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Comparative histology of the testes in *Scutigera* and *Anopsobius* (Chilopoda)

Abstract: The male genital system in representatives of the order Scutigeromorpha (*Scutigera coleoptrata* and *Thereuonema tuberculata*) is characterised by the presence of two genital tracts. Each one of these tracts is composed of a distal vesicle – the macrotestis and of a proximal deferent canal named the microtestis because it is the site of microspermatogenesis.The male genital system in the representatives of the subfamily Anopsobiinae (Fam. Henicopidae, Ord. Lithobiomorpha) is also characterised by the presence of two genital tracts. One of these tracts is rudimentary, nonfunctional. The other genital tract consists of a macrotestis and a microtestis. The presence of a genital system constituted of macrotestis and microtestis,on both sides of the phylogenetic abyss that separates subclasses Notostigmophora and Pleurostigmophora, represents a character of exceptional phylogenetic importance. An interpretation of the rudimentary gonad in the male genital sysem of the subfamily Anopsobiinae as a case of gynandromorphism, is rejected.

Key words: *Scutigera*, *Anopsobius*, macrotestis, microtestis, macrospermatogenesis, microspermatogenesis, rudimentary testis

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INTRODUCTION

After the description in *Scutigera coleoptrata* L. of double spermatogenesis with the localisation of the macrospermatogenesis in the macrotestis and of the microspermatogenesis in the microtestis (BOUIN 1934), FAHLANDER (1938) also described in *Thereuonema tuberculata* the existence of two male genital tracts, each one being composed of a macrotestis which is continued with a microtestis. The peculiarities of the male genital system in the order Scutigeromorpha subclass

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Notostigmophora, have been the subject of numerous studies (PRUNESCU 1969, 1992b, CAMATINI *et al.* 1977, MAZZINI *et al.* 1992, PRUNESCU *et al.* 1995).

In a paper about the presence of a rudimentary embryonic gonad in the male genital system of *Anopsobius neozelandicus* SILVESTRI (Fam. Henicopidae, Ord. Lithobiomorpha). PRUNESCU & JOHNS (1969) also recorded the existence in the same individuals of the symmetric gonad, composed of normally developed macrotestis and microtestis.

The objective of this work is a comparative study of the histology of the testes of *Scutigera coleoptrata* and *Anopsobius neozelandicus*, the establishment of the plesiomorphic status of these testicular tracts, and a discussion about the significance of this character for the phylogenetic interpretation of the two subclasses of Chilopoda.

MATERIAL AND METHODS

Male individuals of *Scutigera coleoptrata* collected in Dobrogea (Romania) and in Sicily (Italy) were fixed in Bouin fluid or in 70% ethyl alcohol.

Male individuals of *Anopsobius neozelandicus* collected in New Zealand (Kaituna Valley) were fixed in 70% ethyl alcohol.

After routine histological techniques, this material was embedded in paraffin and transversely sectioned. The histological sections were stained in Hemalum–Eosin (H–E).

RESULTS

The testes in *Scutigera coleoptrata*

The male genital system consists of two testes. Each testis begins with a dilated, somewhat long testicular vesicle – macrotestis, which is continuous caudally with a long narrow coiled tube named a microtestis.

The lumens of the two macrotestes are occupied by groups of large spermatocytes of 50–70 μm, spermatids (Figs 1 & 2) and fascicles of spermatids in course of macrospermiogenesis.

Every group of germinal cells in the process of the spermatogenesis is situated in a cavity well delimited by thin foliated walls. These structures are formed by the cytoplasmic flat processes of the epithelial cells of the gonad wall.

The structure of the gonad wall continues in the microtestis portion of the gonads. The flat epithelial cells present foliated processes which separate the lodges where microspermatogenesis occurs (Fig. 3).

Unlike the macrotestes, in the microtestes the microspermatogenesis is localized in the marginal zones of the gonads but the lumina are occupied by the fascicles of the macrospermatozoa in transit from the macrotestes to the complex system of the seminal vesicles. The marginal zones of the microtestis present small evaginations in which an active microspermatogenesis develops (Fig. 3).

Fig. 1 *Scutigera coleoptrata*. Detail of the two macrotestes (*M*). H–E, 36x.

Fig. 2. *Scutigera coleoptrata*. Macrotestis (*M*) with macrospermatocytes. H–E, 36x.

Fig. 3. *Scutigera coleoptrata*. Microtestis (*m*). The peripheral zone of the microtestis is filled with microspermatocytes. In the lumen are present spermatozoa. H–E, 180x.

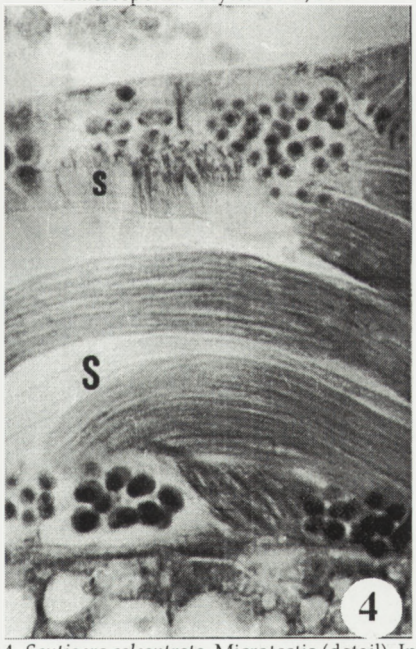

Fig. 4. *Scutigera coleoptrata*. Microtestis (detail). In the peripheral cavities are groups of microspermatocytes, microspermatids and microspermatozoa (*s*). In the centre: fascicles of macrospermatozoa (*S*). H–E, 450x.

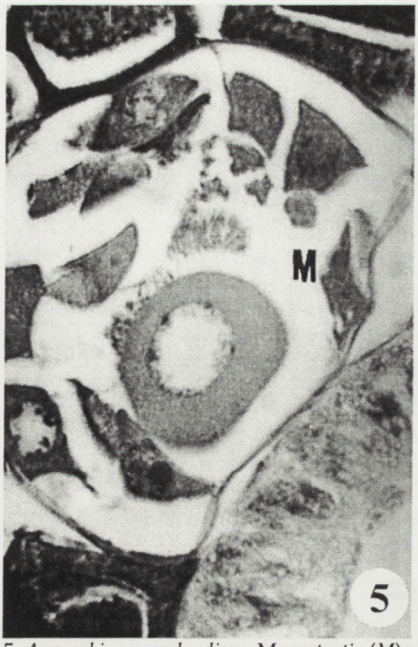

Fig. 5. *Anopsobius neozelandicus*. Macrotestis (*M*) with macrospermatocytes. H–E, 450x.

Fig. 6. *Anopsobius neozelandicus*. Macrotestis (*M*) near coiled microtestis (*m*). H–E, 450x.

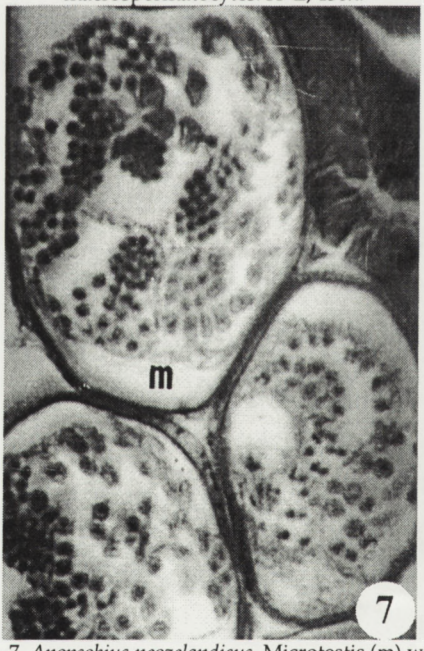

Fig. 7. *Anopsobius neozelandicus*. Microtestis (m) with microspermatocytes and microspermatids. H–E, 120x.

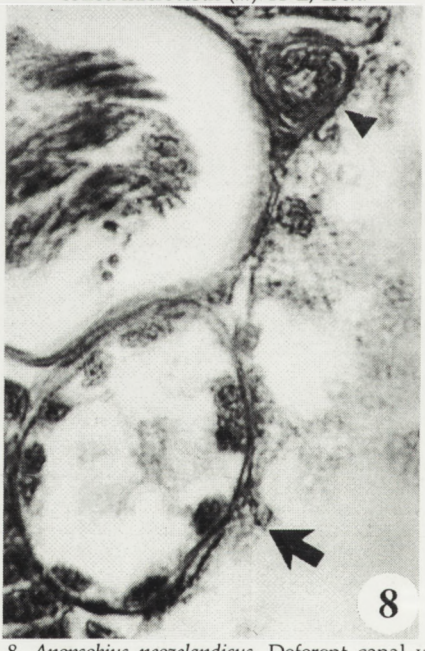

Fig. 8. *Anopsobius neozelandicus*. Deferent canal with virtual lumen of the embryonic gonad (arrow) near the caudal zone of the microtestis and the deferent canal of the functional gonad (arrowhead). H–E, 120x.

Along the two microtestes numerous germinal cells in different stages of microspermatogenesis are present. On the same histological section are frequent concomitant images of the stages of microspermatogenesis and microspermiogenesis (Fig. 4). Microspermatozoa organized in fascicles are thinner than macrospermatozoa.

The testes in *Anopsobius neozelandicus*

The male genital system consists of two gonads. One of the gonads is well differentiated into macrotestis and microtestis and is functional. The other gonad is undifferentiated.

The macrotestis is a dilated tube closed at the anterior extremity. It is continuous caudally with the microtestis – a narrow, long and coiled tube with a diameter about 3–4 times smaller than the macrotestis. The macrotestis is populated by large spermatocytes of 50–70 μm, spermatids and spermatozoa (Figs 5 & 6). The microtestis is populated with microspermatocytes, microspermatids and numerous fascicles of spermatozoa (Fig. 7).

The paired gonad is a rudimentary organ, tubular in form with few gametogonia. This organ is prolonged into a deferent canal (Fig. 8). This canal joins the deferent canal with muscular walls of the functional gonad, and finally forms a unique, very short canal, which opens in the common region of the two seminal vesicles.

DISCUSSION

The testes morphology in *Scutigera coleoptrata* and *Anopsobius neozelandicus* reveals the existence in representatives of the two subclasses of Chilopoda of two male genital tracts, of macrotestes and microtestes, of macrospermatogenesis and microspermatogenesis.

Phylogenetically, these similarities show the plesiomorphic character of this testicular type which can be assigned to the common ancestor of Scutigeromorpha and Lithobiomorpha.

The testicular type of the subfamily Anopsobiinae demonstrates the close relationship between the order Scutigeromorpha and Lithobiomorpha, diminishing the great distance created by the organization of the respiratory system, which divides Chilopoda in the subclasses Notostigmophora and Pleurostigmophora. In this context, the originality of the respiratory system in Notostigmophora (PRUNESCU & PRUNESCU 1993, 1996, HILKEN 1996, 1998) may be attributed to the morphological adaptations to the life in the open air (PRUNESCU 1996).

Chilopods as elongate organisms, present a female genital system consisting of a single ovary which results from the union of the two primordial gonads during larval development (HEYMONS 1901, BIEGEL 1922, ZERBIB 1966).

We suppose that the invariable formula of the unique ovary in Chilopoda is a functional solution bound to the great size of the ovocytes in relation to the long and relative thin trunk of these arthropods.

By virtue of an obligatory procedure during larval development of Chilopoda, the two primordial ovaries unite into a single one. Similarly, the primordia of the paired

testes fuse into a single testis in the family Lithobiidae (BIEGEL 1922, ZERBIB 1966) and probably in the subfamily Henicopinae, in which the adults possess a single testis (PRUNESCU *et al.* 1996).

In the subfamily Anopsobiinae, which have a narrow trunk, one observes a functional gonad with macrotestis and microtestis and a rudimentary embryonic gonad (PRUNESCU & JOHNS 1969, PRUNESCU 1992a). This organization type of the testis apparatus, distinguishes the subfamily Anopsobiinae both within the order Lithobiomorpha and the family Henicopidae.

The suppressed development of the one of the testis in the subfamily Anopsobiinae seems to represent a solution to the problem of the space which is insufficient for the development of two macro and microtestes in small animals with the width of the trunk of about 1 mm.

In the subfamily Henicopinae and in the family Lithobiidae, the relatively thin trunk permitted the function of a single, long, flagelliform testis resulting from the fusion of two larval primordial testes.

The coexistence of a larval male gonad with an adult testis in *Anopsobius neozelandicus* (PRUNESCU & JOHNS 1969) and in *Dichelobius* (PRUNESCU 1970) were considered by LEWIS (1981) as cases of gynandromorphism. In fact, the male genital system in *A. neozelandicus* and in *Dichelobius* (PRUNESCU 1970, 1992a) represent a complete male genital tract of the *Scutigera* type and an immature male genital tract. The histological structure of the gonads described here and the presence of the two male seminal vesicles in the subfamily Anopsobiinae (PRUNESCU 1992a) confirms the male character of this genital system. These data are inconsistent with the idea of gynandromorphism.

The present work reinforces the fact that this undifferentiated gonad is characteristic for two genera of the subfamily Anopsobiinae and does not represent an individual exception.

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