A Preliminary Observation on the Evolutionary Trend of Fulgoromorpha Male Genitalia

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The phylogeny among families of Fulgoroidea so far is still unclear. Thus a single organ, i.e., the male genitalia, is selected for extensive study in an attempt to obtain data that will make significant contributions to future discussion on the phylogeny of the Fulgoroidea.

The male genitalia of Fulgoroidea have been studied by Kershaw and Muir [5], Singh-Pruthi [7,8], Fennah [3,4], Bourgoin [1]. This study has taken a different approach.

In Tettigometridae, the pygofer has a deep and wide emargination caudoventrally; the connective arms and connective support are present; the parameres apodemes are present; the parameres plate reaches over apices of parameres. All these characters make Tettigometridae far apart from the other families of Fulgoroidea. The nymphal abdominal segment IX in Tettigometridae is modified to conical shape, but in *Symplana glauca* O'Brien and Yang (Caliscelidae, Augilini) [6], it is only less modified; nymphal abdominal segment X in Tettigometridae breaks into three parts but in the other families as anal combs. According to these data, the male genitalia of Tettigometridae is considered originating from the unknown remote ancestor of Fulgoroidea.

The male genitalia of *Symplana glauca* is proposed to be the most primitive form of the Fulgoroidea, except Tettigometridae. This hypothesis is based on : 1). The abdominal segment IX of fifth instar nymph is less modified (nearly the same as in Thysanura), the tergo-sternal separation is distinctly present at anterior two-thirds, fuses entirely at posterior third, but the tergo-sternal suture is absent and more modified to conical shape in Tettigometridae, U-shaped and membranous ventrally in Caliscelini (Caliscelidae) and other fulgoroid families; 2). The abdominal sternite VIII (=subvaginal plate, Fennah [4]) of adult female is complete and less modified, but is rudimendary in other Fulgoroidea; and 3). The male paramere in profile is rod-like, less modified, nearly the same as in Tettigometridae (outgroup comparison).

The evolutionary trend of Fulgoromorphy male genitalia

Step A1. The male genitalia has phallus well sclerotized, large, tubular, always reaching over apex of phallobase. Phallobase is membranous. Suspensoria suspend from pygofer. Paramere in profile rod-like. This step is observed in *Symplana glauca* (Caliscelidae, Augilini).

Step A2. The male genitalia changes from step A1. Phallus is unchanged. Phallobase changes from membranous state into slightly sclerotized, ring-like at base, ventral aspect lobe-like and produces caudad. In front of phallobase is a membranous area (origin of inner phallobase = Eth, endotheca, Snodgrass [9], Bourgoin [1]), which connects with phallus and at apex each side has a sclerotized process. Suspensoria are unchanged. Paramere in profile changes from rod-like state into lobe-like. This step is observed in *Ommatidiotus inconspicuus* Stal (Caliscelidae, Caliscelini). The step A1 and step A2 are observed in different tribe of the same family. Although step A2 is not observed in other branch, theoretically the same change could have happened.

Step A3. The male genitalia changes from step A2. Phallus is reduced, membranous or slightly sclerotized. The phallobase is partly or wholly sclerotized, moves cephalad, usually tubular. Innerphallobase is present, membranous or slightly sclerotized and wrapped by phallobase; at sides with one to three pairs sclerotized processes, reaching near or over apex of phallobase. Suspensoria are unchanged. Paramere in profile is unchanged. This step is observed in *Bruchomorpha decorata* Metcalf (Caliscelidae, Caliscelini), *Mesonitys taenlata* (Schmidt)(Eurybrachidae), *Hypochthonella caeca* China and Fennah (Hypochthonellidae), *Mesepora onukii* (Matsumvra) (Tropiduchidae), Issidae, Gengidae, Ricaniidae, Lophopidae, Nogodinidae, Flatidae, Acanalonidae, Fulgoridae and Dictyopharidae.

Step B1. The male genitalia has phallus sclerotized, large, tubular, reaching to apex of phallobase. Phallobase is membranous, at apical two-thirds of phallus . Suspensurium suspends from anal segment. Paramere in profile appears modified to rod-like form. This step is observed in *Kinnacoma clara* Remana (Kinnaridae). It is proposed to be the most primitive form of Cixiidae-group [2], nearly the same as in *Symplana glauca,* except the modified rod-like paramere and the suspensorium suspending from anal segment.

Step B2. The male genitalia changes from step B1. Phallus is unchanged. Phallobase is small, ring-like, sclerotized and usually fuses with suspensorium. Suspensorium is unchanged. Paramere in profile is unchanged. This step is observed in *Perkinsiella thompsoni* Muir (Delphacidae).

Step B3. The male genitalia changes from step B1. Phallus is reduced. Phallobase is sclerotized at base and membranous at apex. Innerphallobase is present with single paired sclerotized processes. Suspensoria suspend from cross-bar. Paramere in profile is unchanged. This step is observed in *Nisia lomshueusis* Yang and Chang (Meenoplidae).

Step B4. The male genitalia changes from step B3. Phallus is rudimentary. Phallobase is slightly sclerotized. Innerphallobase is unchanged. Suspensoria suspend from cross-bar or pygofer. Paramere in profile is unchanged. This step is observed in *Achilixius tubulifers* (Melichar) (Achilixiidae) and Achilidae.

Step B5. The male genitalia changes from step B3. Phallus is slightly sclerotized, slender and tubular. Phallobase is sclerotized. Innerphallobase moves caudad, exposed from apex of phallobase, having processes or modified sclerotized plates. Suspensorium suspends from anal segment. Paramere in profile is unchanged. This step is observed in *Borythenes lacteus* Tsaur and Lee (Cixiidae) and Derbidae.

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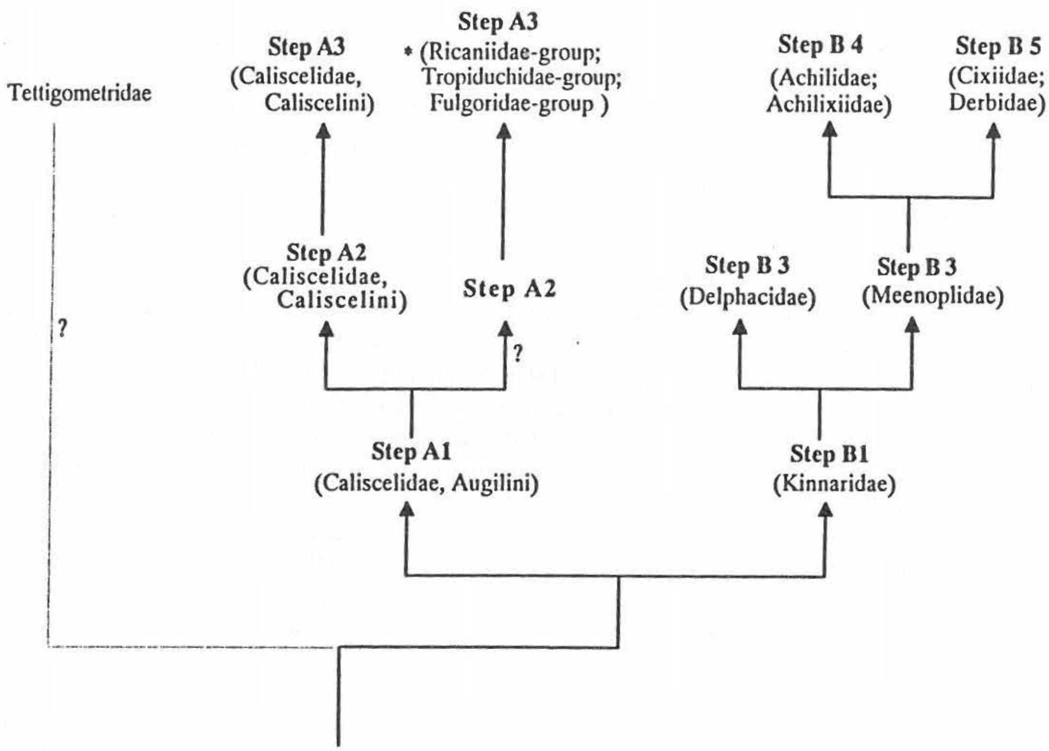

Fig. 1. The evolutionary trend of Fulgoromorphy male genitalia.

* Ricaniidae-group includes Hypochthonellidae, Gengidae, Ricaniidae, Eurybrachidae and Lophopidae; Tropiduchidae-group includes Tropiduchidae, Flatidae, Nogodinidae, Issidae and Acanalonidae; Fulgoridae-group includes Fulgoridae and Dictyopharidae; Cixiidae-group includes Kinnaridae, Delphacidae, Meenoplidae, Achilidae, Achilixiidae, Cixiidae and Derbidae.

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