



# Comparative morphology of the male abdomen in the minute litter bugs (Heteroptera: Dipsocoromorpha: Schizopteridae)



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## Introduction

Schizopteridae is the largest family of the infraorder Dipsocoromorpha and currently comprises around 50 genera and more than 200 species. The very small size (less than 2 mm) and cryptic habits of schizopterids are the main reasons why the family is so poorly studied. Such small insects also require specialized dissection and documentation techniques for morphological studies. The structure of the male genitalia thus was well studied only for several representatives of the family. The present comparative study focuses on male *genital* structures for 10 genera in the 3 subfamilies of Schizopteridae.

## Objectives

- Document male genitalic structures in representatives of all major generic groups of Schizopteridae
- Analyze variability and propose homology of male genitalic structures across Schizopteridae

### Color coding used for morphological features in illustrations

- Aedeagus
- Left paramere
- Right paramere
- Segment X and its processes
- Tergite VIII and its processes
- Other structures

## Material and Methods

Twelve representatives of Schizopteridae were studied: *Hypselosomatinae* – *Hypselosoma* Reuter, 1891, *Williamsocoris* Carpintero & Dellape, 2006. *Ogeriinae* – *Chinannus* Wygodzinsky, 1948, *Kokeshia* Miyamoto, 1960. *Schizopterinae* – *Nannocoris* Reuter, 1891, *Pinochius* Carayon, 1949, *Corixidea* group (*Corixidea* Reuter, 1891, *Hoplonannus* McAtee & Malloch, 1925, *Schizoptera* Fieber, 1860, *Ceratocomboides* McAtee & Malloch, 1925).

Compound microscopy images (Figs. 1C, 2B, 5C, 7B) were taken using a Zeiss Axioskop 2.

Confocal microscopy images (Figs. 1AB, 2AB, 3AB, 4A, 5AB, 6) were taken using Leica SP5 Inverted and Zeiss 510 confocal microscopes. Argon and He543 lasers were used, two detectors collected emission in 500-580 nm and 580-700 nm bandwidth.

The scanning electron micrograph (Fig. 7A) was taken using a XL30 FEG microscope.

## Results and Discussion

Table 1. Terminology for male genitalic structures in Schizopteridae

| Structure               | Favored term         | Synonyms found in the literature   |
|-------------------------|----------------------|--|
| Sternum VII             | Subgenital plate     | Zygoternum VII <sup>[1]</sup> , Ventricle VII <sup>[2]</sup>   |
| Segment IX              | Pygophore            | Genital capsule <sup>[2]</sup> , [4] <sup>[6]</sup> , [3]  |
| Left paramere           | Left paramere        | Left-hand paramere <sup>[4]</sup>  |
| Right paramere          | Right paramere       | Right-hand paramere <sup>[4]</sup>   |
| Male copulative organ   | Aedeagus             | Phallus <sup>[6]</sup>   |
| Distal part of aedeagus | Vesica               | Penis <sup>[2]</sup> , [4], Apical portion of phallus <sup>[6]</sup> , Processus gonopori <sup>[5]</sup> , [7] |
| Basal part of aedeagus  | Basal plate          | Phallobase <sup>[3]</sup> , Basal portion of phallus <sup>[6]</sup>  |
| Segment X               | Anal tube            | Anal conus <sup>[4]</sup> , Anal segment <sup>[2]</sup> , Proctiger <sup>[7]</sup> , [8]                       |
| Appendages of Seg. X    | Anophoric appendages | Paraproctal appendages <sup>[1]</sup>  |

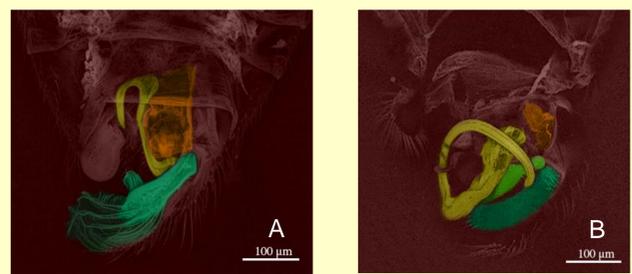


Figure 1. *Hypselosomatinae*. A. *Hypselosoma* sp., apex of abdomen. B. *Williamsocoris* sp., apex of abdomen. C. *Williamsocoris* sp., aedeagus.

*Hypselosoma* and *Williamsocoris* have an asymmetrical **pygophore** with apical process and large, club-shaped **right paramere**. The smaller **left paramere** in *Hypselosoma* is completely covered by the aedeagus and segment X. The **aedeagus** has a single well sclerotized process (indicated by arrow), which is considered to be a conjunctival spicule ([5], [9], [4]).

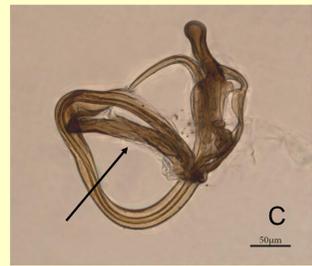


Figure 2. *Ogeriinae*. A. *Chinannus* sp., apex of abdomen. B. *Kokeshia* sp., abdomen.

The main feature of the male genitalia in *Chinannus* and *Kokeshia* is a large **sternite VII** (subgenital plate), which completely covers the **pygophore** ventrally (indicated by arrow). The **Tergite VIII** has a large process arising from the left side.

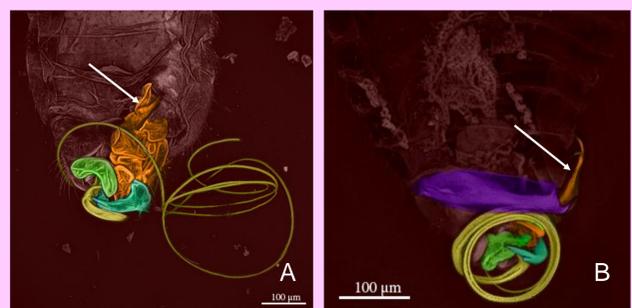


Figure 3. Apex of abdomen. A. *Nannocoris* sp. B. *Pinochius* sp.

Although *Nannocoris* and *Pinochius* were not considered to be closely related genera, recent phylogenetic reconstruction based on molecular characters [8] showed a sister-group relationship between these genera. They also demonstrate some similarities in male genitalic structures; e.g., the presence of large and well-sclerotized **anophoric appendages** (indicated by arrow); equal-sized **parameres**; and a tightly coiled **vesica** (2-3 loops in *Pinochius* and 6 loops in *Nannocoris*).

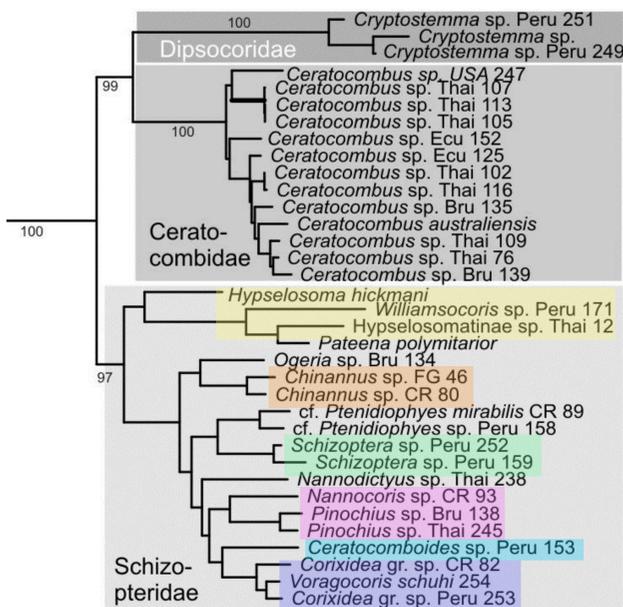


Figure 8. Phylogenetic reconstruction of Dipsocoromorpha based on 18S and 28S rDNA [8]. Color codes correspond to discussion sections. The tree is used to show diversity of structures across the phylogeny.

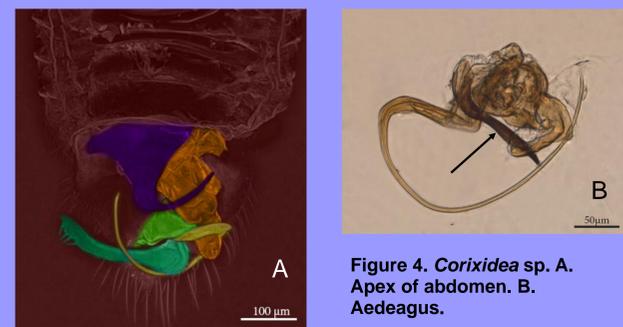


Figure 4. *Corixidea* sp. A. Apex of abdomen. B. Aedeagus.

The genus *Corixidea* differs from other closely related genera in the absence of **anophoric appendages** and the presence of a large spine-like process on **tergite VIII**. The **right paramere** is large and curved apically, the **left paramere** is triangular and small. The **aedeagus** of studied species contains a single conjunctival spicule (indicated by arrow); the **vesica** is short with one incomplete loop.

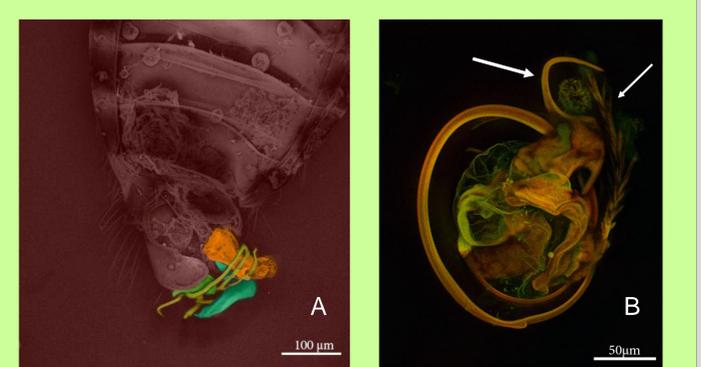


Figure 5. *Schizoptera* (Schizoptera) sp. A. Apex of abdomen; B and C. Aedeagus.

There are currently six recognized subgenera, three of which are studied within this project. The **subgenital plate** is usually well developed and ventrally covers the **pygophore**. The **parameres** are almost equal in size. The **aedeagus** bears two conjunctival spicules, a long serrated spicule and a short and thick spicule. The **vesica** is tightly coiled, with 3 loops.

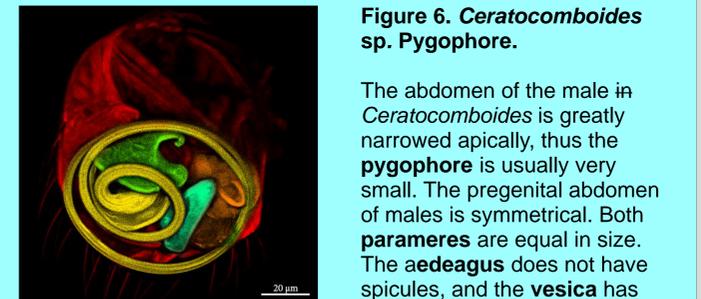


Figure 6. *Ceratocomboides* sp. Pygophore.

The abdomen of the male in *Ceratocomboides* is greatly narrowed apically, thus the **pygophore** is usually very small. The pregenital abdomen of males is symmetrical. Both **parameres** are equal in size. The **aedeagus** does not have spicules, and the **vesica** has two or three loops.



Figure 7. *Hoplonannus* sp. A. Pygophore. B. Aedeagus.

The main feature of the *Hoplonannus* male genitalia is a large and well sclerotized **anophoric appendage**, which in some species almost reaches the base of the abdomen. As in *Corixidea*, the **right paramere** is much bigger than the **left**. The **vesica** is short and barely makes one loop, and the conjunctival appendages are absent.

## Conclusions

Schizopteridae have polymorphic male genitalia that have great potential for phylogenetic studies across the family. The pregenital abdomen bears various processes, parameres may be almost symmetrical or one of them (either left or right) may be bigger than the other, and the aedeagus consists of basal plates, conjunctiva, and a vesica. The conjunctiva is often membranous, but sometimes bears sclerotized spicules and the vesica is coiled, with 1 to 6 loops. Confocal microscopy and scanning electron microscopy offer novel ways of exploring and documenting these features.

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