choroterpes* s.s. in eastern North America. Evidence in support of this hypothesis I believe can be obtained from three sources: the current distribution of Nearctic taxa; what are known to be the macroecological requirements of the group; and taxonomic similarities with the European fauna, especially *C. (C.) picteti*.

Although reported from the western U.S. and Canada, the Nearctic *Choroterpes* s.s. are more broadly distributed in the eastern and northeastern half of the continent. Even after redistributional events following the Pleistocene Epoch, this type of pattern is what you would expect of a taxon that originally entered North America following some northeasterly dispersal corridor. Along with this eastern concentration of populations we see that although members of this group occur in

Figure 22. Geographical distribution of the two subgenera of *Choroterpes* in North America.



both lentic and lotic habitats, these habitats are usually cool and well oxygenated. This is also consistent with the type of ecological requirements that some ancient colonizing group is expected to have had if they originated from northern latitudes. Finally, comparison of specimens studied with the detailed description of the European species *C. (C.) picteti* given by Eaton (1884) shows them to be closely related. Except for what seem to be clear differences in the genitalia of male imagos, nymphs appear to be almost identical. This seems to indicate a close sister group relation between the taxa of both regions. Currently, I am unaware of any other taxa outside of Europe that exhibit a comparable degree of morphological similarity with the eastern North American species. These facts argue in support of a recent connection between the faunas of these two areas.

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