

## An Attempt to Construct a Phylogenetic Tree for Planthoppers (Homoptera, Cicadina)\*

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The phylogeny of the fulgoroid planthoppers has still not been fully discussed. There have been individual ideas expressed concerning the relationships of various families in many studies, but they do not make it possible to present a complete, unified picture. The greatest contribution to the preliminary development of the question of the relationships within the superfamily was made by the authors Muir, Metcalf, and Fennah. Muir (1923, 1930), who developed the modern classification for the Fulgoroidea, laid the foundation for subsequent phylogenetic investigation. Further progress was made in solving the issue by Metcalf (1951) who worked out a highly fragmented system of taxonomic ranking from family to superfamily in the usual sense and applied it to the superfamily Fulgoroidea. Metcalf equated phylogeny and classification as cladists do, but seemingly did not take the process to its logical end. The dendrogram of Singh-Pruthi (1926) does not entirely fit into the dominant trends; he depicted the interrelations of the families based on ♂ genital characters taken alone. The nodes of the dendrogram are not all substantiated and there are many mistakes since no distinction was made between true similarity and convergence.

Recently Asche (1987) attempted to work out the earlier stages of the phylogeny of the Fulgoroidea. Along with his conclusions he included a graphic representation. The diagram includes the families Tettigometridae, Cixiidae, Delphacidae, and a stem leading to other more advanced families. Asche's dendrogram incorrectly interprets the Cixiidae and Delphacidae as sister groups based on the precarious synapomorphy of the presence of a piercing-sawing ovipositor with medially fused second valvulae. If the Tettigometridae with a completely reduced ovipositor are a sister group to Cixiidae-Delphacidae and other fulgoroids, then how does one decide whether their ancestor with a developed ovipositor had the second valvulae fused or not? A number of other characters (items 11-14, see below) make it possible to believe that the Cixiidae along with the other Fulgoroidea, except for Tettigometridae, are a sister group to the Delphacidae (Emel'yanov, 1987).

Construction of a reliable phylogeny for the Fulgoroidea that is substantiated by many characters at each node is a matter for the future, but it is already possible to outline such a phylogeny substantiated for the most part by 1-2 characters for each branching point and developed to the family rank. The cladogram does not include the problematic families Achilixiidae, Hypochthonellidae, and Gengidae, which apparently may be merged into the families Achilidae, Flatidae, and Eurybrachyidae, respectively. The family Acanaloniidae, in agreement with Fennah (1954), is considered a part of the Issidae. The family Nogodinidae is accepted in the strict sense without the subfamily Bladiniinae, which is placed in the Issidae.

### LIST OF APOMORPHIES ON WHICH THE PHYLOGENETIC TREE OF THE FULGOROIDEA IS BASED

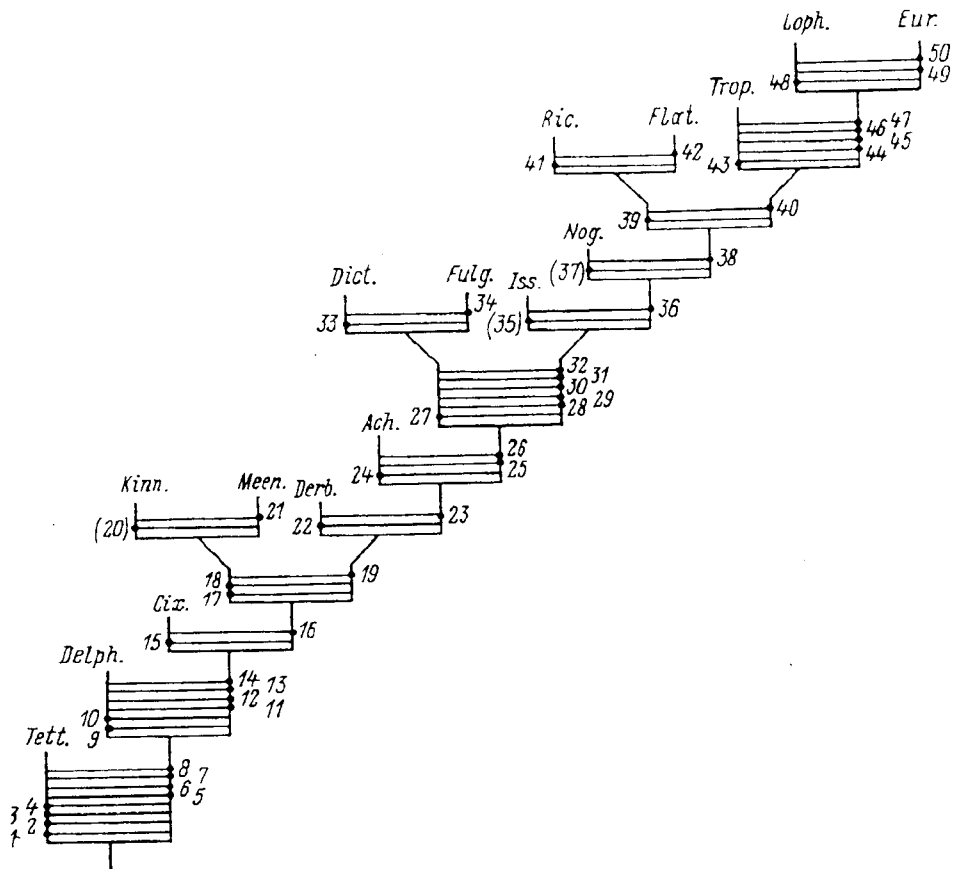
(see Figure)

Autapomorphies of individual families are not entirely presented since they do not have a de-

\*Originally published in Entomologicheskoye Obozreniye, No. 2, 1990, pp. 353-356.

cisive influence on the configuration of the tree; all synapomorphies of two and more families that were found are included.

1. Completely converged *C* and *ScR* veins on hindwings.
2. Stems from *C* to *CuA* converged distad of arculus on hindwings.
3. Specific bend of *CuA* fork on hindwings.
4. Loss of jumping in larvae (Emel'yanov, 1987).
5. Sensory pits in larvae.
6. Loss of genital plates (Emel'yanov, 1987).
7. Loss of basicubital plate in forewings (Shcherbakov, 1984).
8. Bifurcation of first segment of the rostrum (in the Delphacidae the rostrum of *Ugyops* G.-M. is so structured).
9. Posttibial spur.
10. Bridge of pygofer in ♂ (sclerotized crosspiece of genital phragma between penis and harpagones).
11. Fenestra between posterior tentorial arms and wings of hypopharynx (Emel'yanov, 1987).
12. Detachment of pleurite from sternite on abdomen (Emel'yanov, 1987).
13. Detachment of peritreme from sclerotization of segment on abdomen (Emel'yanov, 1987).
14. Tooth in basal cell in region of arculus in ventral view on forewings (Haupt, 1929).
15. Extravenal pterostigma (formed by expansion and thickening of section of peripheral membrane).
16. Gathering-mixing ovipositor that arose from piercing-sawing type from shortening and modification of valvulae when functions changed (Emel'yanov, 1979).
17. Reduced gathering-mixing ovipositor (Emel'yanov, 1984).
18. Wax areas (wax-bearing plates) on abdominal tergites 6-8 (Muir, 1930).
19. Annular rectal mycetome in ♀ (Muller, 1940).
20. Not found.
21. Base of weakened costa connected to *ScR* stem on forewing (Anufriev and Emel'yanov, 1987).



Phylogenetic tree (cladogram) of superfamily Fulgoroidea.

In the diagram, apomorphic characters are indicated by black circles and numbered as in text. The numbers in parentheses indicate that respective apomorphies (autopomorphies of families Kinnariidae, Issidae, and Nogodinidae) are not found. Names of families: Ach. = Achilidae, Cix. = Cixiidae, Delph. = Delphacidae, Derb. = Derbidae, Dict. = Dictyopharidae, Eur. = Eurybrachyidae, Flat. = Flatidae, Fulg. = Fulgoridae, Iss. = Issidae, Kinn. = Kinnariidae, Loph. = Lophopidae, Meen. = Meenoplidae, Nog. = Nogodinidae, Ric. = Ricaniidae, Tett. = Tettigometridae, Trop. = Tropiduchidae.

22. Shortening of distal segment of rostrum.

23. V-shaped amplification of  $ScR$  and  $A_1 = Pcu + A_1$  on forewing.

24. Transformation of apices of clavus and  $Pcu + A_1$  into  $CuP$ .

25. Amplification of peripheral vein anterior to pterostigma lying distad of nodus (Anufriev and Emel'yanov, 1987).

26. Shortening and straightening lengthwise of dentate ridge of tooth and ridge articulation on hindtrochanters of larvae (Emel'yanov, 1979).

27. Phallotheca with swollen sections in distal part of ventral region.

28. No more than two teeth on second segment of hindtarsus.
29. Claval vein *Pcu* + *A*<sub>1</sub> abuts apex of clavus.
30. Base of forewing in ventral view basad of subcostal capitulum, a digitate ridge developed.
31. Anapleural suture of mesothoracic episternum developed only in fully winged individuals.
32. Precostal area with crossveins.
33. Dorsal lobes of 3rd valvulae of ovipositor lacking sensory appendix (Emel'yanov, 1974).
34. Additional folding of hindwing along *A*<sub>1a</sub> vein (Emel'yanov, 1979).
35. Not found.
36. Ovipositor laterally compressed.
37. Not found.
38. Loss of posterior tentorial arms (Bourgoin, 1986).
39. Laterotergites of abdomen fused with tergites, suture distinct.
40. Behind apex of clavus with approximately lanceolate marginal cell in frontal view abutting its apex.
41. Hindwing with falcate precostal lobe (Scherbakov, 1982).
42. Sensory pits on clavus of forewing.
43. Lateral ends of tentorial bridge fused with wall of head capsule (Bourgoin, 1986).
44. Ventral surface of ♀ anal tube transformed into wax secreting area.
45. Lanceolate marginal cell of membrane behind clavus added onto truncate apex of clavus.
46. Hindwing with at least a single crossvein between *CuP* and *Pcu* (Shcherbakov, 1982).
47. Sides of vertex below antennae protrude angularly.
48. Several (more than 2) rows of teeth on tips of hindtibiae.
49. ♀ anal tube falcate, in cross-section triangular because of tectate convex lower wall.
50. Broad vertex with specific contour.

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