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External egg structure of the Pentatomidae (Hemiptera: Heteroptera) and the search for characters with phylogenetic importance

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Abstract

The chorionic structure of sixteen pentatomid species is described. Morphological patterns in different taxonomic levels are discussed. In addition, egg characters useful in cladistic analyses are listed, and some of those characters are tested for congruence with two cladistic analyses previously conducted within Pentatomidae. Descriptive studies were conducted with *Banasa induta*, *Capivaccius bufo*, *Catulona pensa*, *Chinavia armigera*, *Chinavia aseada*, *Chinavia brasicola*, *Chinavia runaspis*, *Dichelops furcatus*, *Euschistus heros*, *Euschistus riograndensis*, *Euschistus paranticus*, *Mormidea cornicollis*, *Podisus distinctus*, *Podisus nigrispinus*, *Serdia apicicornis*, and *Thoreyella maracaja*. The eggs were examined and photographed under light and scanning electron microscopy. Based on literature data, a list of 40 egg characters with potential phylogenetic importance has been compiled. Some of these characters were included in the cladistic analyses of the genus *Nezara* (six characters) and of the *Chinavia obstinata* group (five characters). Both analyses were performed in TNT with equal weighting of characters. The eggs of most of the Neotropical species studied were barrel-shaped, chorion translucent and spinose, with aero-micropylar processes that were short and clubbed. The patterns of egg morphology could be identified in Carpocorini, Procleticini, and in the genera *Banasa*, *Chinavia*, *Euschistus*, *Mormidea*, and *Podisus*. In the cladistic analyses, the inclusion of egg characters did not affect the topology of the trees shown in the original papers. For the analyses, the egg characters were somewhat informative. At present, a total of 286 Pentatomidae species have their egg stage described.

Key words: Asopinae, Carpocorini, Discocephalinae, Nezarini, Pentatominae, Procleticini

Introduction

The importance of egg structure in defining the status and relationships among heteropteran groups has long been recognized. In the Pentatomoidea, patterns of egg morphology have been identified at different levels (Leston 1955; Southwood 1956; Cobben 1968; Javahery 1994; Matesco *et al.* 2009, 2012). The egg stage has been rarely used in cladistic analyses, although its importance has been widely emphasized. Egg characters usually support groups at high taxonomic levels (Hasan & Kitching 1993; Wheeler *et al.* 1993; Henry 1997; Grazia *et al.* 2008).
The most important list of characters for the eggs of the Pentatomoidea is shown by Javahery (1994), who attempted to conduct a phylogenetic analysis of genera based on the egg stage. The matrix sums 22 characters for 23 pentatomoid genera, with an aim of identifying the characters with phylogenetic value and separating them from characters that are temporary adaptations to a specific environment. Because of several methodological problems in Javahery's analysis (e.g., non-independence of characters, absence of an outgroup and obscure computational analysis), his results are often overlooked despite their relevance to the contribution of the egg stage in phylogenetic studies.

Prevosti and Chemisquy (2010) demonstrated that distribution of missing data in most matrices is not random but instead concentrated on some characters, taxa, or both, as would be expected due to the combination of different sources of phylogenetic characters in different taxon sampling. They concluded that the concentration of the missing entries in a few characters (the "character bias," as observed in our matrices, instead of the "taxa bias" or the "block bias") produced the least detrimental effect in recovering relationships. In this sense, the inclusion of more characters could make the matrices more robust against the missing data problem. Therefore, it is unwise to exclude characters prior to the analysis because they have missing cells.

On the other hand, minimization of missing data for egg characters in future analyses could be achieved by either choosing the terminals based on the availability of information on the egg stage or preferably by applying efforts to obtain the eggs of terminal species. The latter alternative can be accomplished even by dissecting the abdomen of dry conserved females prior to immersion in KOH for preparation of the genitalia.

Detail descriptions of pentatomid eggs with the use of SEM are still needed. The phylogenetic information contained in the egg stage can only be unraveled by testing the characters suggested here and others for congruence with other sets of morphological and molecular characters in a cladistic framework.

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