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New Genus of Mayflies from Eastern North America[1] (Ephemeroptera: Ephemeridae)

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Abstract: Based on a detailed morphological study of the family Ephemeridae, a new genus, **Litobrancha**, is erected to include **Litobrancha** *recurvata* (Morgan) comb. n. which was previously placed in the genus *Hexagenia* Walsh. The description is based on several previously unstudied characters along with some heretofore regarded as being of only specific importance. Both nymphal and adult stages of **Litobrancha** are compared with those of *Hexagenia*. The relative phylogenetic position of the new genus is discussed, and the distribution and biology of **L.** *recurvata* are reviewed.

Information gained through a comprehensive phylogenetic study of the family Ephemeridae has indicated that certain revisions in regards to the generic classification of this group are necessary before a more natural classification can be realized. Morphological differences pertaining to both nymphal and imagal characters, between the species previously known as *Hexagenia recurvata* Morgan and all other known species of the genus *Hexagenia* Walsh are widespread and distinct. For this reason the erection of a new and separate genus to include the above mentioned North American species is believed warranted. This new genus is herewith named **Litobrancha**.[2]

Litobrancha new genus

IMAGO

SIZE: Length of male body, 18.0–20.5 mm.; fore wings, 15.0–18.0 mm.; lateral cerci 1.9–2.6 times length of body; median terminal filament vestigial. Length of female body, 19.0–28.0 mm.; fore wings, 19.0–24.0 mm.; lateral cerci 1.6–2.4 times length of body; median terminal filament vestigial.

HEAD: Compound eyes of male bicolorous, approximated dorsally; median margins strongly convergent dorsally in facial view (fig. 1). Compound eyes of female unicolorous, separated anteriorly by distance 2.2–2.4 times width of one eye; median margins convergent dorsally

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[2] Etymology: Litos, Gr. meaning simple; branchos, Gr. meaning gill.

in facial view (fig. 2). Transverse shelf of head below antennae extended ventral to nasal carina and bilobular as seen in facial view (figs. 1 and 2).

THORAX: Pronotum with posterior width approximately 1.5 times length; lateral margins tapered anteriorly to width three fifths to two thirds of posterior width; pronotum not constricted sublaterally in anterior third. Scutellum of mesothorax variable, usually acute posteriorly as seen in dorsal view (fig. 3), if notched then only very slightly (fig. 4), never deeply concave. Length of male body 1.2–1.3 times length of fore legs; tibiae of fore legs 1.4 times femora; tarsi 1.4–1.6 times tibiae. Length of female body 2.2–2.6 times length of fore legs; tibiae of fore legs 0.8–1.0 times femora; tarsi 0.9–1.0 times femora. Fore wings (fig. 5) with crossveins not crowded along line of bullae; A_1 nearly straight to slightly sinuate, not exactly paralleling CuP; 2–4 veinlets extending between A_1 and anal margin; A_2 paralleling A_1 for over one half of its length. Hind wings (fig. 6) with MP_2 not attached basally to CuA; A_1 ending on margin over one half of length of anal margin; anal venation with much reticulation.

ABDOMEN: Genitalia of male (fig. 7) with posterior margin of subgenital plate slightly emarginate medially; forceps four-segmented, second segment curved medially mostly in distal half, dorsal to semi-globose basal segment at attachment, third and fourth segments combined over one half of length of basal segment; penes divergent in distal two thirds, with narrowed apices recurved ventrally. Terminal abdominal sternum of female with no distinct posterolateral processes.

MATURE NYMPH

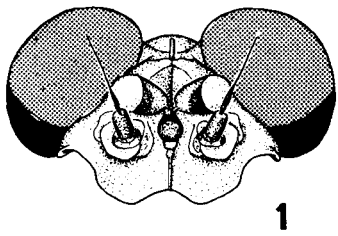
HEAD: Frontal process complete, at least as long as wide; lateral margins slightly divergent from base (fig. 8). Antennae with pedicel at least as long as scape; flagella covered with very short scattered setae (fig. 8). Labrum with distal margin nearly straight (fig. 9). Mandibular tusks stout, circular in cross section, less than twice length of body of mandible, not spuriferous (fig. 10). Hypopharynx with median lingua emarginate (fig. 11). Maxillae slender, palpi three-segmented (fig. 12a); galea-laciniae acute apically, with 1 large tridenticulate apical spine (fig. 12b) and 2 small subapical spines medially, distal subapical spine not as distinct and appearing juxtaposed with apical spine. Labium (fig. 13) with paraglossae distinctly extended basally; palpi two-segmented, terminal segment truncate and spuriferous apically.

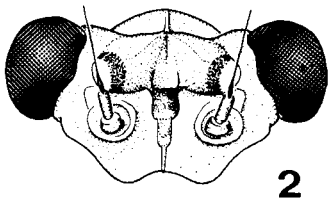
THORAX: Tibiae of fore legs produced anterodistally into large acute process dorsal to tarsi, posterodistal margin with distinct comb of stout apical setae. Tibiae of middle legs distinctly produced posterodistally beyond origin of tarsi, and with distinct comb of stout apical setae at posterodistal margin. Tibiae of hind legs with tibial processes nearly equal to tarsi in length.

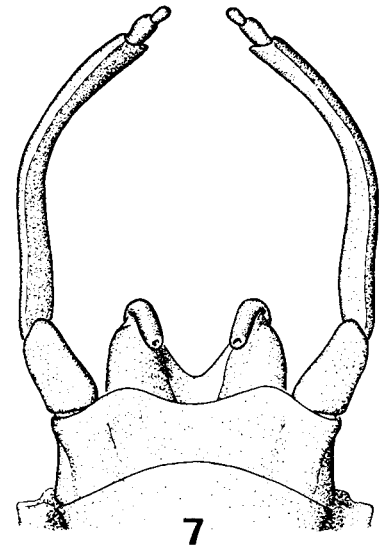
ABDOMEN: Gill 1 slender and unbranched (fig. 14). Dorsal branch of gill 2 with outer margin of lamella distinctly expanded in basal half (fig. 15).

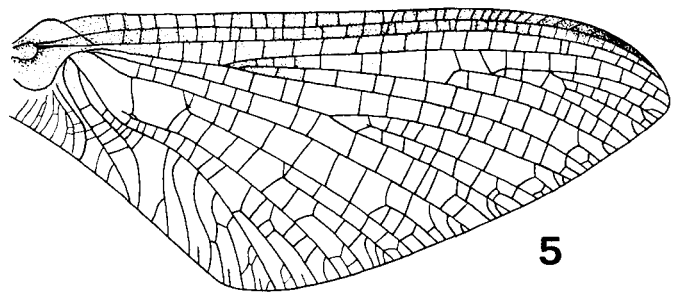
DISCUSSION

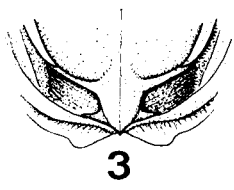
Litobrancha *recurvata* (Morgan) comb. n. was discovered to be quite distinct morphologically by Spieth (1941); nevertheless, he maintained its original status in the genus *Hexagenia* in his revisionary work at that time. Prior to this Traver (1931) had noted several nymphal characteristics unique to **L.** *recurvata*. Detailed study of additional characters and specimens of

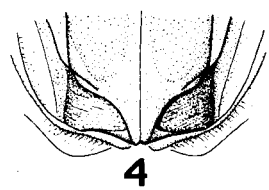


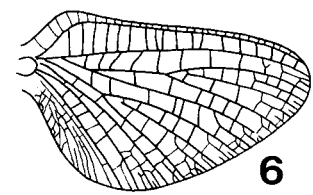




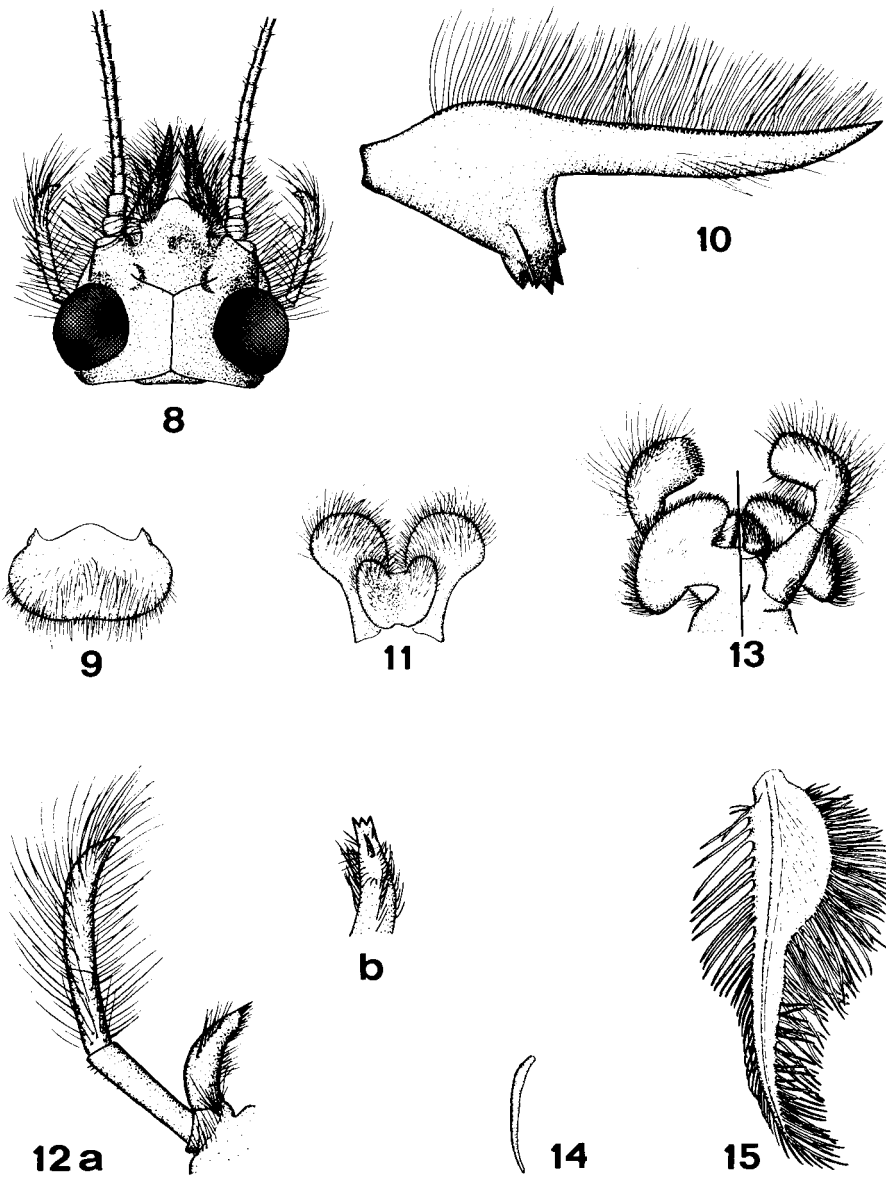








FIGS. 1–7. **Litobrancha** *recurvata*, imago. 1. Male head, anterior view. 2. Female head, anterior view. 3 and 4. Scutellum of mesothorax, dorsal view. 5 and 6. Fore and hind wings respectively. 7. Male genitalia, ventral view.



FIGS. 8–15. **Litobrancha** *recurvata*, nymph. 8. Head, dorsal view. 9. Labrum, anterior view. 10. Right mandibular tusk, lateral view. 11. Hypopharynx. 12a. Right maxilla posterior view. 12b. Galea-lacinia, median view. 13. Labium. 14. Abdominal gill 1. 15. Dorsal section of right gill 2.

Ephemeridae from throughout the world however, definitely supports the proposed classificatory change. Based on the total number of character state differences and degrees of differentiation, **Litobrancha** is as distinct as other such natural groups of species presently recognized within the family. Since **Litobrancha** is presently monospecific, an effort has been made to incorporate in the description those characters which have proven to be of generic consequence for the family as a whole. Certain of the generic characters used herein (with particular reference to measurements) may necessarily be modified if in the future the genus is found to include additional species.

Litobrancha and *Hexagenia* can be generically differentiated very clearly on the basis of several characters, many of which have not been previously studied. The more important diagnostic characters include the following: The compound eyes of the male imago are more convergent dorsally in **Litobrancha** (fig. 1), being convergent only slightly in most *Hexagenia*. Regarding the compound eyes of the female imagos, they are unicolorous in **Litobrancha** (fig. 2) and bicolorous in *Hexagenia*. A striking difference occurs in the shape of the head of the adults (see figs. 1 and 2). In the anterior or facial view, the head of **Litobrancha** is extended ventrally on either side of the midline or nasal carina, appearing somewhat bilobular. However, in *Hexagenia*, this transverse shelf of the face below the antennae is not extended as far as the nasal carina, and may appear slightly concave on either side. The next important distinguishing feature between the two genera pertains to the thoracic morphology. The scutellum of the mesothorax of *Hexagenia* is notched posteriorly as seen in the dorsal view. In **Litobrancha** the scutellum is usually acute posteriorly (fig. 3); if it is notched (fig. 4) it is much less so than that condition found in *Hexagenia*. In the anal area of the fore wings, **Litobrancha** possesses 2–4 veinlets extending from A_1 to the anal margin, and A_2 parallels A_1 for over one half of the length of A_2 (fig. 5). Whereas, in *Hexagenia*, as pointed out by McCafferty (1970), species of the Nearctic subgenus *Hexagenia* s.s. usually have 8–14 veinlets and never less than 5, only species of the Neotropical subgenus *Pseudeatonica* having as few as 3 veinlets. In addition A_2 is divergent with A_1 for more than one half of the length of A_2 in *Hexagenia*. Concerning the male genitalia of **Litobrancha**, the dorsal side of the basal segment of the forceps is extended somewhat distally beyond the point of attachment with the second segment (fig. 7). This is not the case in *Hexagenia*. The study of the Ephemeridae has shown that the general shape of the penes is of consequence in delineating the genera, and here again **Litobrancha** and *Hexagenia* differ. The penes are separate to their bases in *Hexagenia*, but attached and divergent only in the distal two thirds in **Litobrancha** (fig. 7). Moreover, the tips of the penes are peculiarly recurved ventrally in **Litobrancha**, a condition not occurring in *Hexagenia*.

Several nymphal characters are also of significance in differentiating the taxa. The flagella of the antennae is whorled with long coarse setae for at least two thirds of its length in *Hexagenia*, but possesses only very short, sparsely located setae in **Litobrancha** (fig. 8). The frontal process is more angular in **Litobrancha** as seen in figure 8, and typically rounded in *Hexagenia* with lateral margins convergent from the base. The mandibular tusks also appear shorter and more stout relative to the head in **Litobrancha**. In regards to these above mentioned nymphal characters, it is of interest to note that Needham (1920), in his study of North American burrowing mayflies, misfigured the head drawings of **L.** *recurvata* and *H. bilineata* (Say) so that the attributes of each appear opposite of that discussed above. The median lingua of the hypopharynx is deeply emarginate in **Litobrancha** (fig. 11), and straight to very slightly emarginate in *Hexagenia*. The apical spine on the galea-lacinia of the maxillae is tridenticulate in **Litobrancha** (fig. 12b) and bidenticulate in *Hexagenia*. The first abdominal gill of **Litobrancha** is unbranched (fig. 14), whereas the first gill of *Hexagenia* is bifid from near its base.

Phylogenetically, **Litobrancha** is most closely related to the genera *Eatonica* Crass, *Eatonigenia* Ulmer, and *Hexagenia*, sharing many characteristics with them. Present evidence based on derived character states in common shows **Litobrancha** to perhaps hold more affinities for the Old World genera *Eatonica* and *Eatonigenia* than for *Hexagenia*. If in fact **Litobrancha** shares a most recent common ancestor with the evolutionary line leading to *Eatonica* and *Eatonigenia*, it stands somewhat intermediate between *Hexagenia* and the latter two, along with having many specialized characteristics of its own.

The known distribution of **Litobrancha** is based on reported records of **L.** *recurvata*, see Spieth (1941). Its distribution is centered in the northeastern United States, but it has been reported from Ontario and Quebec, north; the upper peninsula of Michigan, west; and North Carolina, south.

The biology of **L.** *recurvata* has been variously treated by Morgan (1913), Needham (1920), Morgan and Grierson (1932), Morgan and Wilder (1936), and Spieth (1941). Needham referred to this species as an upland bog-stream species, and in fact **L.** *recurvata* is usually associated with colder and swifter streams than are other North American burrowing mayflies. As pointed out by Spieth, the relatively small populations of this species may be due to this restricted habitat. The species reportedly emerges during May and June of each year in the northeastern United States.

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