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NOTES ON THE FEMALE REPRODUCTIVE SYSTEM OF *XIPHIDORUS* MONTEIRO, 1976 (NEMATODA: LONGIDORIDAE)

by
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Summary. The morphology of the female reproductive system has been studied in six species of *Xiphidorus* Monteiro, 1976. The didelphic-amphidelphic reproductive tract has equally developed branches, each consisting of a reflexed ovary, oviduct, *pars dilatata oviductus*, sphincter muscle, uterus, ovejector, vagina and vulva. Although the reproductive organ is quite similar in *X. achalae* Luc *et* Doucet, 1984, *X. amazonensis* Uesugi, Huang *et* Cares, 1985, *X. balcarceanus* Chaves *et* Coomans, 1984, *X. minor* Rashid, Coomans *et* Sharma, 1986, *X. saladillensis* Chaves *et* Coomans, 1984 and *X. tucumanensis* Chaves *et* Coomans, 1984, some interspecific differences are evident in the length of the uterus and oviduct, and the shape and size of the ovejector and spermatheca. Spiniform structures are present in the proximal part of the uterus of *X. achalae*, *X. amazonensis* and *X. balcarceanus* and appear to be attached in a uterine network. Spines seem to be absent from the uteri of *X. minor*, *X. saladillensis* and *X. tucumanensis*, but this needs further confirmation. Objects resembling crystalline structures are conspicuous in the uterine lumen of *X. tucumanensis*. Spermatozoa are present in the female gonoducts of *X. tucumanensis* and *X. amazonensis*, but not in any of the other *Xiphidorus* species included in this study.

The genus *Xiphidorus* Monteiro, 1976 was erected to accommodate a newly discovered longidorid, *X. yepesara*, with several characteristics intermediate between *Xiphinema* Cobb, 1913 and *Longidorus* (Micoletzky, 1922) Thorne *et* Swanger, 1936 (see Chaves and Coomans, 1984). Seven additional species have subsequently been described viz. *X. parthenus* Monteiro, Lordello *et* Nakasono, 1981, *X. balcarceanus* Chaves *et* Coomans, 1984, *X. saladillensis* Chaves *et* Coomans, 1984, *X. tucumanensis* Chaves *et* Coomans, 1984, *X. achalae* Luc *et* Doucet, 1984, *X. amazonensis* Uesugi, Huang *et* Cares, 1985 and *X. minor* Rashid, Coomans *et* Sharma, 1986. The known distribution of the genus is restricted to South America (Table I). Sperm cells were observed in the uteri and *pars dilatata oviductus* (i.e. spermatheca) of most amphimictic species, but males are rare and even absent in some cases (Table I) (Luc and Doucet, 1984).

Although the female reproductive system has been described in all known species of *Xiphidorus*, the descriptions are somewhat sparse and in three cases without illustrations. Luc and Doucet (1984) made several observations on the systematics of the genus and concluded *inter alia* that no Z-differentiation or spines are present in the uterus of the type species, *X. yepesara*. However, in the same article they described a new species viz. *X. achalae*, with several small refringent spines in the proximal portion of the uterus. A study of paratype material from Pampa de Achala, Argentina confirmed this observation (Kruger, 1988), and suggested that the spines are probably attached in a uterine network, similar to that in *Xiphinema coomansi* Kruger *et* Heyns, 1986.

TABLE I - *Some characteristics and distribution of the species of* Xiphidorus.

Species	Uterine spines	Males	Sperm in female repr. syst.	Type locality
X. achalae	yes	no	no	Argentina
X. amazonensis	yes[a]	yes	yes	Brazil
X. balcarceanus	yes[a]	rare	no	Argentina
X. minor	no (?)	no	no	Brazil
X. saladillensis	no (?)	yes	no[b]	Argentina
X. tucumanensis	no[c]	yes	yes	Argentina
*X. parthenus**	no	no	no	Brazil
*X. yepesara**	no[d]	yes	yes[d]	Brazil

[a] see this article.
[b] sperm not referred to in text, nor depicted in illustration (Chaves and Coomans, 1984).
[c] crystalline structures in uterus (see text).
[d] spines/sperm not referred to in text (Monteiro, 1979), but see Luc and Doucet, 1984?
* paratypes not available for this study and according to the literature, no uterine spines in *X. parthenus*.

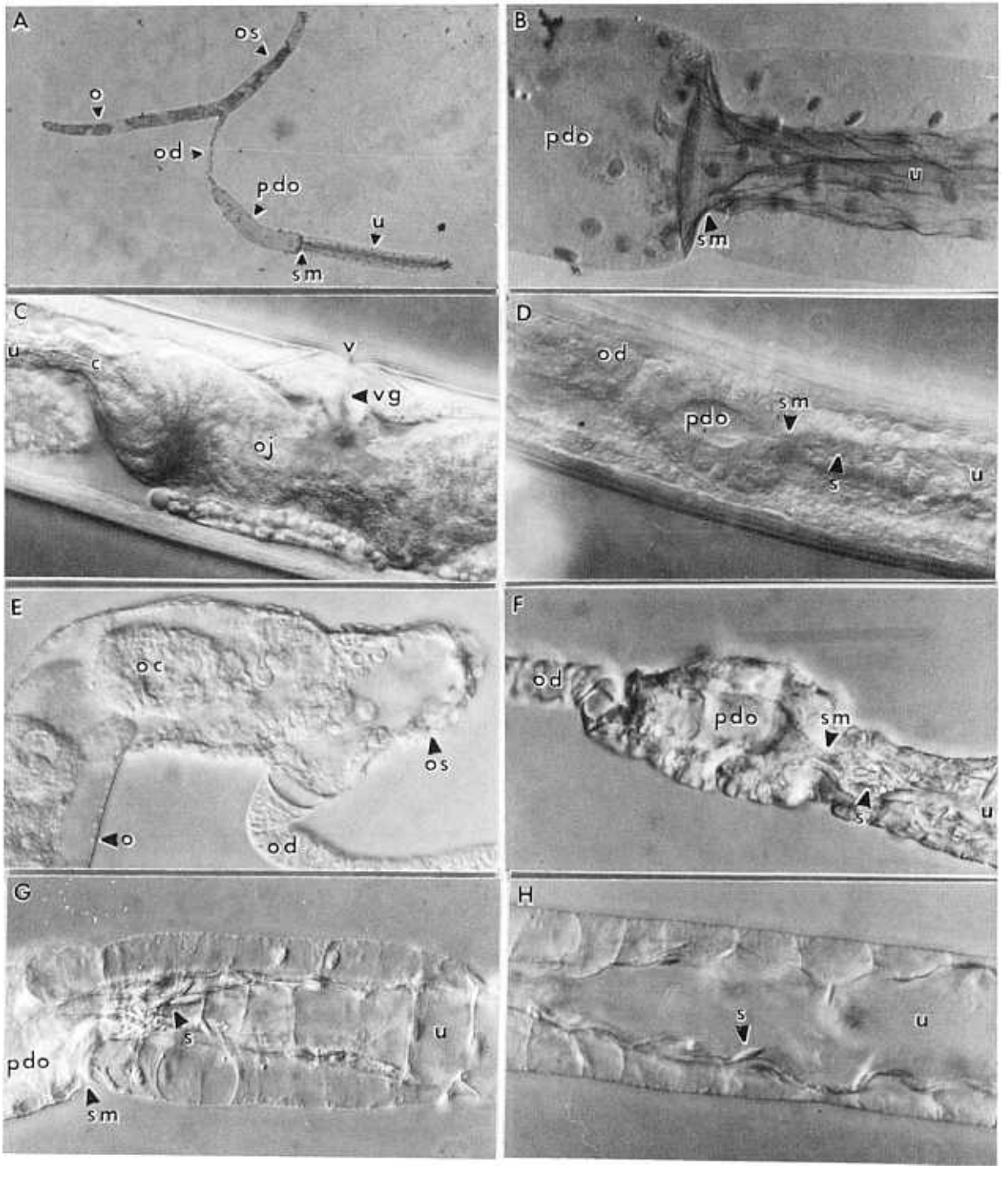

Fig. 1 — Differential interference contrast photomicrographs of the female reproductive tract of *Xiphidorus balcarceanus*: A-B, reprod. tract dissected and stained with orcein-propionic acid; C-D, reprod. tract *in situ* in fresh specimens; E-H, reprod. tract freshly dissected out in a 0,9% saline solution [Photomicrographic magnification 25mm = 120μm (A); 30mm = 40μm (B-H)]. [constriction (c), ovary (o), oocyte (oc), oviduct (od), ovejector (oj), ovarial sac (os), *pars dilatata oviductus* (pdo), spines (s), sphincter muscle (sm), uterus (u), vulva (v) and vagina (vg)].

During November 1987 one of us (J. H.) collected a soil sample from Balcarce, Argentina which yielded several specimens of *Xiphidorus balcarceanus* (see Heyns and Chaves, 1988). A preliminary light microscopy study of the freshly dissected female genital tract of this species disclosed the presence of several small uterine structures resembling spines. These spiniform structures had apparently been overlooked at the time of the original description. This led us to suspect that the same may have happened with other species of *Xiphidorus*, as has in fact occurred in a few species of *Xiphinema*, apparently due to the poor condition of relatively old specimens used for descriptions (Stocker and Kruger, 1988; Kruger, 1988). This prompted us to undertake a more detailed study of the female reproductive system of *Xiphidorus* to establish whether any of the other species also possess uterine spines, to determine whether these spines are similar to those found in several species of *Xiphinema* and to make available more details of the general morphology of the female reproductive system of *Xiphidorus*.

Materials and methods

The light microscopy study included relatively old *in toto* mounted paratypes of *Xiphidorus amazonensis*, *X. minor* (also the holotype), *X. saladillensis* and *X. tucumanensis*, and paratype material and recently fixed and *in toto* mounted topotypes as well as freshly dissected female reproductive organs of *X. balcarceanus*. Although the uterus of *X. achalae* has been studied before (Kruger, 1988), an *in toto* mounted paratype of this species was again re-examined. Specimens of *X. parthenus* and *X. yepesara* were not available for the study and the reproductive systems of these two species were not illustrated in the original description.

For the *in vitro* study of the female reproductive system of *X. balcarceanus*, specimens were extracted from soil and the genital tract dissected in physiological saline and examined on temporary mounts as described by Kruger (1988).

Results and discussion

The morphology of the female reproductive system is quite similar in the six *Xiphidorus* species studied. However, considerable interspecific differences are evident, particularly in the length of the uterus and oviduct, the shape and size of the ovejector, and to a lesser extent the spermatheca (Table II). Uterine spines may be present or absent (Table I).

The didelphic-amphidelphic female organ has equally developed branches entirely enveloped by a thin membrane. Each branch is composed of a reflexed ovary, oviduct, *pars dilatata oviductus*, sphincter muscle, uterus, ovejector, vagina and vulva (Fig. 1 A,C).

The reflexed, telogonic ovaries of the *Xiphidorus* species studied differ considerably in length and contain, usually in a linear fashion, several progressively ripening germ cells (Fig. 1E). The terminal sac-like ovarial or blind sac is more distinct in dissected material (Fig. 1A, E).

The oviduct of *Xiphidorus* is a clearly demarcated region and consists of a single row of cells. In the dissected tract (Fig. 1E), individual oviduct cells appear quite similar to those in the genus *Xiphinema* i.e. disc-shaped and uninucleated (Kruger and Heyns, 1989). The orientation of the oviduct cells in a single row corresponds with that found for the Dorylaimida in general (Geraert, 1983). The terminal cell of the oviduct enlarges into a *pars dilatata oviductus* (Fig. 1D, F), which apparently functions as a spermatheca (in the absence of a uterine pouch such as the *pars dilatata uteri* in *Xiphinema*) in the amphimictic species of *Xiphidorus*. The oblong sperm cells observed in the oviduct pouch of *X. tucumanensis* (Fig. 2D) and *X. amazonensis* (Fig. 2E) are similar to those seen in the testes of males of these species (Fig. 2G and 2H respectively). The oviduct varies in length from about 50 µm in *X. minor* to about 160 µm in *X. achalae* (Table II), and also displays some interspecific variation in width.

A distinct sphincter muscle (Fig. 1A, B) separates the oviduct from the relatively short, stout cylindrical uterus, which varies interspecifically in length from about 60 µm to 145 µm (Table II). Measurements cited in Table II for

TABLE II - *Morphometrics of the anterior female genital branch in six species of* Xiphidorus.

Species (µm)	Ovejector[a]	Uterus[a]	Vulva to sphincter	*Pars dilatata ovidoctus*	Oviduct	Total genital branch (excl. the ovary)
X. achalae	– (168)[b]	– (104)	– (188)	– (43)	– (160)	– (391)
X. amazonensis	178 (171)?	126 (162)?	216 (248)	55 (43)?	89 (?)	360 (?)
X. balcarceanus[c]	95 (151)	115 (100)	163 (176)	43 (45)	129 (93)	335 (314)
X. minor[c]	25 (47)	30 (?)	40 (24)?	? (38)	50 (45)	? (107)
X. saladillensis	50 (67)	66 (60)	91 (94)	36 (40)	– (83)	– (217)
X. tucumanensis	63 (–)	145 (–)	177 (–)	53 (–)	151 (–)	381 (–)

[a] only approximate measurements, except for *X. balcarceanus* *X. amazonensis* and *X. minor* (see text)
[b] measurements obtained from original illustrations, in brackets ( ).
[c] posterior branch illustrated in original description.

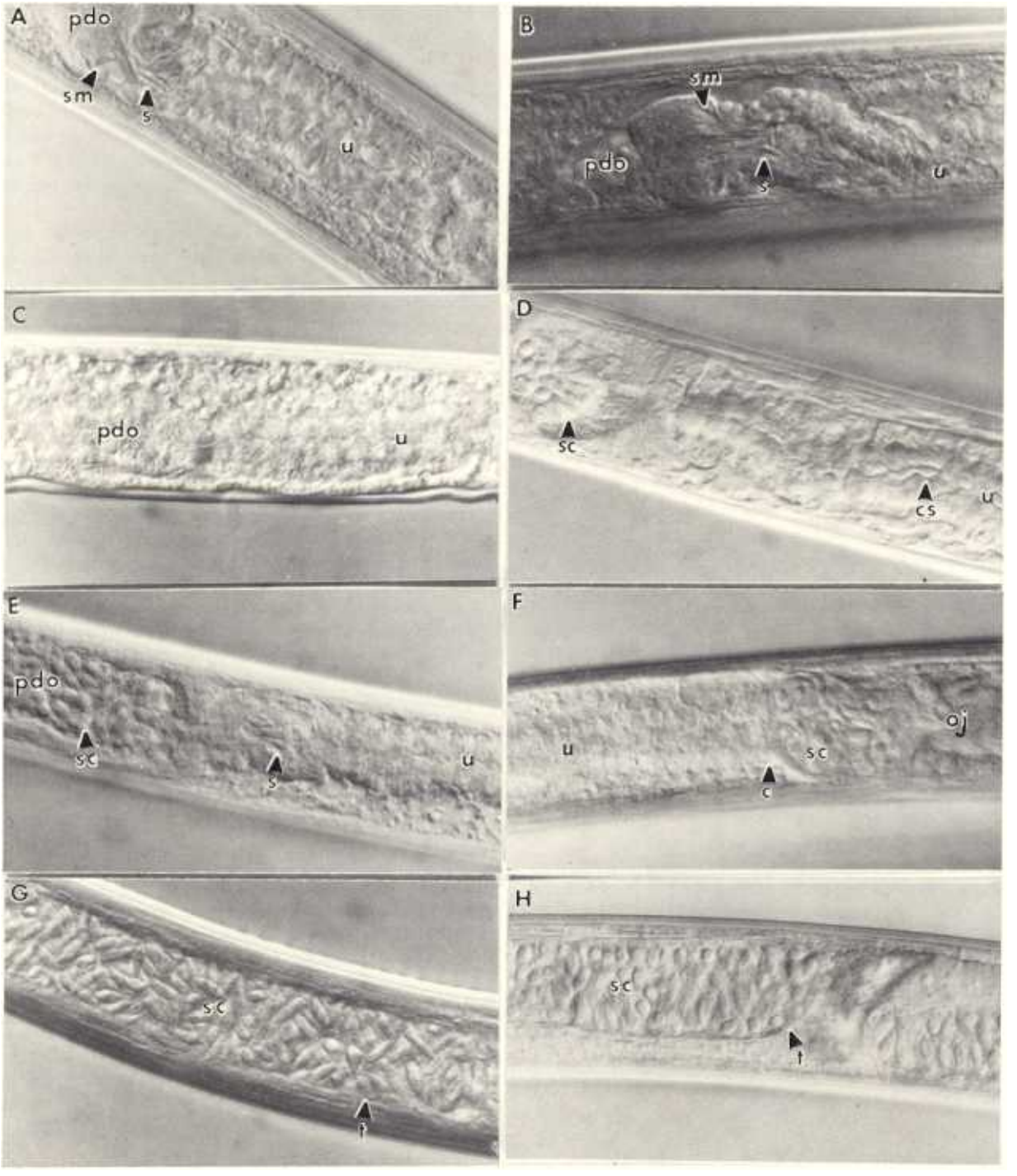

Fig. 2 — Differential interference contrast photomicrographs of the *in situ* female reproductive tract of specimens on relatively old slides: A-B, *Xiphidorus achalae*; C, *X. saladillensis*; D, *X. tucumanensis*; E-F, *X. amazonensis*; G-H, oblong spermatozoa in the testes of *X. tucumanensis* (G) and *X. amazonensis* (H). [Photomicrographic magnification 30mm = 40μm (A-H)]. [constriction (c), crystalline structures (cs), ovejector (oj), *pars dilatata oviductus* (pdo), spines (s), sperm cells (sc), sphincter muscle (sm), testis (t), uterus (u)].

the uterus (and the ovejector) should however be considered as approximate only, due to the fact that a clear boundary between the uterus and the ovejector are present in only half of the species studied (see later). This could possibly explain the descriptions (and illustrations) of the uteri in two species (Chaves and Coomans, 1984) as consisting of a narrow proximal and wider distal portion leading to the vagina, the wider portion thus actually constituting part of the ovejector (see Figs 1F and 3B in Chaves and Coomans, 1984). As previously mentioned, there is no *pars dilatata uteri* and apparently no Z-differentiation in the uterus of this genus (Fig. 1D, F).

Several objects resembling uterine spines are present in all the fresh specimens of *X. balcarceanus* studied. These structures are usually more conspicuous in the dissected reproductive tract (Fig. 1F-H) than in the recently fixed and mounted specimens (Fig. 1D), but could not be seen in stained material (Fig. 1B). Similar (but less distinct) uterine structures were observed in the relatively old material. Individual spines appear to be pointed at both ends (Fig. 1G-H) and therefore do not seem to be anchored by one end in the uterine wall. Thus they could possibly be attached in a uterine network, similarly to those in *Xiphinema coomansi*. In all specimens studied the spines are most conspicuous in the proximal part of the uterus, and seem to be slightly more numerous just adjacent to the spermatheca (Fig. 1F-G). Spiniform structures similar in shape and position to the above were observed in the uteri of *X. achalae* (Fig. 2A-B) and *X. amazonensis* (Fig. 2E).

Although spiniform structures seem to be absent from the uteri of *X. minor*, *X. saladillensis* and *X. tucumanensis* (Table I), this could not be confirmed beyond all doubt, due to the general poor condition of the type material and the fact that the uteri are often constricted and somewhat obscured by the darkish-coloured intestine (Fig. 2C), especially in the first two species. However, objects resembling crystalline structures are quite conspicuous in the uterine lumen of *X. tucumanensis* (Fig. 2D). Similar structures were observed in the uterus of *Xiphinema ingens* Luc *et* Dalmasso, 1963, which could also be interpreted as dilated spines (cf. Fig. 2D in this article with Figs 6G and 10J in Kruger, 1988).

The slightly elongated ovejector varies considerably in size among the different species (47 — 178 µm) (Table II). It is clearly delimited from the uterus (probably by a muscular sphincter) in *X. amazonensis* (Fig. 2F), and possibly also in *X. balcarceanus* (Fig. 1C) and *X. minor* (see Fig. 5D in Rashid *et al.*, 1986), but appears less demarcated in the other species studied. In some species the ovejector is thus a less conspicuous feature, and corresponds more to that of *Longidorus* than that of *Xiphinema*. Sperm cells were observed in the ovejector of *X. amazonensis* (Fig. 2F).

The vagina has a relatively thick cuticular lining and the vulva is a transverse slit situated slightly anterior to the middle of the body (Fig. 1C).

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