Proventriculus of three nemobiinae crickets (Orthoptera: Grylloidea: Trigonidiidae)

NEUCIR SZINWIELSKI, MORENO S. RODRIGUES, MARCELO RIBEIRO PEREIRA, JOSÉ EDUARDO SERRÃO, CARLOS FRANKL SPERBER

(NS, MS) Programa de Pós-Graduação em Biologia Animal, Departamento de Biologia Animal, (MRP) Programa de Pós-Graduação em Entomologia, Departamento de Biologia Animal, (JES) Departamento de Biologia Geral, (CFS) Laboratório de Orthopterologia, Departamento de Biologia Geral, Universidade Federal de Viçosa, 36570-000, Viçosa, MG, Brazil. Email: sperber@ufv.br

Abstract

The morphology of the proventriculus may supply useful taxonomic characters for some species of crickets. This study evaluated if the proventriculus can be used to distinguish three species of Nemobiinae crickets: Phoreuma sp. n., Zucchiella sp. n., and Amanayara sp. n. In crickets the proventriculus presents six lobes, each one bearing eight appendices along its longitudinal axis. In Phoreuma sp. n., the central portion of the first appendix has a tooth like a spear, with two denticles; the central portion of the second appendix presents one plate formed by five denticles, whereas in Zucchiella sp. n., the apex of the first appendix is U-shaped with denticles absent, and the second appendices differ from those of Phoreuma sp. n. by the number of denticles. In Amanayara sp. n., the central portion of the first and second appendices form a long and sharpened tooth, the denticles are lacking. In the other proventriculcular appendices there was variation in the number of denticles and in their shape. These results indicate that the morphology of the proventriculus can provide auxiliary characters for taxonomy of Nemobiinae, especially useful for this subfamily, since for many species the external morphology is insufficient for characterization of genera and species.

Key words

taxonomy, scanning electron microscopy, Phoreuma, Amanayara, Zucchiella, morphology, gut

Introduction

The proventriculus is an organ situated between the foregut and midgut, its lumen lined by cuticle with teeth-like projections. These, together with associated well-developed muscles, aid the food triturating process (Isely & Alexander 1949).


The discovery of morphological characters that allow discrimination of taxonomically cryptic groups, whose morphology is otherwise very similar, is particularly important. Nemobiine crickets are taxonomically cryptic. These crickets are in common in litter of tropical forests (Desutter-Grandcolas 1992, 1993; Ribas et al. 2004; Sperber 1999). However taxonomic determination is difficult, due to great similarity in external morphology and genitalia among related species or genera. The objective of the present study was to assess if proventriculus structure could provide characters to distinguish three sympatric species of Nemobiine crickets.

Materials and Methods

The proventriculus of two adult males each of Phoreuma sp. n., Zucchiella sp. n. and Amanayara sp. n. were analyzed by scanning electron microscopy (SEM). All individuals were collected in a remnant of Atlantic Forest in the region of Viçosa, Minas Gerais (lat 20°42'30"S, long 42°56'15"W) (see Sperber [1999]), and stored in 70% ethanol. Species descriptions are in preparation; voucher specimens were deposited at the Laboratório de Orthopterologia, affiliated with the Museu Regional de Entomologia da Universidade Federal de Viçosa (MUFV).

Individuals were dissected in ethanol and the proventriculus isolated from the gut. A longitudinal section in the proventriculus wall gave access to the proventriculus lumen surface and its lining cuticle. The samples were dehydrated in a graded ethanol series (70%, 80%, 90% and 100%), 5 min in each bath, they were then transferred to hexamethyldisilazane (HMDS) for 5 min, air dried (Nation 1983), fixed onto aluminum stubs, gold coated and observed with a LEO VP1430 scanning electron microscope.

Results

In all three cricket species analyzed, the proventriculus has six longitudinal lobes, each with eight transverse sclerotized appendices arranged in longitudinal series (Figs 1A, 2A, 3A). The appendices of each lobe become progressively less elaborate posteriorly. Each appendix presents projections that angle posteriorly, i.e., they point away from the mouth. The projections of each appendix are comprised of a median tooth (mt) (Figs 1B, C; 2B, C) and projections with lateral teeth (lt) to each side (Figs 1C, 2C, 3C).

Intimately associated with the median tooth are median denticles (md) (Figs 1C, 2C, 3C), which vary among the analyzed species in number, size and distribution, especially for the first two appendices, where the median teeth are more developed. The median tooth (mt) is absent from the final appendix of all species (Figs 1D, 2D, 3D, black arrow).

Each lateral tooth is comprised of two projections, the first more anterior and internal (i), larger than the second, external (e) (Figs 1C, 2C, 3C). Each lateral tooth presents a small rounded callosity, with the subsequent margin having two long apical lobes, also
rounded. Occasionally, the appendices show hair-like projections associated with the median tooth (Figs 1C, 2C, 3C; white arrow).

Although the proventriculus of the three species shows the same basic morphology, there is variation among species in the number and shape of the denticles, in median tooth morphology, in the size and location of both the hair-like projections and the lateral projections.

In Phoremia sp. n., the median tooth (mt) (Fig. 1C) of the first appendix is a spear-shaped structure with two small and globular denticles laterally; whereas the central portion of appendix II is a long and widened structure with five denticles, one median, long and rounded, and two lateral pairs, small and rounded (Fig. 1B).

In Zucchiella sp. n., although the median tooth (mt) of the first appendix is similar to that of Phoremia sp. n., its apex is U-shaped, with an absence of lateral denticles (Fig. 2B). The second appendix is more developed than in Phoremia sp. n., showing six rounded denticles: one central, four lateral and one on the median surface of the structure (Fig. 2B; Fig. 2A black circle). In Amanayara sp. n., the central portion of the first and second appendices comprises a long and sharpened tooth (mt) without denticles (Fig. 3B).

In all other species of the proventriculus, the central portion varies in number and location of denticles (md). Phoremia sp. n., has 3 to 5, Zucchiella sp. n., 3 to 6, and Amanayara sp. n., presents a maximum of four denticles (Figs 1A, 2A, 3A, 3C). None of the studied species bear teeth on the last appendix (Figs 1D, 2D, 3D, 4D, black arrow).

The lateral projections (lt) are present from the second to the seventh appendix in Phoremia sp. n., and Zucchiella sp. n., whereas in Amanayara sp. n., these projections are present in all appendages (Figs 1A, 2A, 3A). Phoremia sp. n., shows gradual reduction in the size of these lateral projections, but without morphological simplification (Fig. 3A). In Zucchiella sp. n., only the second appendix differs from the others, with a subtle division into two plates and with a long projection arising in the more internal plate (Fig. 2A).
In Phoremius sp. n., and Amanayara sp. n., the third and fourth appendages have a hair-like structure on the base of the median tooth (Figs 1C, 3C), but this structure was reduced in the fifth, sixth and seventh appendages, whereas in Zucchiella sp. n., the reduction occurs only on the third appendix (Fig. 2C).

Discussion

A direct relation of proventriculus morphology with diet is established for termites: these wood feeders show a proventriculus armed with stronger teeth and strongly sclerotized appendages, compared to noncellulose feeders, where the proventriculus is less sclerotized and presents reduced appendices (Gibbs 1967, Lebrun 1985, Lebrun & Lequet 1985, Caetano 1988, Bland & Rentz 1991). In Endecous (Grylloidea: Phalangopsidae) the presence of large teeth positioned at the median and lateral portions of the proventricular appendages, can provide these insects with an apparatus effective in the trituration of several food sources (Fontanetti et al. 2002).

The Nemobiinae species here analyzed have several morphological characters of the proventriculus that may be associated with omnivore feeding habits: i) long lateral denticles in the anterior appendages and small denticles on the posterior appendix, ii) robust and truncated median teeth, iii) rounded denticles on the lateral projections and iv) hair-like structures on the central portion of median teeth.

The proventriculus of crickets has been suggested as a powerful tool for taxonomic separation in Oecanthidae, Trigoniidiidae, Eneopteridae, Mogoplistidae and Gryllidae (Judd 1948), Gryllacrididae (Bland & Rentz 1991), Gryllidae (Fontanetti & Zefa 2000) and Phalangopsidae (Fontanetti et al. 2002). These studies detected morphological differences among families and subfamilies (Judd 1948, Bland & Rentz 1991), but small or no differences among
species of the same genus (Fontanetti & Zefa 2000, Fontanetti et al. 2002).

Our results show conspicuous differences in the proventriculus among the analyzed species, suggesting its taxonomic usefulness in these genera Phoremia sp. n. and Zuchiella sp. n. have the lowest number of distinct proventricular characters between them, while Amanayara sp. n. has the most discrepant proventriculus morphology. This coincides with external morphology of these species: Phoremia sp. n. and Zuchiella sp. n. are externally more similar than Amanayara sp. n. (Pereira 2008). Subsequent studies will need to evaluate if the differences among the species studied here are maintained among genera, or if there is intra-generic morphological variation.

We conclude that proventriculus morphology provides useful taxonomic characters to distinguish Nemobilineae species. Further studies will evaluate interspecific variation within genera, so as to establish which characters are genus-specific.

Acknowledgements

We thank Carina Marciela Mews, Micael Eiji Nagai and Cristiano Lopes-Andrade for suggestions and improvement of the photos; thanks to Silvia Rosa and Glenn Morris for valuable suggestions in the text; appreciation to Núcleo de Microscopia e Microanalise from UFV for access to scanning electron microscope facilities; we acknowledge Programa de Capacitação em Taxonomia – PROTAX (CNPq/CAPES/MCT), CNPq and FAPEMIG for financial support.

References


