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## The gonosacs ('gonopods') of female pseudoscorpions (Arachnida, Chelonethi)

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par  
Mark L.I. Judson

**Summary:** The form and systematic distribution of the gonosacs ('gonopodes' Vachon) of the female genitalia of pseudoscorpions are reviewed. The new term 'gonosacs' is proposed for these organs in order to avoid confusion with the male gonopods of other arthropods. Gonosacs are present in all pseudoscorpion groups except the Chthonioidea. The form of the everted gonosacs is described and compared with that in the retracted state.

### 1. INTRODUCTION

Although authors such as VACHON (1938) and LEGG (1971) have added greatly to our knowledge of the functional anatomy of the genitalia of pseudoscorpions, some aspects are still problematic. One source of confusion is the 'gonopodes' of female Chelonethi. These eversible sacs were first described by VACHON (1938) who gives an excellent description of their role in the formation of the brood-sac in the cheliferid *Chelifer cancroides* (Linneus). He also recorded the presence of gonopodes in members of the Neobisiidae, and Chernetidae.

VACHON (1938) adopted the name '*gonopodes*' in accordance with his theory that the genital operculum (anterior genital sternite) is derived from fused opisthosomal appendages. This hypothesis, which is at best highly speculative, has been rejected by WEYGOLDT (1969) and LEGG (1974a). LEGG, however, continued to use the name gonopodium "on the grounds that it is an adequately descriptive term". A more important objection to its use is the possibility of confusion with the male gonopods of diplopods, spiders, ricinulei and mites. The name 'gonosacs' is therefore proposed here for the eversible sacs of female pseudoscorpions.

MAKIOKA (1970) described 'a temporary gonopodium' (actually paired gonosacs) in *Garypus japonicus* Beier (Garypidae). According to MAKIOKA, the gonosacs were only formed a few days prior to ovoposition, by extension and folding of the epithelium of the "anterior wall of [the] median chamber of the oviduct". They were rapidly retracted 10-11 days after ovoposition, after which the gonosacs slowly degenerated and finally disappeared. It is not clear from MAKIOKA's description that the gonosacs are cuticular and persist as internal, folded sacs when not extended. Only the tissues associated with functional gonosacs (muscles and vacuoles) are ephemeral.

Gonosacs have never been identified in illustrations of whole mounts of female genitalia, such as are used in taxonomic descriptions. This has often led to their being confused with spermathecae. The purpose of this note is to illustrate the gross morphology of the gonosacs in both their extended (functional) and retracted (non-functional) states.

## 2. METHODS

MAKIOKA (1970) found that ethanol-fixation of females with extended gonosacs resulted in the retraction of the gonosacs into the genital atrium. However, females preserved in alcohol are occasionally found with the gonosacs still protruding from the genital opening. The sacs are usually collapsed and could be mistaken for a brood sac without eggs. They can be returned to what is probably their natural state by clearing the specimen in lactic acid. If necessary, the turgidity of the sacs can be enhanced by transferring the cleared specimen to a weaker dilution of lactic acid.

## 3. MORPHOLOGY AND SYSTEMATIC DISTRIBUTION OF GONOSACS

### 3.1 Superfamily Chthonioidea

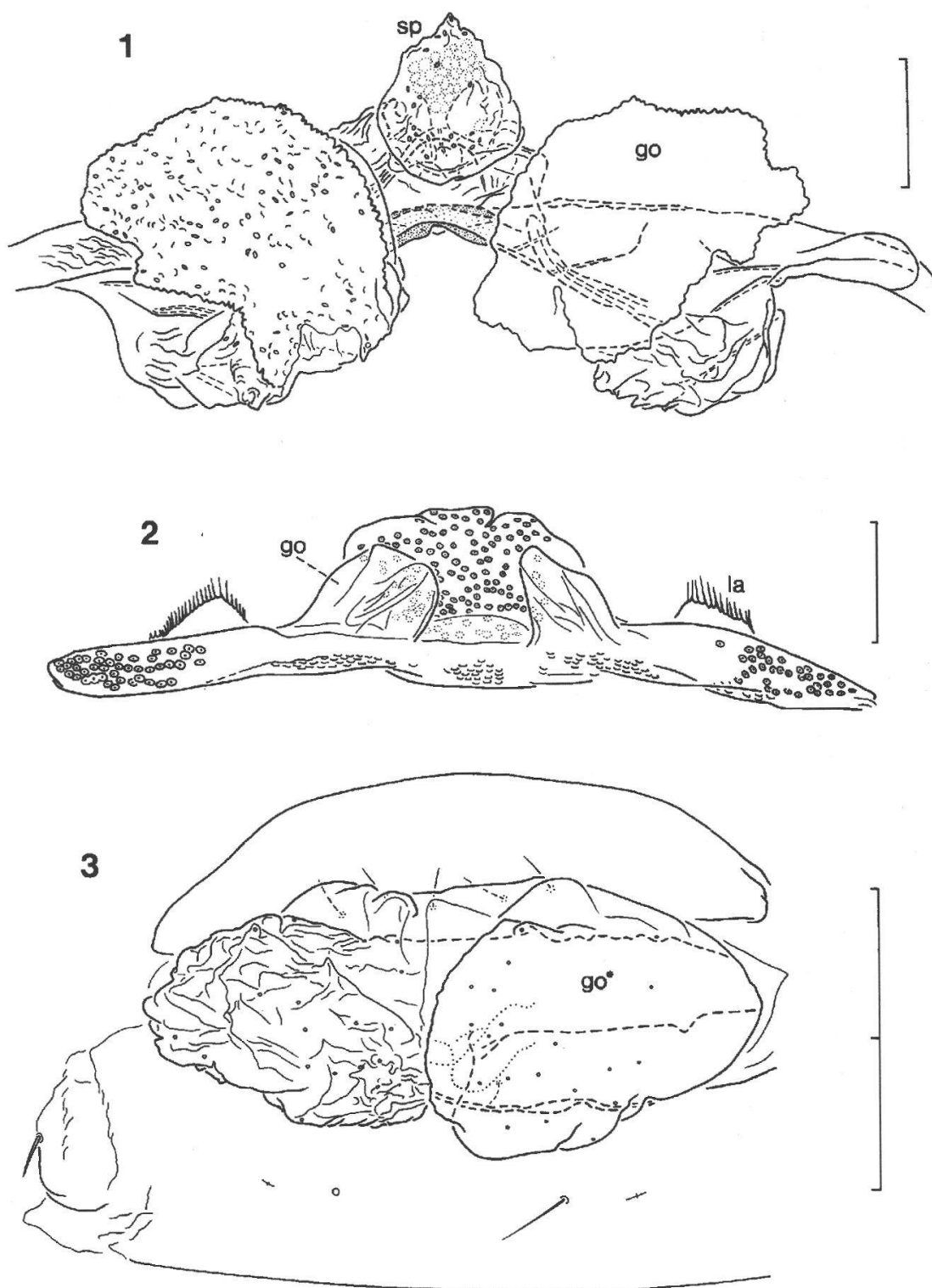
The Chthonioidea are the only pseudoscorpions without gonosacs. The lack of gonosacs in the Chthoniidae is probably correlated with the absence of a typical brood-sac (WEYGOLDT 1968). However, the Tridenchthoniidae, which seem also to lack gonosacs, are reported to form a normal brood-sac (WEYGOLDT 1968). Obviously, detailed observations of brood-sac formation in the Tridenchthoniidae would be of interest.

### 3.2 Superfamily Feaelloidea

The gonosacs of fealloids are large, paired and covered by numerous gland-pores (e.g. figure 1). Those of the Feallidae have been confused with spermathecae by HEURTAULT-ROSSI & JEZEQUEL (1965).

### 3.3 Superfamily Neobisioidea

The gonosacs of neobisioids are usually small, and often bear isolated pores on their surface. They have been described and figured as spermathecae (or seminal recep-

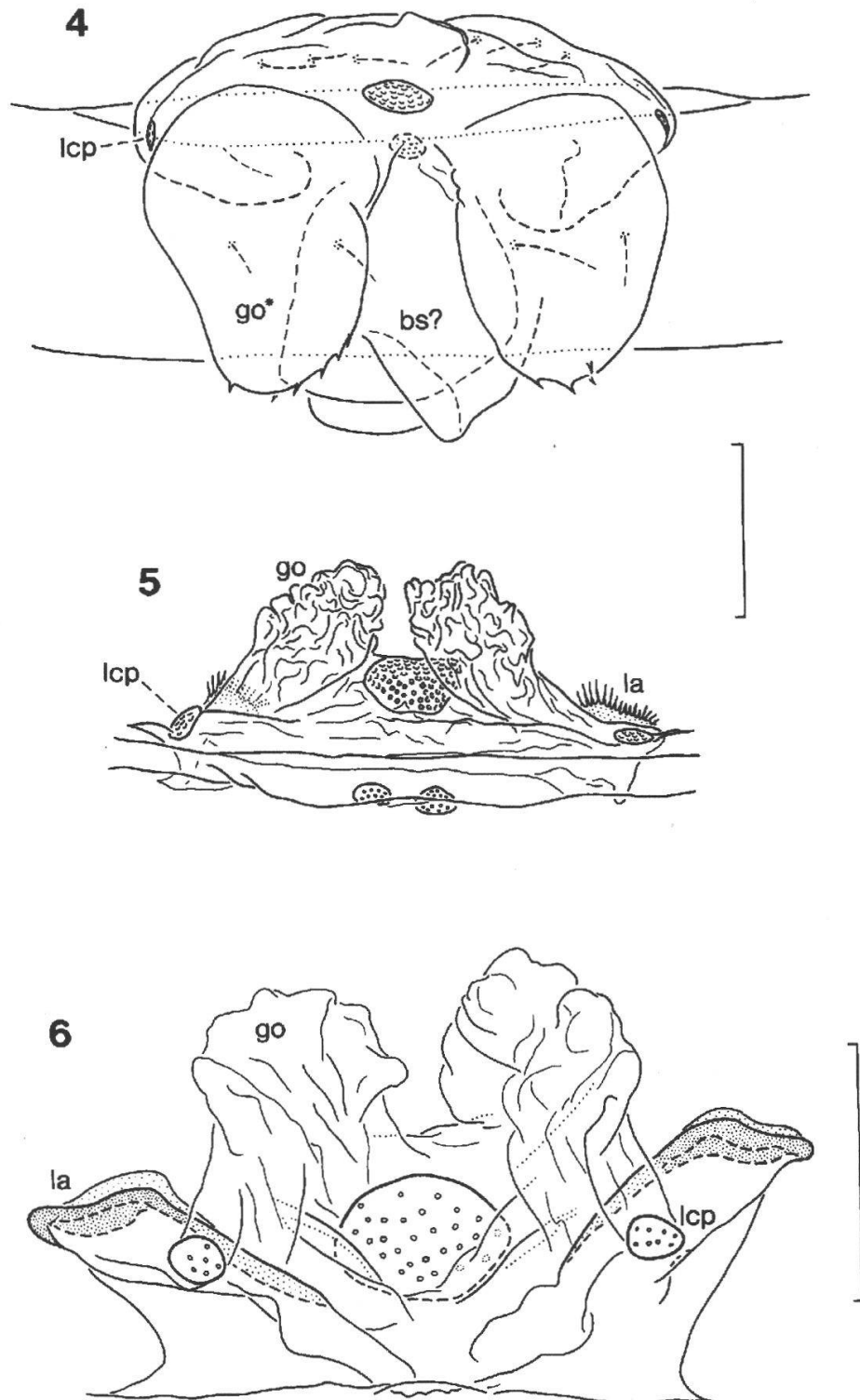


**Fig. 1** - *Pseudogarypus banksi*, ventral view of internal genitalia of female.

**Fig. 2** - *Neobisium carcinoides*, ventral view of internal genitalia of female.

**Fig. 3** - *Negroroncus* sp. (Zimbabwe), ventral view of female genital area, with gonosacs everted.

Abbreviations: **go** gonosac, **la** lateral apodeme, **sp** spermatheca. Scale line = 0.2mm (both figs. to same scale).



**Fig. 4-5** - *Calocheiridius* sp., 3. ventral view of female genital area, with gonosacs everted, 4. ventral view of internal genitalia, with gonosacs retracted. Scale line = 0.1mm.  
**Fig. 6** - *Cryptocheiridium* sp., ventral view of female genitalia. Scale line = 0.05mm.  
Abbreviations: **bs?** possible rudiment of brood sac, **go** gonosac, **la** lateral apodeme, **lcp** lateral cribriform plate.

tacles) in species of the families Hyidae (CHAMBERLIN 1946), Vachoniidae (CHAMBERLIN 1947, DUMITRESCO & ORGHIDAN 1977) and Bochicidae (MUCHMORE 1984). They are also present in the families Neobisiidae (e.g. figure 2), Gymnobisiidae and Syarinidae (pers. obs.). The gonosacs of the Ideoroncidae are relatively large and bear scattered pores on their surface (e.g. figure 3).

### 3.4 Superfamily Garypoidea

Gonosacs are present in the Garypidae (MAKIOKA 1968, 1970), Geogarypidae and Olpiidae (pers. obs.). They do not bear any pores on their surface.

The extended gonosacs of a gravid female of *Calocheiridius* sp. (Olpiidae) from Cameroon are shown in figure 4. They are confluent with the cuticle of the genital atrium, which is itself partly everted. Small, sharp spines are present on the posterior face of the gonosacs. The lateral cribriform plates, which secrete the brood sac (VACHON 1938), lie near the base of the sacs. Between them is a third, folded, slightly thicker 'sac' which may be a partially-formed brood sac. By comparison, the strongly folded form of the retracted gonosacs can be seen in figure 5. The spines on the surface of the gonosacs are not visible when the sacs are retracted.

### 3.5 Superfamily Cheiridioidea

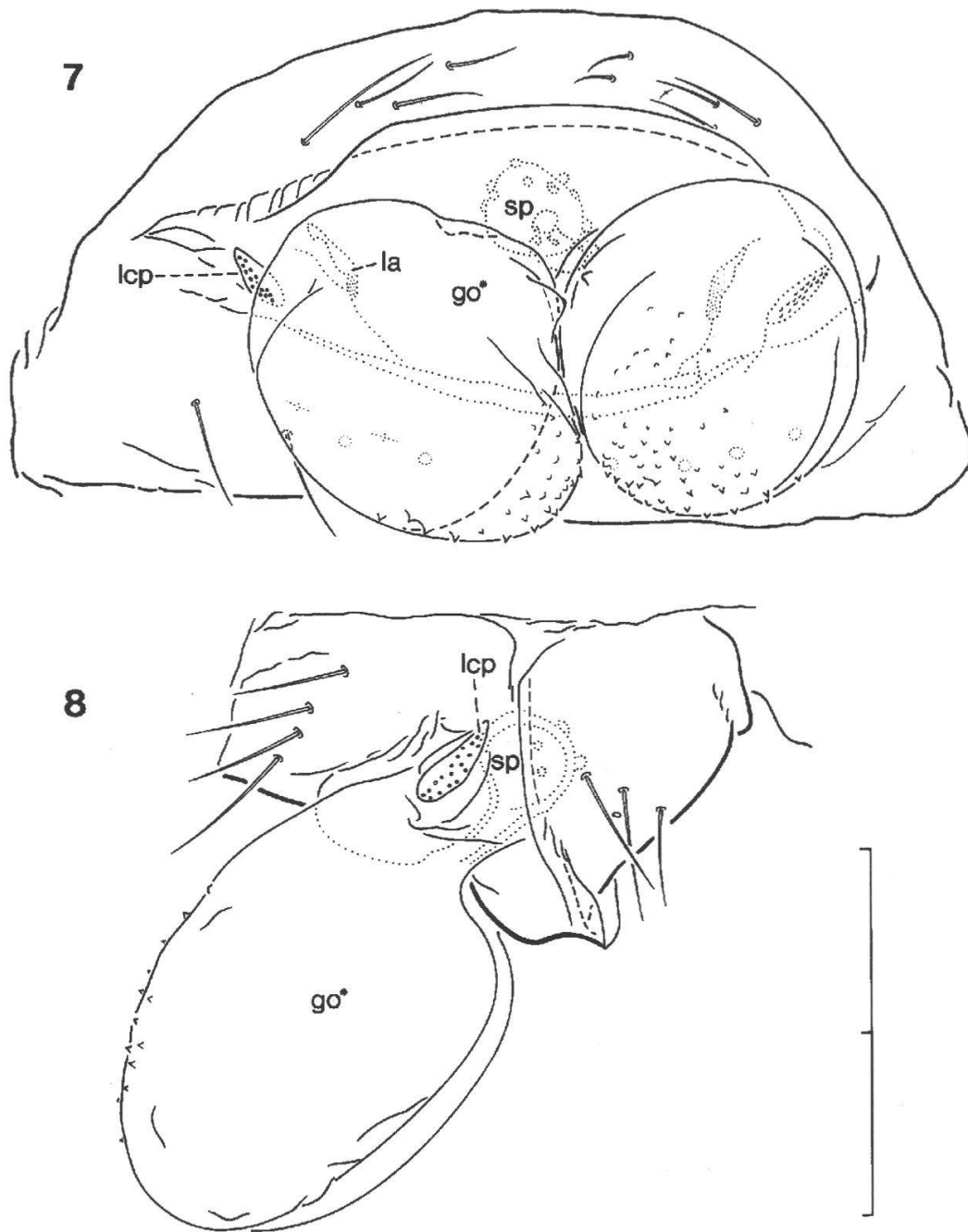
CHAMBERLIN (1931), LEGG (1974b), BENEDICT (1978) and DUMITRESCO & ORGHIDAN (1981) have all confused the gonosacs of Cheiridiidae with spermathecae or 'spermathecal pockets'. The gonosacs of the Cheiridiidae (e.g. figure 6), Pycnocheiridiinae and Pseudochiridiidae all lack glandular pores.

### 3.6 Superfamily Cheliferoidea

The gonosacs of Cheliferidae, Withiidae and Atemnidae the gonosacs are large and strongly folded; those of the Chernetidae appear to be rather smaller. WEYGOLDT (1966, 1969) illustrated the everted gonosacs of the chernetid *Pselaphochernes scorpoides* (Hermann), which he called 'erectile bodies' (Schwellkörpern).

Figures of retracted chernetid gonosacs are provided by DUMITRESCO & ORGHIDAN (1977), though they are not labelled as such. The gonosacs of cheliferids of the tribe Dactylocheliferini have sometimes been mistaken for spermathecae (e.g. CHAMBERLIN 1949). The spermathecae illustrated by MUCHMORE (1973) in *Mexichelifer reddelli* Muchmore might also be gonosacs. JUDSON (1990), aware of the possible confusion between spermathecae and gonosacs, referred to the gonosacs of *Ellingsenius fulleri* (Hewitt & Godfrey) as 'membraneous sacs'.

The everted gonosacs of a *Micratemnus*(?) sp. (Atemnidae) from Cameroon (Chuboh, Bamenda Highlands) are shown in figures 7-8. These bear small spines on their posterior surface, similar to those of *Calocheiridius*. The spermatheca remains internal, opening between the bases of the gonosacs.



**Fig. 7-8 - *Micratemnus(?)* sp.**(Cameroon), 5, ventral and 6, lateral (anterior at right) views of female genital area with gonosacs everted.

Abbreviations: **ago** anterior genital sternite, **go** gonosac, **la** lateral apodeme, **lcp** lateral cribriform plate, **mcp** median cribriform plate, **pgo** posterior genital sternite, **r** folded ridge of anterior genital operculum, **sp** spermatheca.



#### 4. DISCUSSION

Retracted gonosacs can be distinguished from spermathecae by their thinner, highly-folded cuticle and by having broad openings into the genital atrium. Identification of the the gonosacs as a constant feature of the female genitalia removes much of the confusion concerning the systematic distribution of spermathecae in Chelonethi. Gonosacs are present in all pseudoscorpions with the exception of the Chthonioidea. Because Feaelloidea (the sister-group of the Chthonioidea) possess gonosacs, we can assume that their absence in the Chthonioidea is due to secondary loss. Similar 'gonopods' are present in the females of Amblypygi (WEYGOLDT et al. 1972) and there is the intriguing possibility that these might be homologous with the gonosacs of pseudoscorpions.

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