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Phylogeny of pentatomomorphan bugs (Hemiptera-Heteroptera: Pentatomomorpha) based on six *Hox* gene fragments

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Abstract

Pentatomomorpha is one of the most diversified infraorders of the true bugs (Insecta: Hemiptera: Heteroptera). The phylogenetic relationships among superfamilies within this infraorder are still in dispute. In this study, 31 species representing 26 pentatomomorphan and four cimicomorphan putative families were chosen, and six *Hox* gene fragments with as many as 4 kilobases for each representative were analyzed to reconstruct the phylogeny of the Pentatomomorpha. The (*Homeotic*) *Hox* gene family is a group of nuclear genes, which is considered to determine animal segmentation. The combined nucleotide and amino acid sequences were used separately as two data matrices, and analyzed by employing maximum likelihood and Bayesian methods. Results strongly support the monophyly of Trichophora and the superfamilies Pentatomoidea, Lygaeoidea, Coreoidea, and Pyrrhocoroidea. The relationship of (Aradoidea + (Pentatomoidea + (Lygaeoidea + (Coreoidea + Pyrrhocoroidea)))) was mostly congruent with previous results based on the morphological data. Our results suggested that the *Hox* genes could be used as novel molecular markers for phylogenetic research on the Pentatomomorpha and other insects.

Key words: Pentatomomorpha, Trichophora, molecular phylogeny, *Hox*

Introduction

Of the seven infraorders of Heteroptera (Insecta: Hemiptera), Pentatomomorpha is the second largest in species diversity after its sister group Cimicomorpha (Schuh 1979; Schaefer 1993; Wheeler *et al.* 1993; Xie *et al.* 2008; Schuh *et al.* 2009).

Schaefer (1993) reviewed the systematic history of Pentatomomorpha, comprising Trichophora (Tullgren 1918) and Aradoidea, and discussed different superfamily-level arrangements. The animals of this taxon share some morphological synapomorphies, e. g. the lamellate pulvilli (Tullgren 1918; Schuh 1979), the similar spermatheca with an apical bulb and pump flanges (Pendergrast 1957), the lack of a true operculum in eggs (Leston *et al.* 1954; Cobben 1968) and the presence of an embryonic egg burster (Southwood 1956; Cobben 1968).

Henry (1997) recognized Pentatomomorpha as monophyly, comprising 6 superfamilies (Aradoidea, Pentatomoidea, Idiostoloidea, Lygaeoidea, Coreoidea and Pyrrhocoroidea), rather than 4 (Schaefer 1964), 5 (Štys 1961; Schaefer 1993; Schuh & Slater 1995) or 7 (Schuh 1986) superfamilies. Among these superfamilies, only Aradoidea and Pentatomoidea are consistently recognized as monophyletic groups (Leston 1958; Wheeler *et al.* 1993; Henry 1997; Li *et al.* 2005; Xie *et al.* 2005; Hua *et al.* 2008).

The Trichophora (including the superfamilies of Pentatomomorpha except Aradoidea) has its morphological synapomorphies, e. g. the existence of abdominal trichobothria (Tullgren 1918; Schaefer 1975). The Eutrichophora (including the superfamilies of Trichophora except Pentatomoidea) has been raised based on molecular data (Xie *et al.* 2005) and has several morphological synapomorphies, e. g. the presence of an m-chromosome (Leston 1958), the typically 3 trichobothria on at least some of the sterna (Schaefer 1975), and the 3-lobed (or more) salivary glands (Southwood 1955).

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