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PENTAGENIIDAE: A NEW FAMILY OF
EPHEMEROIDEA (EPHEMEROPTERA)^{1,2}

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ABSTRACT

On the basis of a detailed morphological analysis of the superfamily Ephemeroidea a new family, Pentageniidae, is erected and described for the genus *Pentagenia* Walsh. Character state distribution among adult and nymphal stages indicates close phylogenetic relationships between the Ephemeridae, Pentageniidae, and Palingeniidae. Affinities of the genus *Fontainica* McCafferty are also discussed.

Key Words: Ephemeroptera, *Pentagenia*, new family, evolutionary relationships, Ephemeridae, Pentageniidae, Palingeniidae.

An exhaustive study of the comparative exoskeletal morphology of the superfamily Ephemeroidea has shown the North American genus *Pentagenia* Walsh to be morphologically and evolutionarily intermediate between the families Ephemeridae and Palingeniidae. This intermediary position is expressed by the fact that the nymphs of *Pentagenia* are basically similar to those of the Palingeniidae, both of which share many apparently commonly derived characters. On the other hand, the adults of *Pentagenia* are basically similar to those of the Ephemeridae, having retained many of the relatively more ancestral characters present in the latter group. In addition, *Pentagenia* demonstrates several character states in both the adult and nymphal stage which appear intermediate between those of the Ephemeridae and Palingeniidae. In view of this unique character distribution found among these groups, I believe *Pentagenia* represents a true intergrade and, at the same time, as distinct a taxon as either the Ephemeridae or Palingeniidae.

In order to call attention to these evolutionary relationships and to insure a more meaningful classification phylogenetically, a new family, Pentageniidae, is herein erected for the genus *Pentagenia*.

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Family Pentageniidae, new family

Imago. Compound eyes of male large, contiguous or nearly so dorsally (fig. 1). Pronotum of male much reduced, with width approximately three times length (fig. 2). All legs of both sexes functional and well developed. Tarsus of prothoracic legs shorter than tibia; prothoracic legs of male approximately one half of length of body not including caudal filaments. Tarsal claws of meso- and metathoracic legs of male and all legs of female dissimilar. Wings hyaline, never with longitudinal veins geminating, with considerable marginal venation. Fore wings (fig. 3) with Sc visible from above for entire length; venation of radial triad somewhat reduced; MA bifurcating in middle third of wing; CuA singular for entire length, usually with no cubital intercalaries, but series of variously shaped cubital veinlets attaching CuA to anal margin; variable number of free veinlets at anal margin; A₁ not forked, connected to anal margin by 2-3 veinlets. Hind wings (fig. 4) with costal angulation obtuse; R₁ attached basally to MA; R₂ - R₄ & 5 fork subequal in length to Rs. Forceps of male genitalia four-segmented, second segment longest (fig. 5). Terminal filament shorter than body in both sexes.

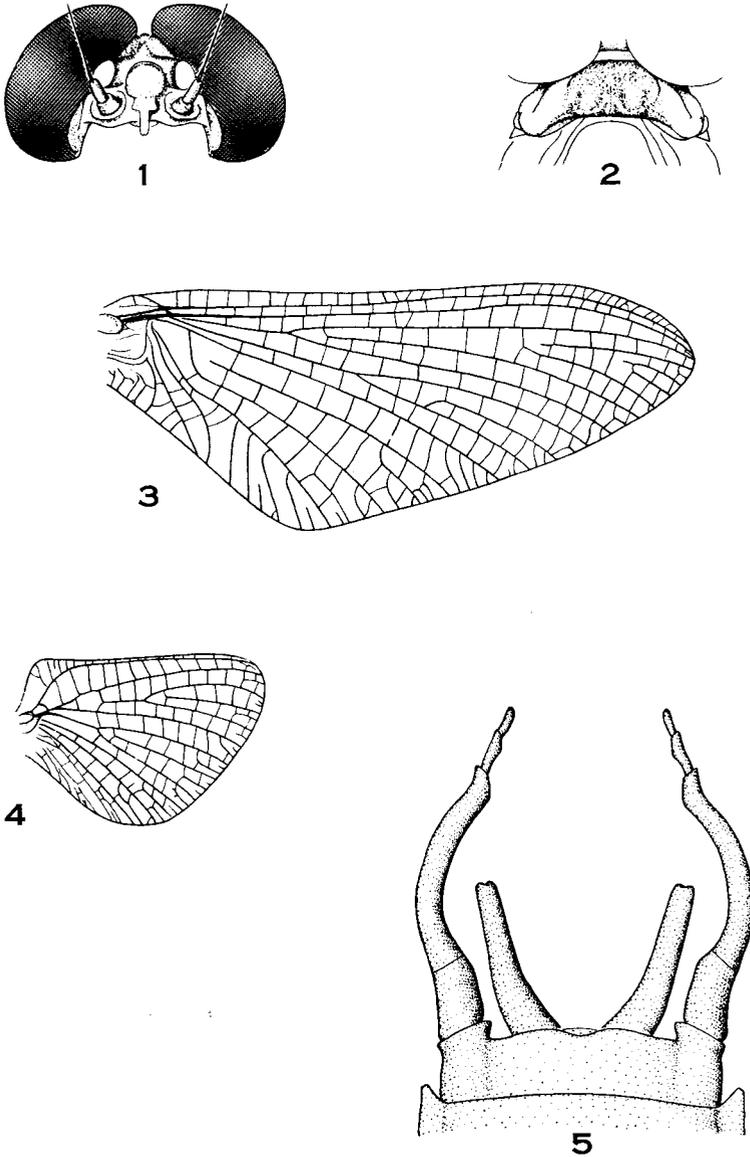
Mature Nymph (Fig. 6). Frons of head (fig. 7) produced anteriorly into a distinct frontal process, emarginate anteriorly with anterior margin smooth or sometimes variously serrated (see Burks, 1953, fig. 49). Pair of distinct bifurcate processes located anterolaterally on head dorsal to insertion of antennae. Labrum approaching truncate (fig. 8). Mandibles produced anteriorly into well developed tusks (figs. 7 and 9), somewhat depressed, and with linear row of spurs along lateral margin. Maxillae (fig. 10) robust, palpi never greatly extended in length. Labial palpi (fig. 11) two-segmented, lateral to body of labium, rounded apically. Prothoracic legs (fig. 12) fossorial, tibiae flattened, femora produced posteriorly then proximally beyond trochanters in dorsal view. Metathoracic legs with tibia produced distally posterior to tarsus to form an acute tibial process (fig. 13). Abdominal gills 2-7 oriented dorsal to abdomen (fig. 6).

DISCUSSION

The above description is based primarily on those characters that have historically been used to separate the families of the Ephemeroidea (e.g. Ulmer, 1932-33; Edmunds et al., 1963). Along with these, certain new characters which have been found to be of diagnostic value for these families including Pentageniidae have been introduced.

Some of the more important distinguishing characters of the Pentageniidae include the following: Unlike the adults of Ephemeridae, the Pentageniidae possess a pronotum which is very reduced in length in the male (fig. 2), and the prothoracic legs are no more than half the length of the body. The terminal filament of *Pentagenia* is approximately one-fifth of the length of the body in the male and approximately three-fourths of the length of the body in the female. The nymphs of Pentageniidae are quite similar to those of Palingeniidae except for instance, that the tusks are spuriferous along the outer margin (fig. 7 and 9), and the metathoracic legs possess a tibial process (fig. 13). This tibial process however, is not as well developed as in the Ephemeridae.

Previous to this study the genus *Pentagenia* has been included in the family Ephemeridae or subfamily Ephemerinae of some authors (e.g. Needham et al., 1935). In a phylogenetic study of North American mayflies, Spieth (1933) first noted that *Pentagenia* appeared quite distantly related to the genera *Ephemer*



Figures 1-5. *Pentagenia vittigera* (Walsh), imago. 1. Male head, anterior view. 2. Male pronotum. 3. and 4. Fore and hind wings respectively. 5. Male genitalia, ventral view.

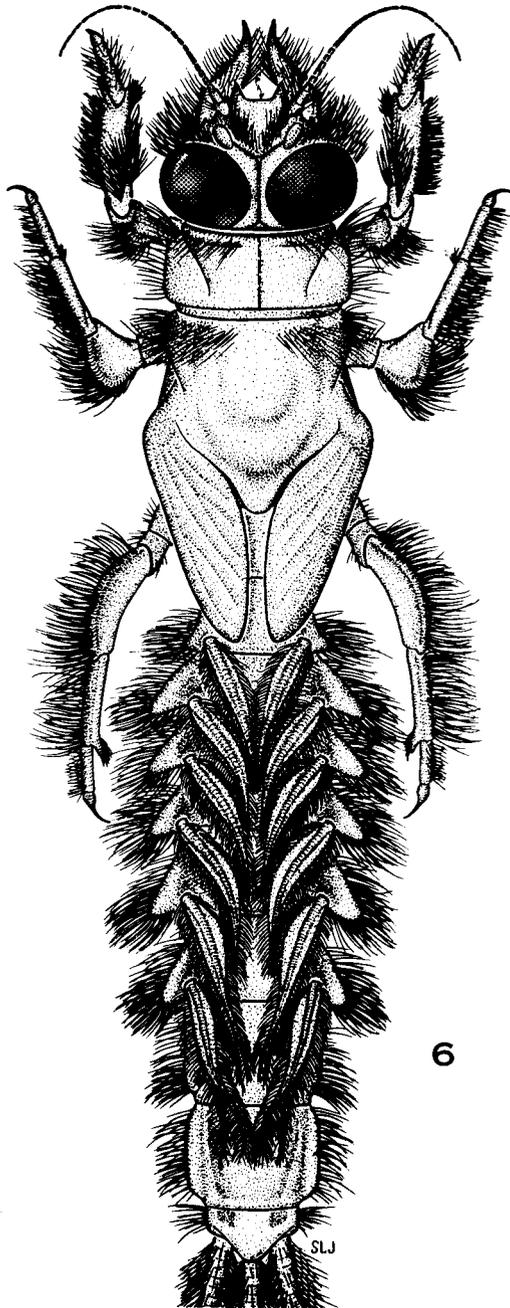
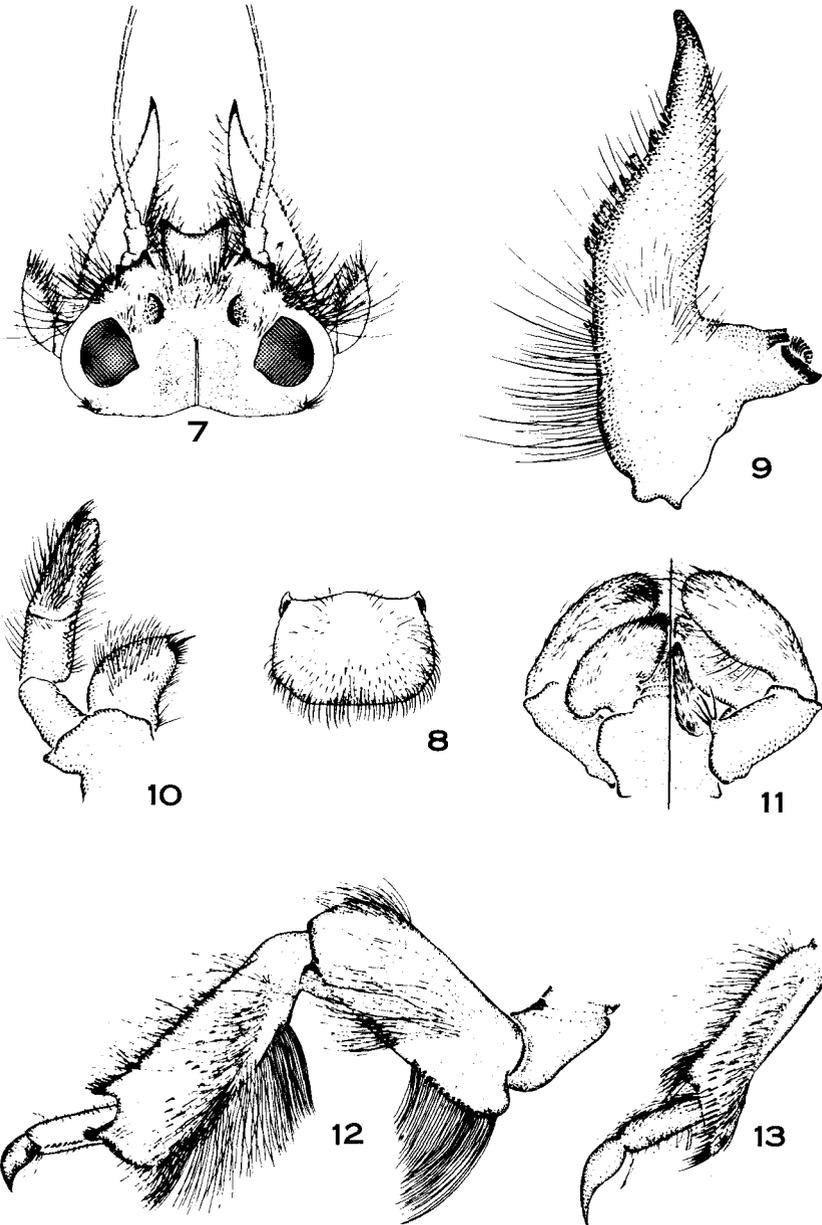


Figure 6. *Pentagenia vittigera*, male whole nymph, dorsal view (from Edmunds et al., 1963).



Figures 7-13. *Pentagenia vittigera*, mature nymph. 7. Female head, dorsal view. 8. Labrum, anterior view. 9. Right mandibular tusk, ventral view. 10. Right maxilla, posterior view. 11. Labium, anterior and posterior views respectively. 12. Left prothoracic leg, dorsal view. 13. Tibia and tarsus of left metathoracic leg, dorsal view.

Linn. and *Hexagenia* Walsh. Later, Edmunds et al. (1963) suggested that in totality of characters *Pentagenia* was the most atypical member of the Ephemeridae. Until this time however, the phylogenetic relationships of many of the Ephemeroidea have been poorly understood. The discovery of the affinities of *Pentagenia* and the Old World family Palingeniidae has greatly aided in interpreting these relationships. Current evidence supports the hypothesis that there existed a direct evolutionary line leading from the Ephemeridae to the common ancestor of the Pentageniidae and Palingeniidae during which time a great deal of morphological change in the nymphal stage took place. Subsequent to this a great deal of morphological change in the adult stage occurred in the evolutionary line leading to the Palingeniidae. The differential and independent rates of evolution in the nymphal and adult stages become very apparent in view of these relationships. A comprehensive account of the comparative morphology and inferred phylogenetic relationships of these groups is currently being prepared for publication and will treat in more detail the justification for the present classificatory arrangement.

McCafferty (1968) placed the genus *Fontainica* McCafferty from Madagascar in the family Ephemeridae because of its striking resemblance in the nymphal stage to *Pentagenia*. Such a placement does not now appear appropriate and *Fontainica* is tentatively transferred to the new family, Pentageniidae. A more definite familial assignment cannot be made at this time since *Fontainica* is unknown in the adult stage. Whether or not *Fontainica* will finally demonstrate closer affinities with Pentageniidae or with Palingeniidae hinges on the discovery of these adults. Moreover, in light of the recent phylogenetic information, there is a remote possibility that *Fontainica* may indeed represent the unknown nymphal stage of the palingeniid genus *Cheirogenesis* Demoulin from Madagascar.

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