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An Account of the Genital Musculature of Pseudoscorpions (Arachnida)

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Introduction

The following paper includes a review of the literature and a general account of the pseudoscorpion genital musculature.

Schtshelkanovzeff (1910), Börner (1921) and Chamberlain (1931) have all described the appendicular musculature of pseudoscorpions. Garin (1937) superficially described the genital musculature of *Chelifer sculpturatus* (Lewis) when he examined this species. Vachon (1938 and 1949) was the first to produce a comprehensive account of pseudoscorpion genital musculature. He examined in detail the genital musculature of *Chernes cimicoides* (Fabricius), *Chelifer cancroides* (Linnaeus) and to a lesser extent that of *Neobisium muscorum* (Leach). Recently, Legg (1973) has described the genital musculature of *Chthonius ischnocheles* (Hermann) and *Cheiridium museorum* (Leach) (Legg, 1974a).

Schtschelkanovzeff (1910) claimed that smooth muscles are present in *Chelifer cancroides;* however, more recent studies (Vachon, 1938) have shown that all the genital muscles are striated.

Vachon (1938) suggested that the genital musculature was a modification of, and derived from, the appendicular musculature. He found that the musculature associated with the invaginated genital atrium and the two endosternites of the prosoma bore close similarities during the development of tritonymphs of *C. cancroides.* In the adult the muscles attached to the lateral apodemes of the genital atrium are similar in disposition to those attached to the two endosternites (fig. 1). He concluded that the lateral apodemes were in fact equivalent to, if not derived from, the endosternite of the second opisthosomal segment. This interpretation may be correct. He then proceeded to name the musculature of the genitalia and included among these were the sternocoxal and coxal muscles. The names of these particular muscles arise not from his original conclusions, but from a quite separate assumption that the genital opercula are formed from the fusion of the coxae of hypothetical appendages.

Materials and methods

Various specimens of species deployed by Legg (1974b, c) were also used for the present study. Representatives of five families found in Great Britain (Chthoniidae, Neobisiidae, Cheiridiidae, Chernetidae and Cheliferidae) were examined.

Observations were made of stained serial sections (see Legg, 1974b, c) of entire animals, and whole mounts cleared in benzene and examined in polarised light.

Genital musculature

The following general description of the genital musculature is based on that of Vachon (1938) with certain modifications to avoid controversial terminology. He recognised five groups of muscles associated with the genitalia: dorso-ventral or tergo-sternal (DV); longitudinal-ventral (LV); transverse (T); sterno-coxal (SC) and coxal (C). The last two sets of muscles, the unmodified appendicular sterno-coxal and coxal muscles, have been given the following alternative and descriptive designations: SA, between the sternite (*st*) and the lateral apodeme (*la*); ES, between the posterior endosternite (*pe*) and anterior genital operculum (*ago*) (a sternite); TS, between tergite (*t*) and sternite (*st*); SS, ventral inter-sternal muscles; G, between sternite (*st*) and genital atrium (*ga*) (forming the gonopodial muscles in females); and AC, between the lateral apodeme (*la*) and leg coxae (*cIV*).

In addition, Vachon included in his terminology the origins and insertions of the various muscles. His convention stipulates that the origin of any muscle is generally posterior, its insertion anterior. It is regretted that in Vachon's (1938) original paper he did not adhere strictly to this convention. Corrections are noted in the following text. Thus the terminology of (2-VI)AC indicates that this muscle originates on the lateral apodeme of the second (2) opisthosomal segment and inserts on coxa IV (segment VI); muscle (3-2)SA originates from sternite three of the

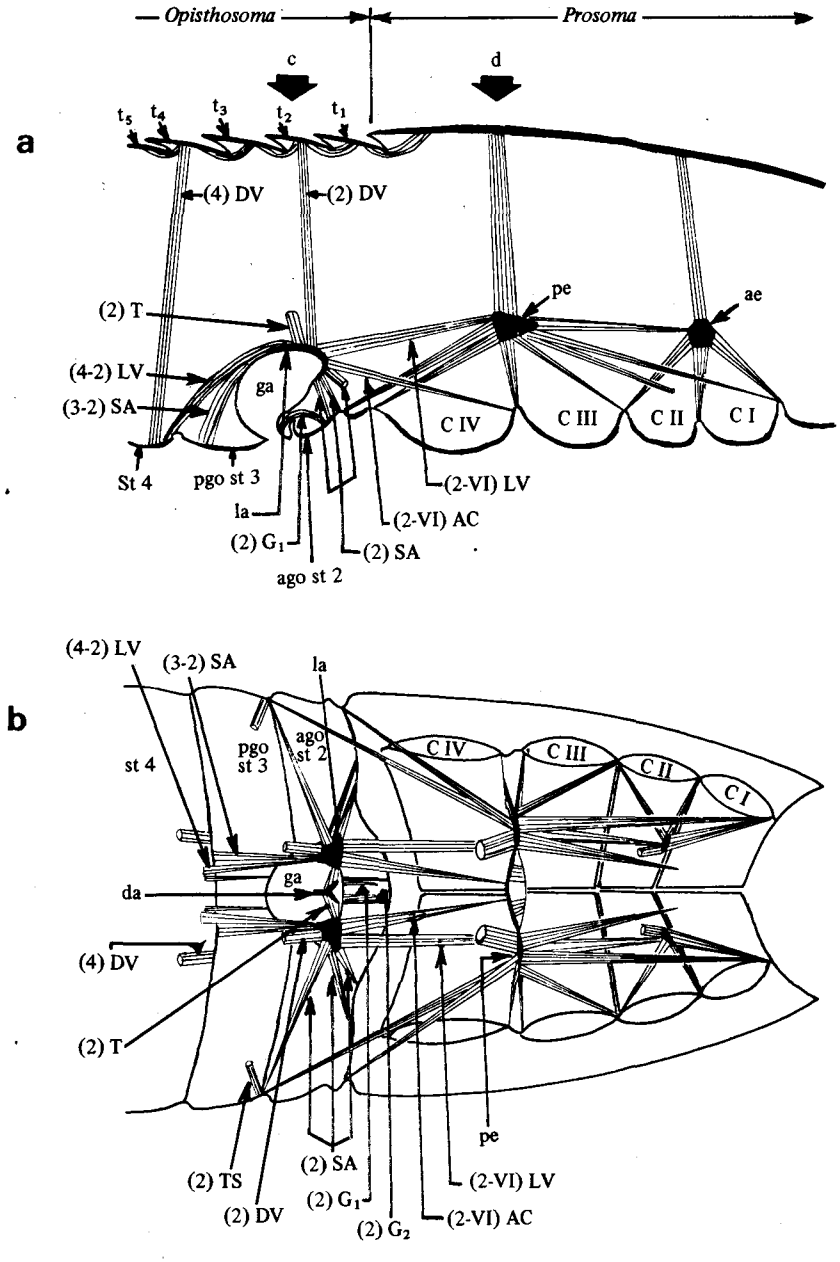

Figure 1. Generalised views of the genital musculature of pseudoscorpions and its relationship with the musculature of the prosoma (based on Vachon, 1949).

(a) Lateral view of the musculature associated with the prosoma and genitalia;

(b) Dorsal view of the musculature associated with the prosoma and genitalia. (anterior endosternite, *ae;* anterior genital operculum, *ago;* coxae of legs one to four, *cI – CIV;* dorsal apodeme, *da;* genital atrium *ga;* lateral apodeme, *la;* posterior endosternite, *pe;* posterior genital operculum, *pgo;* tergites one to five, *t1 – t5;* sternites one to four, *st1 – st4;* other abbreviations (muscles) see text)

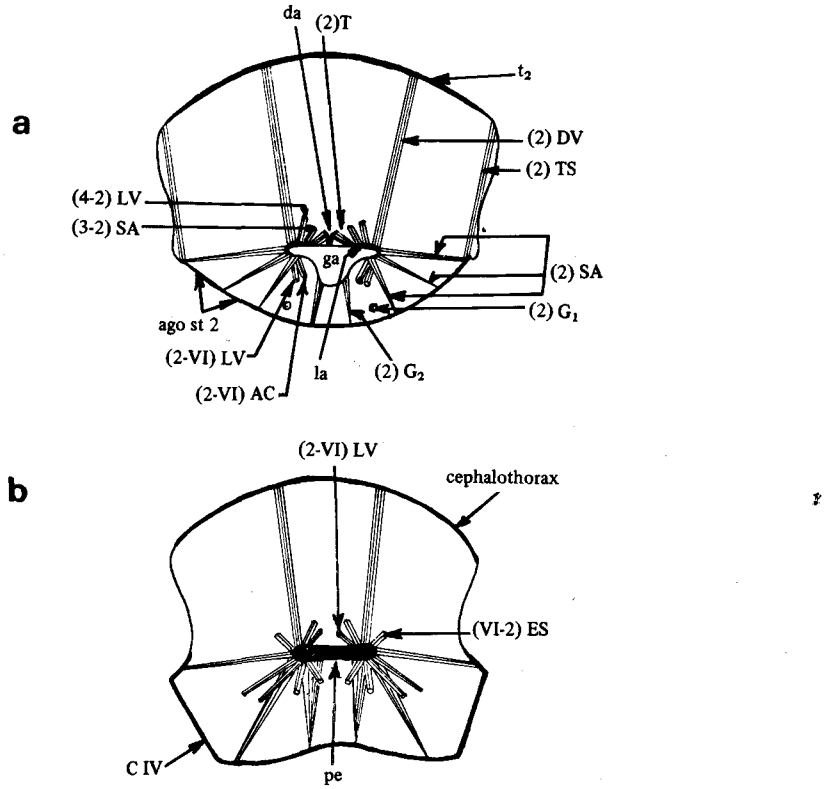

Figure 2. Generalised views of the genital musculature of pseudoscorpions and its relationship with the musculature of the prosoma (based on Vachon, 1949).

(a) Transverse section through the genital region of the opisthosoma showing the associated musculature;

(b) Transverse section through the prosoma in the region of the posterior endosternite showing the associated musculature. (abbreviations see fig. 1 and text).

opisthosoma and inserts on the lateral apodeme in the second segment, and muscle (2-VI)LV is a longitudinal muscle which originates from the lateral apodeme of the second opisthosomal segment and inserts on the endosternite near segment VI of the prosoma.

Twelve muscles are associated with the genitalia. Seven of these are associated with the genital apodemes and five are appendicular (Vachon, 1938). They are as follows (figs. 1 and 2):

1. *Apodeme muscles*

(a) A pair of segmental dorso-ventral muscles (2)DV, between the lateral apodeme and tergite 2.

(b) Longitudinal-ventral muscles: (4-2LV, (=(2-4)LV, Vachon) between the lateral apodeme and sternite four, and (2-VI)LV, (=(VI-2)LV, Vachon) between the lateral apodeme and the posterior endosternite of the cephalothorax.

(c) Appendicular muscles: (2-VI)AC, (=(VI-2)CS, Vachon) between the lateral apodeme and the coxa of leg four. This muscle lies close to (2-VI)LV; (2)SA, (=(2)SC, Vachon) between the lateral apodeme and anterior genital operculum; (3-2)SA, (=(2-3)SC, Vachon) between the lateral apodeme and posterior genital operculum.

(d) One transverse muscle (2)T between the lateral and dorsal apodemes of the genitalia. Part of this muscle is often modified to form the dilator

musculature of the ejaculatory canal (*Mejc*).

2. ***Appendicular muscles***

(a) (VI-2)ES, (=(VI-2)CS, Vachon) between the posterior endosternite of the cephalothorax and the anterior genital operculum.

(b) (4-3)SS, (=(3-4)SC, Vachon) between sternite four and the posterior genital operculum (sternite 3). This muscle is often divided into two regions: internal and external, which are together posteriorly while separating anteriorly.

(c) (2)TS, (=(2)TC, Vachon) a modified dorso-ventral muscle attached between the edge of tergite 2 and the outer edge of the anterior genital operculum.

(d) $(2)G_1$, $(=(2)C_1$, Vachon) between the anterior genital operculum and medial diverticulum of the genital atrium.

(e) $(2)G_2$, $(=(2)C_2$, Vachon) the retractor muscle of the gonopodium, attached to the anterior genital operculum and the gonopodium.

Review

This general plan is subject to modifications according to sex and family. Females tend to show a simplified condition, with the apparent loss of some of the muscles described above such as (2)SA, (2-VI)AC, (2-IV)LV and (3-2)SA. In some cases certain muscles have modified their points of attachment or split, giving rise to additional pairs of muscles (eg. (2)T).

Vachon (1938), Weygoldt (1966) and Makioka (1970) believe that the gonopodia are exerted by haemocoelic pressure and retracted by their associated musculature ($2G_2$). More recently Legg (1973) has shown that it is likely that the action of the genital musculature is antagonistic to the haemocoelic pressure and also to the natural elasticity of the cuticle. Directly antagonistic sets of muscles are not obvious; however, indirectly antagonistic muscles, operating through haemocoelic pressure changes are present. For example the action of the dorso-ventral muscles (2)DV, (4)DV would effectively reduce the volume of the haemocoel by pulling the tergites and sternites together, and thus increasing the haemocoelic pressure. An increase in haemocoelic pressure could have a variety of effects on the invaginated genital atrium, such as the eversion of parts of it (Legg, 1973). The natural elasticity of the cuticle together with the action of specific muscles directly associated with the genital atrium (eg. (2)SA) would act in an antagonistic manner against the haemocoelic pressure (indirectly, the dorso-ventral muscles) and retract any everted region of the genital atrium.

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References

BÖRNER, C., 1921: Die Gliedmassen der Arthropoden, in Lang. *Handb.Morph.wirbellosen Tiere,* **4-5**: 649-694

CHAMBERLIN, J. C., 1931: The arachnid order Chelonethida. *Stanford Univ.Publs.(Biol).,* **7**: 1-284

GARIN, H., 1937: Ueber der Bienen Skorpion *Chelifer sculpturatus.ArchBienenk.,* **1**: 33-48

LEGG, G., 1973: Spermatophore formation in the pseudoscorpion *Chthonius ischnocheles* (Chthoniidae). *J.Zool.,Lond.,* **170**: 367-394

LEGG, G., 1974a: The genitalia and associated glands of the pseudoscorpion *Cheiridium museorum* (Cheiridiidae). *J.Zool.,Lond.* **173**: 323-339

LEGG, G., 1974b: A generalised account of the male genitalia and associated glands of pseudoscorpions (Arachnida). *Bull.Brit.Arachnol.Soc.* (in press)

LEGG, G., 1974c: A generalised account of the female genitalia and associated glands of pseudoscorpions (Arachnida). *Bull.Brit.Arachnol.Soc.* **3**: 42-48

MAKIOKA, T., 1970: A temporary gonopodium in a pseudoscorpion *Garypus japonicus. Sci.Rep.Tokyo Kyoika Daigaka B.,* **14**: 113-120

SCHTSCHELKANOVZEFF, J. P., 1910: Der Bau der männlichen Geschlechtosrgane von *Chelifer* und *Chernes.* Zur Kenntnis der Stellung der Chelonethi im System. *Fest.Sech.Geb.R.Hertwig,* **2**: 1-32

VACHON, M., 1938: Recherches anatomiques et biologiques sur la réproduction et le développement des pseudoscorpions. *Annls Sci.nat.(Zool).,* (11) **1**: 1-207

VACHON, M., 1949: Ordre des Pseudoscorpions, in *Traité de Zoologie,* P-P Grasse (ed), **6**: 437-481

WEYGOLDT, P., 1966: Vergleichende Untersuchungen zur Fortpflanzungsbiologie der Pseudoskorpione Beobachtungen ueber der Verhalten, die Samenübertragungsweisen und die Spermatophoren einiger inheimischer Arten. *Z.Morph.Ökol.Tiere,* **56**: 39-92