INTERNAL MORPHOLOGY AND HISTOLOGY OF THE FISH MITE *LARDOGLYPHUS KONOI* (SASA AND ASANUMA) (ACARINA : ACARIDIAE)

2. THE REPRODUCTIVE SYSTEM *

BY

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ABSTRACT

The female and male reproductive systems are described from serial paraffin sections.

A bursa copulatrix, a receptaculum seminis, a pair of ovary, oviducts, and a median genital opening constitute the female reproductive system. Accessory glands as in some other acarids are absent in the female reproductive system of *L. konoi*. A pair of filiform glands are present at the mouth of the receptaculum seminis.

A pair of testes, accessory glands, vasa deferentia, and a common ejaculatory duct ending in a median penis constitute the male reproductive system. Morphologically the two accessory glands are different and evidences are given for the functional dissimilarity between them.

INTRODUCTION

In a previous publication, Vijayambika and John (in press) the morphology and histology of the alimentary canal of *Lardoglyphus konoi* were described. The present paper reports the detailed morphology and histology of the reproductive system of the same species.

The descriptions are made from serial paraffin sections of adults cultured in the laboratory. For details of fixation and staining methods, readers are referred to the previous publication on the digestive system.

OBSERVATIONS

Female Reproductive System.

The female reproductive system (see Fig. 1) starts with an external opening, the bursa copulatrix situated in the median line at the posterior end of the body. The bursa copulatrix leads into the receptaculum seminis which is situated longitudinally in the dorsal half of the hinder

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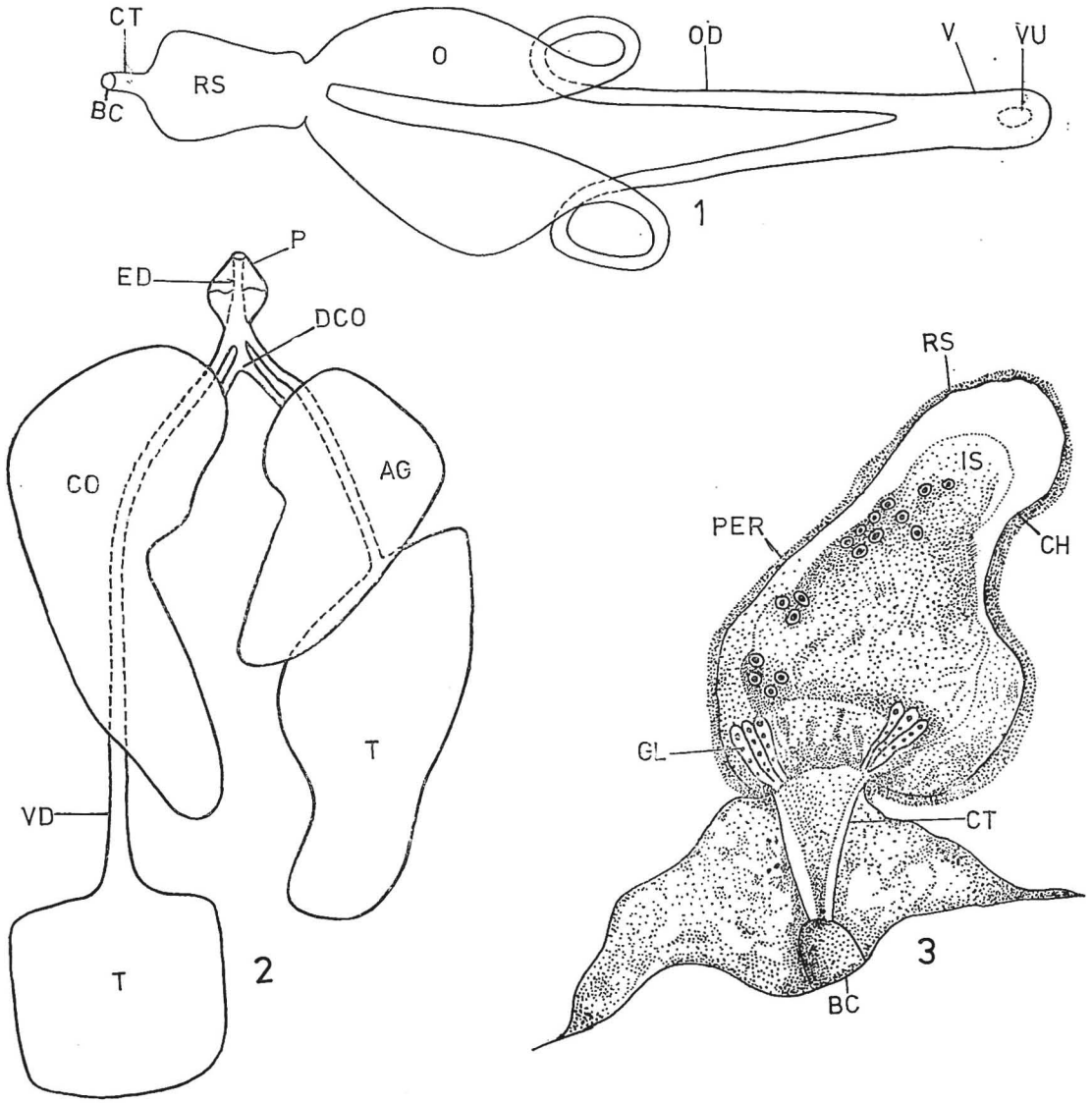
end of the idiosoma, adjacent to the rectal muscles of one side. On either sides of the anterior end of the receptaculum seminis there are two openings which lead into the ovary situated one on either side of the median line and one behind the other. The ovary of each side is lodged between the rectal muscles towards the inner side and the lateral body wall of the posterior idiosoma on the outer side. The distal end of the ovary is tubular and is continued into the oviduct. The oviduct of each side immediately on commencement runs forwards and then curves backwards and downwards, and on reaching the ventral side of the ovary runs mesially. On reaching the median line the two oviducts run side by side for a short distance towards the anterior end



FIGS. 1-3 : 1) Diagramatic representation of the female reproductive system ; BC-bursa copulatrix ; CT-chitinous tube ; RS-receptaculum seminis ; O-ovary ; OD-oviduct ; V-vagina ; Vu-vulva ; 2) Diagramatic representation of the male reproductive system ; T-testis ; VD-vasdeferens ; CO-chambered organ ; AG-accessory gland ; DCO, common duct from the chambered organ and accessory gland ; ED-ejaculatory duct ; P-penis ; 3) Vertical longitudinal section through the receptaculum seminis ; BC-bursa copulatrix ; CT-chitinous tube ; RS-receptaculum seminis ; PER-peritoneum ; CH-inner chitinous layer ; IS-inner sac of the receptaculum ; GL-glandular structures at the mouth of the receptaculum.

of the body. On reaching the anterior half of the hysterosoma they join together to form a median chamber, the vagina. The vagina runs forward for a short length and on reaching the level of the hind margin of the third pair of legs, the distal end ascends upwards and then opens vertically downwards and outwards through the vulva.

The bursa copulatrix (BC. Fig. 3) is formed by a deep dent in the outer cuticle. It leads into a vase-like chitinous tube, (CT. Fig. 3) the broad anterior end of which is directed forwards. At the posterior end this chitinous tube is narrow and marked by a constriction at the junction between the bursa copulatrix.

The chitinous tube opens at the anterior end into a median circular opening in the posterior wall of the receptaculum seminis (RS. Fig. 1, 3). At this junction between the receptaculum seminis and the chitinous tube leading from bursa copulatrix, there is a sphincter guarded by a circular chitinous ring.

The receptaculum seminis (RS. Fig. 3) is an elongated, sac-like structure situated with its length parallel to the length of the body. Its shape may vary according to the level of development of the internal organs. They are usually pearshaped, oval or bell shaped.

The wall of the receptaculum seminis is formed of an outer peritoneum and an inner chitinous layer (see Fig. 3). Within the lumen of the receptaculum seminis there is a sac (IS. Fig. 3) formed of non staining colloidal ground substance. The mouth of the sac is contricted like a purse-string and is directed towards the median opening of the receptaculum seminis. Within this sac can be seen individual sperms and spermatophores also (see Fig. 4). The spermatophores are shuttle shaped and have a wide mouth. The wall of the spermatophore is structureless and refringent and is probably formed by the hardening of the colloidal ground substance within the lumen. At the two sides of the median opening into the receptaculum, filiform structures with multinucleate and glandular appearance (GL. Fig. 3, 4) are present which are probably responsible for secreting the colloidal substance into the lumen.

The paired ovaries are connected by a short and narrow neck to either sides of the anterior half of the receptaculum seminis (see Fig. 1). Immediately after the opening from the receptaculum, the ovary enlarges into an oval or globular sac.

The wall of the ovary is almost entirely formed of a single membrane, the peritoneum. But at some rare locations an inner layer, the ovarial tunica propria is also visible. From a single point in each ovary this tunica propria project into the lumen to form the ovarial stalk or medulla. Each ovarial stalk with the regularly arranged primary oogonia studded to it, may look like a miniature ear of corn.

Each of the ovarial stalk is formed of a central core of lightly staining homogeneous protoplasm (C Fig. 5). Along its length the stalk gives out sheets of protoplasm which radiate outwards. During its course these sheets of protoplasm give out thin strands of protoplasm sideways. The strands from adjacent radial sheets may coalesce, so that a loose net work of protoplasmic strands are formed within the space between the neighbouring radial sheets. The primary oogonia which are budded out from the ovarial medulla are held within the meshes of this net work. The cluster of oogonia is enveloped on the outer surface by a sheath of protoplasm (PR Fig. 5). In sections each ovarial stalk may have a rosette like appearance (see Fig. 5).

Each oogonium (O Fig. 5) is perfectly spherical and consists of a spherical, prominent nucleus surrounded by a ring of nonstaining transparent homogeneous cytoplasm. As the oogonium advances in age the outer rim of cytoplasm grows in width. They are pushed to the periphery, where they would finally rupture the outer envelope of protoplasm and fall into the lumen of the ovary to form the ova. Within the ovary the ova grow in size by apparent yolky inclusions in the cytoplasm. The ova which fall into the lumen are piled in rows and the oldest usually

occur anteriormost in the row and most proximal to the external genital opening. Fairly large sized ova are pushed into the oviducts.

The oviducts are formed by the elongation of the ovarian wall and is formed of a single membranous layer. No circular or longitudinal muscle could be discerned on the wall of the duct.

The vagina is a dorsoventrally compressed median chamber formed by the mesial fusion of the distal halves of the oviducts (see Fig. 1). Its wall is also formed of a single membrane invested on the outer side by connective tissue.

The eggs are extruded through the vulva and it is a median, longitudinal slit like opening on the ventral wall. This slit like opening is guarded by the lateral lips, the labia which are pressed against each other in the central line. The labia are almost perpendicular to the ventral surface. In each labium is sunk a row of dark coloured chitinous rods which may strengthen the wall of the labium (see Fig. 7).

On the upper surface of the roof of the vagina are inserted one or two retractor muscles the contraction of which may help to widen the opening of the vagina into the vulva to receive the eggs.

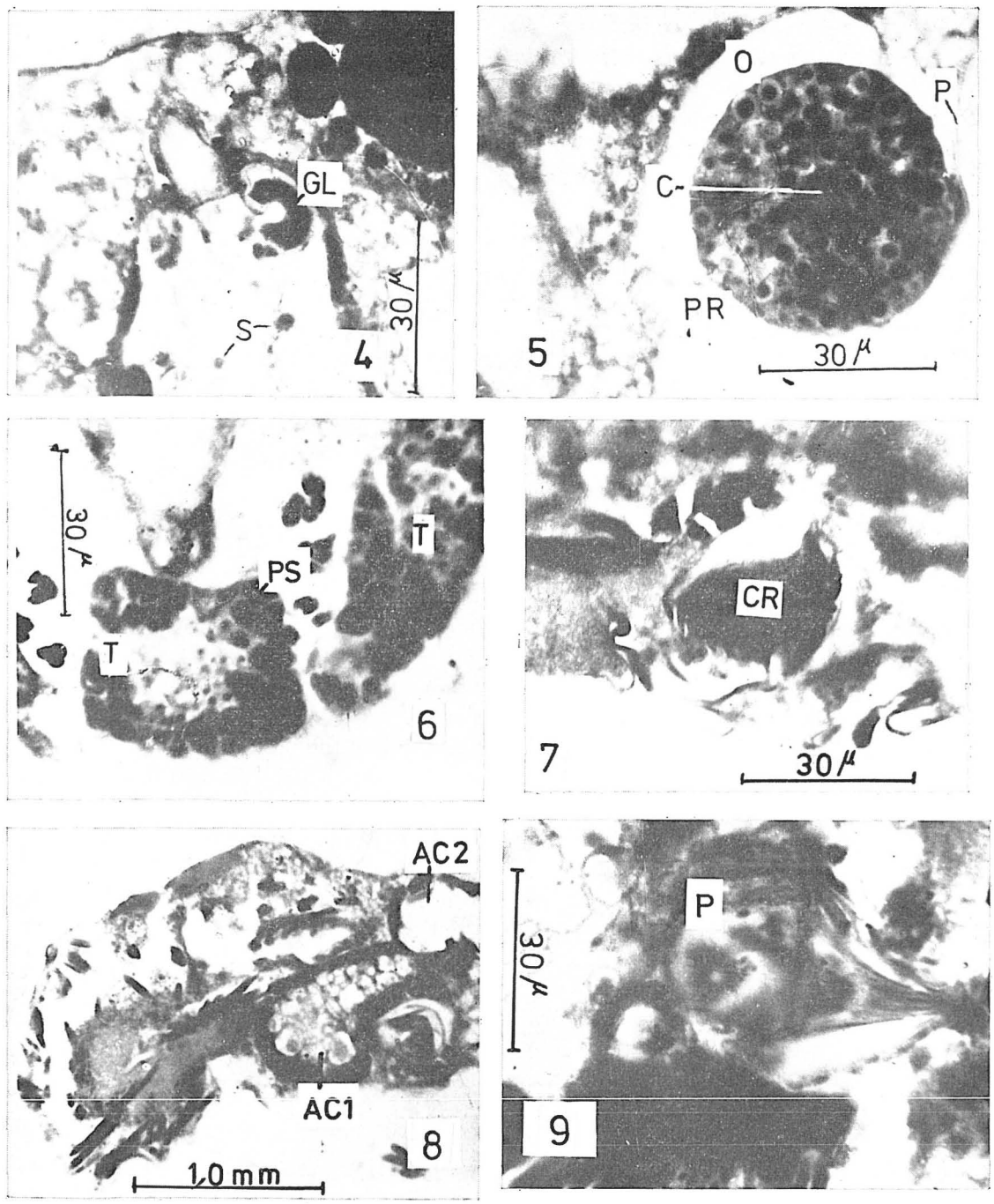
Male Reproductive system.

The male reproductive system (see Fig. 2) consists of a pair of testes, accessory glands, vasa deferentia, a median ejaculatory duct and the penis situated medially on the ventral body wall between the third and the fourth legs.

Testes are two in number and are usually placed one in front of the other, on either sides of the median line and in the posterior half of the body. Each testis is roughly rectangular or pear shaped and is closely packed between the outer body wall and the inner mass of the connective tissue. The testis may be displaced within the body cavity to either side, due to the enlargement of the posterior segments of the digestive tract.

The wall of the testis is formed of a limiting membrane the peritoneum tunica. The peritoneum tunica is thin and nonstaining. Its nuclei are small and elliptical and situated wide apart. The central part of the testis is formed of a protoplasmic mass in which numerous nuclei are embedded (see Fig. 6). Towards the centre of the testis these nuclei are small and crowded but towards the periphery they are larger and lesser in number. The nuclei situated towards the centre are perfectly spherical in shape. During spermatogenesis the protoplasm surround ing each nucleus separates itself from the plasma mass and becomes discrete cells, the primary spermatocytes (PS Fig. 6) which are united by protoplasmic threads. When these primary spermatocytes increase in number they lose their characteristic form through mutual pressure and become hexagonal, so that the testes will have the deceptive appearance of being covered by a pavement epithelium. During transition into the sperm the primary spermatocytes divide further and become smaller in size and cytoplasm becomes more acidophilic in staining. They get crowded towards the mouth of the vas deferens.

The vas deferens arises from the shorter side of each testis, which, as already stated may be highly displaced due to the enlargement of the posterior segment of digestive tract and so, may be lying with its length either parallel or transverse to the length fo the body. The vas deferens from one of the testis runs transversely and on reaching the other side runs anteriorly below the testis and the accessory gland (chambered organ) fo that side. On its way it meets its fellow of the opposite side and the common duct runs forwards up to the base of the penis situated more or less towards the middle of the ventral body wall. During the course of this common duct anteriorly, it also receives another common duct formed by the fusion of the two ducts of the accessory glands (see Fig. 2). The duct formed by the fusion of separate ducts from



FIGS. 4-9 : 4) Vertical longitudinal section through the posterior half of the receptaculum seminis ; GL-glandular structures at the mouth ; S-sperms ; 5) Cross section through an ovarial medulla ; P-peritoneum of the ovarian wall ; O-oogonium ; C-central core of protoplasm ; PR-outer sheath of protoplasm ; 6) Frontal section through the region of the testes ; T-testis ; PS-primary spermatocytes ; 7) Vertical longitudinal section through the region of the vagina ; CR-chitinous rods sunk in the wall of the labium ; 8) Vertical longitudinal section through an adult male ; AC_1-chambered organ ; AC_2-accessory gland ; 9) Vertical section through the penis in the resting condition ; P-penis.

the testes and accessory glands, on reaching the base of the penis slightly expands into a wider chamber which may be termed the ducts ejaculatoris, and traverses the penis.

The wall of the vas deferens is a thin peritoneum formed of very flattened cells.

As already stated the accessory glands are two in number and both of them are displaced to one side of the body. Both the glands are flattened, oval in shape and one is situated in front of the other (see Fig. 2). Posterior one is usually smaller and it lies above the testis of that side with its posterior end reaching up to the hind end of the body. The anterior one is larger, usually as large as the stomach and its hinder end may reach posteriorly up to penis (see AC_1 Fig. 8).

Among these the larger one which may be termed the " chambered organ " (AC_1 Fig. 8) has a rather thick tunica propria forming its wall. But their whole mass except the lumen in the centre is divided into very large cells. These cells are crowded against one another so that their rounded surfaces are lost. The walls of these cells are thick and formed of dense, deeply staining cytoplasm. The inner ends of these cells are usually broken so that in sections the gland will have the appearance of a honeycomb or as if formed of several chambers (see Fig. 8). These chambers are usually filled with a finely granular secretory matter which is weakly acidophilic in staining.

The other gland which may be termed the " accessory gland " (AC_2 Fig. 8) is usually smaller. Though it will resemble the chambered organ in the basic pattern of structure, some differences are seen in the detailed structure. As in the chambered organ the mass of the gland is formed of very large cells. But these cells are confined only to the periphery of the gland so that the central region is hollow and empty. Also the distal ends of the cells are not broken as in the chambered organ and they remain in tact. Compared to the chambered organ the secretory matter is sparse, being distributed near about the wall of the cells. The granules are larger in size and are basophilic in staining.

The accessory gland and chambered organ discharge by very short and rather wide ducts which join together before meeting the common duct of the vas deferens at the level of ducts ejaculatoris, which finds its way out through the penis.

The penis is cone shaped (see Fig. 9) and project into the genital atrium. While at rest the penis is inclined at 180° to the ventral body wall. The penis is essentially a double walled cone consisting of an inner and an outer cup, the lumen of the inner cup forming the ductus ejaculatoris. The inner cup is two segmented, a shorter segment towards the start of the ductus ejaculatoris and a longer second segment. The second segment narrows downwards to a small opening at the distal end. The wall of the shorter segment is also longitudinally folded into several pleats. There is a collar like cuticular plate forming a bridge between the outer and inner cups at the level of the junction between the two segments of the inner cup (see Fig. 9).

The males also possess two suckers on the ventral side of the genital opening which are the genital suckers. In whole mounts they are circular with a chitinous disc in the centre. But the details of the structure were not available from sections.

Discussion

Sections of the ovary and oviduct in other Acaridiae have been described as far as the authors know by Nalepa (1884) and Michael (1901). According to Nalepa in *Caloglyphus anonymus*, the plasma mass, which is analogous to the ovarian stalk in the present species contains no definite nuclei, but only clusters of finely granular nuclear substance. In *L. konoi* the ovarian stalk or plasma mass lodges within it a large number of discrete nuclei.

In *Caloglyphus mycophagus*, Acaridae, the female system consists in addition to the components described in the present species a pair of accessory glands as well. (KUO & NESBITT, 1970). These glands are absent in *L. konoi*. The present results correspond to the results obtained by HUGHES (1959) from the acarids that there are no accessory glands associated with female reproductive system. It also gives evidence to the view of MICHAEL (1901) that the inner sac seen within the receptaculum seminis may be formed due to the hardening of the " granular mass ", (colloidal ground substance) in the present species.

The presence of a pair of filiform glands at the mouth of the receptaculum seminis as pointed out in the present species is being described for the first time. These glands may probably be responsible for the secretion of the colloidal material seen within the receptaculum seminis.

In the Oribatei *Ceratozetes cisalpinus* there is only a single median ovary. (WOODRING and COOK, 1962). *Ceratozetes* also seems to differ from *L. konoi* in the absence of a receptaculum seminis.

In describing the female reproductive system of *Eylisis extendens* Easwari Amma (1969) has observed that one half of the wall of the ovary is usually crowded with ova in all stages of development and the other half which is sterile is formed only by undifferentiated cells. She has suggested that this type of tubular ovary with a partial germarium represents an archaic condition of organisation. It will be recalled that in the present species also, the ovarian stalk is localised only to a particular point of the ovarian wall with the other areas sterile and undifferentiated. This is reminiscent of the archaic condition of organisation of ovary suggested to be present in arachnids by ESWARI AMMA.

In the essential characters the male reproductive system of *L. konoi* resembles that of other tyroglyphids like *Glycyphagus platygaster* (Michael, 1901), and *Tyroglyphus longior* (Nalepa 1884), with their paired testes, vasa deferentia, and a median ejaculatory duct. According to MICHAEL (1901) the accessory glands in *Glycyphagus* cannot be considered as paired because they differ in form, size, and structure. In the present case also the two glands are not identical in size and structure. In the one which has been designated as chambered organ, the structure resembles that of the same in *Glycyphagus*. The walls of the cells are thick, and the distal ends of the cells are broken. The interior is also filled with coarsely granular secretory materials.

According to MICHAEL (1901), the other accessory gland is considerably larger than the chambered organ and so he has preferred to call it the " receptacular accessory gland ". In *L. konoi* the second gland is smaller than the chambered organ, and it is the chambered organ that assumes larger dimensions so that it has been preferred to call it merely accessory gland.

In *Glycyphagus* according to Michael the walls of the cells in these organs are fine and difficult to see, and they never persist if the cells are empty. But in *L. konoi* the cellular wall of the accessory glands is fairly thick and visible under all conditions. The secretory materials in the receptacular accessory gland in *G. platygaster* stains only slightly. But in *Lardoglyphus* the secretion of the accessory gland, when compared with that of chambered organ, is deeply stained.

L. konoi differs from *C. mycophagus* because the latter has only one median chamber (KUO & NESBITT 1970). The male reproductive system of the Oribatei *C. cisalpinus* seems to vary widely from that of *L. konoi* because in the former, accessory glands are absent which is lacking in the present species. (WOODRING and COOK 1962). In association with the penis a stalk gland has also been described in *Ceratozetes* which is not present in *Lardoglyphus*.

WOODRING (1970) has categorised two types, a weak and strong type of penis in the oribatids. The structure of the penis in *Lardoglyphus* seems to tally more with that of the weak type of penis, with the thin walls and a thin weak tongue.

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