



## Review, cladistic analysis and biogeography of *Nezara* Amyot & Serville (Hemiptera: Pentatomidae)

AUGUSTO FERRARI<sup>1</sup>, CRISTIANO FELDENS SCHWERTNER<sup>1,3</sup> & JOCELIA GRAZIA<sup>2</sup>

Laboratório de Entomologia Sistemática, Departamento de Zoologia, Programa de Pós-Graduação em Biologia Animal,  
Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves, 9500, Bloco IV, prédio 43435, 91501-970 Porto Alegre, RS, Brazil.  
E-mail: ferrariaugusto@gmail.com acrosternum@yahoo.com.br jocelia@ufrgs.br

<sup>1</sup>CAPES Fellowship

<sup>2</sup>CNPq Fellowship

<sup>3</sup>Current address: Departamento de Ciências Biológicas, Universidade Federal de São Paulo – Campus Diadema, Rua Prof. Artur Riedel, 275, 09972-270, Diadema, SP, Brazil

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## Abstract

In this paper, the genus *Nezara* Amyot & Serville is reviewed and a hypothesis of relationships among its species is proposed. Also, diagnoses for the genus and the 12 included species are provided. A key to separate the species is also provided. Of the seven other species assigned to *Nezara* in the literature, four of them are considered *incertae sedis*, two are transferred to different genera, and one is considered a junior synonym. The cladistic analysis include 15 taxa and 34 characters. The cladogram was rooted with *Carpocoris purpureipennis* (DeGeer); outgroup comparison also include species of the sister-groups *Aethemenes chloris* (Dallas), and *Pseudoacrosternum cachani* Day. The results showed *Nezara* as a monophyletic taxon. Biogeographical scenarios of the evolution of *Nezara* were discussed.

**Key words:** Nezarini, Pentatominae, key to species, synonymies, Afrotropical region, Oriental region

## Introduction

Among phytophagous green stink bugs, species of the genus *Nezara* Amyot & Serville are medium to large in size, and found mainly in the Afrotropical region (Freeman 1940; Linnavuori 1972, 1982). Only three species are distributed elsewhere: *N. viridula* (Linnaeus, 1758) (cosmopolitan); *N. antennata* Scott, 1874 (northern Oriental region and Japan), and *N. yunnana* Zheng, 1982 (northern Oriental region) (Freeman 1940; Zheng 1982; Rider 2006). As far as is known, species of *Nezara* are polyphagous, some of them related to crop damage (Panizzi *et al.* 2000). The southern green stink bug, *N. viridula*, is a serious pest of several important crops worldwide (McPherson & McPherson 2000; Panizzi *et al.* 2000), and is one of the most studied pentatomid species (i.e. DeWitt & Godfrey 1972; Todd 1989; Panizzi 1997).

Amyot & Serville (1843) proposed *Nezara* in the group 'Rhaphigastrides' to include *Cimex smaragdulus* Fabricius, 1775 (= *viridulus* Linnaeus) and *Pentatoma marginata* Palisot de Beauvois, 1817. Dallas (1851) considered *Nezara* as a subgenus of *Rhaphigaster* Laporte, 1833, which was followed by Stål (1858, 1860). Stål (1865) recognized *Nezara* as a valid genus, however its identity and composition were never well understood during the subsequent years (i.e. Mulsant & Rey 1866; Stål 1872, 1876; Lethierry & Severin 1893). Several species were described or included in the genus during that time, but most of them are currently recognized as synonyms or have been transferred to other genera (i.e. Bergroth 1914; Freeman 1940; Orian 1965; Day 1965). To account for the diversity in the genus, Kirkaldy (1909) recognized in his catalogue six subgenera in *Nezara*, all of which are now considered to be distinct genera (Bergroth 1914; Freeman 1940; Linnavuori 1972; Thomas & Yonke 1981; Rolston 1983; Grazia & Fortes 1995).

The taxonomic limits of *Nezara* as known today were established by Bergroth (1914). He followed Stål (1876) in considering *Acrosternum* Fieber as a valid genus, using the morphology of the ostiolar peritreme to distinguish it from *Nezara*. Therefore, following Bergroth (1914), *Nezara* contained the species placed by Stål (1876) in his division **a** of the genus. However, only the revision carried out by Freeman (1940) firmly established the limits of the genus; he recognized 11 species of *Nezara* and 21 varieties; nine of the varieties were described by him. More recently, Schwertner (2005) tested and corroborated the monophyly of *Nezara*, and proposed a hypothesis of relationship with other genera of the green stink bugs.

Most of the species of *Nezara* have chromatic polymorphism that were described by many authors (e.g. Linnaeus 1758; Fabricius 1803; Horváth 1889; Schouteden 1910; Leston 1953; Freeman 1940; Kiritani & Yukawa 1963), showing great inter- and intraspecific variability. In *Nezara viridula*, the relative frequency of the chromatic polymorphic forms is dependant on environment conditions, i.e. photoperiod and temperature (Kiritani & Sasaba 1969; Musolin & Numata 2003). Yukawa & Kiritani (1965) hypothesized that the polymorphic forms in a population of *N. viridula* are determined by the genetic composition followed by genetic drift and natural selection. The genetic basis of polymorphism in *N. viridula* was demonstrated recently (Ohno & Alam 1992). Although Poe & Wiens (2000) stated that analyses using polymorphic characters are consistently more accurate, we excluded polymorphic characters from our study for two reasons. First, the number of the polymorphic forms for all the species of *Nezara* was low in our sample. Second, based on the morphological characters used (i.e. genitalia of both sexes), we did not find any evidence to support the polymorphic forms as valid species or subspecies.