Phylogenetic study of the family Dictyopharidae (Hemiptera: Fulgoromorpha) based on morphological data of adults

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With more than 720 species in 155 extant and extinct genera, Dictyopharidae Spinola, 1839 (Hemiptera: Fulgoromorpha) are currently divided into two subfamilies Dictyopharinae Spinola, 1839 and Orgeriinae Fieber, 1872 (Metcalf 1946, Bourgoin 2017). Most dictyopharid species are moderate to small in size, compared to their asserted sister group Fulgoridae Latreille, 1807. An elongate and tapering head is common to both families, but is not unique to them, occurring widely in the Fulgoromorpha (O'Brien 2002), and reported to be homoplastic (Urban & Cryan 2009). Members of Dictyopharidae are found in every part of the world, excluding Arctic and Antarctic regions, with highest diversity in the tropical and subtropical zones. Most dictyopharids are predominantly dicot feeders, and a few species are economically important agricultural pests on grasses (Wilson & O'Brien 1987).

To date, the phylogenetic relationships and monophyly of two subfamilies and most tribes within Dictyopharidae have not been tested quantitatively or cladistically. The current classification suggested mainly by Emeljanov (*e.g.* 1969, 1983, 2011) is a basic hypothesis from which a higher-level phylogeny is constructed in this study. Here we use morphological data to investigate the phylogeny and monophyly of the family Dictyopharidae and its constituent extant tribes. New characters and character states are included in the current analysis along with those used in previous studies (Song *et al.* 2016a, b). To examine the monophyly and phylogeny of Dictyopharidae, and evaluate their tribal-level classification, we perform a matrix of 146 morphological characters of adults. Our analysis includes 104 of 125 recognized genera and subgenera within 12 extant tribes of Dictyopharinae, plus nine genera representing all four tribes of Orgeriinae. The results of this study support Dictyopharidae as a monophyletic group in its current definition with Aluntiini sister to the remaining Dictyopharidae; but do not support Orgeriinae as sister to Dictyopharinae. Seven major lineages: Aluntiini, Arjunini, Hastini, (Taosiini + Lappidini) + Nersiini, a *Xenochasma*$^{+}$ Complex (including "Orgeriinae"), Orthopagini, and Dictyopharini, are recovered in Dictyopharidae. The resulting *Xenochasma*$^{+}$ Complex appears as a new monophyletic lineage and includes *Xenochasma* clade + (Scoloptini + ((*Fernandea* clade + Phylloscelini) + (Rancodini + (Capenini + Orgeriinae)))). Within this complex, some genera are of uncertain tribal placement, and Orgeriinae are retained as a

subfamily until a robust phylogenetic analysis can be conducted. The analysis supports the monophyly of most tribes of Dictyopharinae (except Taosini), the sister group relationships of (Taosiini + Lappidini) with Nersiini, and Orthopagini + Dictyopharini, and the current tribal classification for Dictyopharinae.

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