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A comparison of external and internal maxilla and mandible morphology of water bugs (Hemiptera: Heteroptera: Nepomorpha)

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Abstract

This paper describes the file of the mandible, the apices of the maxillae, the rupturing device on the maxillae, and the internal structures of the mouthparts in sixty representatives of the nepomorphan families (Heteroptera), using scanning electron microscopy. Eight morphologically distinct types of files are identified on the mandibular tip, as well as six distinct types of the maxillary endings, and three distinct types of rupturing devices of the maxillae. The features of the internal maxillary and mandibular structures share a common connection model, differing only by virtue of specific appendages in different subfamilies. The water bugs morphological ground plan is represented by a mandibular file identically serrated, asymmetrical apices of maxillae (left maxilla tapers with lobe + right maxilla tapers and straight), rupturing device evidently exposed ventrally and inner structures: the maxillae are extended dorso-laterally, forming a wide lobe; symmetrical processes connect with the mandibles. The main patterns (belostomatid and nepid) together with two more specialized patterns (gelastocorids, corixids, micronectids, and diaprepocorids) and (ochterid, aphelocheirid, naucorid, notonectid, pleid and helotrephid) are reported. Diversity of the elements (maxillae and mandibles) are analyzed from a phylogenetic signals and nutrition perspective. Finally, further lines of study are suggested for future work on the phylogeny of the group based on the studied characters.

Key words: Nepomorpha, shape of the distal part of the maxillae and mandibles, internal structures of the mouthparts, phylogenetic signal

Introduction

In general, insects belonging to the suborder Heteroptera are among the most diverse in the Insecta. Various members of this suborder are specialized for typical phytophagy, zoophagy, or hematophagy, and a large number of species from various families successfully combine phytophagous and zoophagous preferences, referred to as zoophytophagy (Alomar & Albajes 1996; Zeng & Cohen 2001). The trophic shift of Heteroptera to carnivores and the trophic switch to hematophages and phytophages in the course of heteropteran evolution have been analyzed by Cohen (1996). According to Schaefer (1997), heteropterans are primitively carnivorous because that is the way of life of all but two of the major heteropteran groups (infraorders). In fact, out of the eight heteropteran infraorders (including the Aradomorpha sensu Sweet), four are completely carnivorous (Enicocephalomorpha, Dipsocoromorpha, Gerromorpha, Leptopodomorpha), two are primarily carnivorous with only a few exceptional families Nepomorpha, except most corixids and micronectids; and Cimicomorpha, except of Triatominae, Tingidae and much of the Miridae; and also two are primarily herbivorous Pentatomomorpha, of except the Asopinae, Geocorinae and part of Berytidae and Aradomorpha.

Carnivory is nearly the rule in water bug families (Gerromorpha, Nepomorpha), but is less common among the terrestrial bugs (McGavin 1993). The predominately predatory water bugs (Nepomorpha) includes eight aquatic families (Nepidae, Belostomatidae, Naucoridae, Notonectidae, Aphelocheiridae, Pleidae, Helotrephidae and Potamocoridae) and two terrestrial families (Ochteridae, Gelastocoridae) (Cobben 1978). In the Nepomorpha, departures from zoophagy can be found in the many species of Corixidae (Corixinae) and Micrtonectidae, whose members prefer a varied diet (algivorous, detritophagous and omnivorus) (Sutton 1947, 1951; Wollmann 2000; Papáček 2001; Chen *et al.*, 2005). In turn, the species of Cymatiinae and Diaprepocoridae, and some species of

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