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A STUDY ON THE ANATOMY OF *HAEMONCHUS CONTORTUS* (NEMATODA)

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ABSTRACT

The present paper describes the anatomy of various organ-systems of *Haemonchus contortus*, a gastrointestinal parasite of ruminants. The anatomical structure of buccal cavity, oesophagus, intestine, rectal glands, excretory organs, ovary, oviduct, uterus, vulvar flap, testis, seminal vesicle, vas deferens and spicules was discussed.

KEYWORDS: Anatomy, *Haemonchus contortus*, Nematoda,

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INTRODUCTION

The gastrointestinal nematode, *Haemonchus contortus* (Rudolphi, 1803) Cobb, 1898, commonly known as Barber's pole worm or twisted worm. It is a major pathogen of sheep and goat throughout the temperate and tropical regions of the world and is a significant cause of production losses. It is a highly pathogenic blood feeder helminth that causes acute amaemia, edema, diarrhoea and ultimately death.

The gastrointestinal nematode *Haemonchus contortus* (Rudolphi, 1803) is a major pathogen of small ruminants throughout the temperate and tropical regions of the world and is a significant cause of production losses. It is a highly pathogenic blood-feeder helminth that causes anaemia and reduced productivity and can lead to death of infected animals (Burke *et al*., 2007). Over years attempts have been made to study various aspects of *Haemonchus* spp. from different parts of the world (Sood, 2006). Previously, the microscopic structure of various organ systems of *Haemonchus contortus* has been studied by Singh and Johal (1997), Singh (2000), Singh and Johal (2001a, 2001b and 2001c) and Singh and Johal (2004). Over the years, attempts have been made to study the various aspects of *Haemonchus* spp. from different parts of the world. (Veglia, 1915: Smith and Harness, 1972: Weise, 1977; Sood and Kalra, 1977; Sood and Sehajpal, 1978; Sood, 2006). The present study focus on the anatomy of various organ-systems of this parasite.

MATERIALS AND METHODS

The adult female *Haemonchus contortus* extracted from the abomasum of sheep (*Ovis aries*) were washed in 0.85% NaCl solution to remove debris. For whole mount preparation, after fixation in 70% alcohol at 60 ^{0}C, the nematode worms were cleared and mounted in lectophenol. For studying some of the external and internal characters of the parasites the fresh specimens were stained in 1% methylene blue at 60 degree centigrade for 18 hours. The specimens were differentiated in 80% alcohol and cleared in lactophenol. The parasites were finally mounted in lactophenol.

For histomorphological studies, each worm was fixed in alcoholic Bouin's fixative for 12-24 hours, dehydrated in a graded series of alcohol, cleared in methyl benzoate and embedded in paraffin wax. The sections were cut at 7µm in transverse and longitudinal planes. The serial sections arranged on slides were stained with haematoxylin and eosin. The slides were examined under the microscope and photo micrographed.

RESULTS AND DISCUSSION

The sexual dimophism is present in *Haemonchus contortus*. The male worm is easily distinguished from the female by its size being smaller than the female and also by the presence of a well-developed copulatory bursa at its posterior end. The male worm is 10-20 mm long and 400 µm broad, whereas the female is 18-30 mm long and 500 µm broad.

A pair of cuticular expansions in the form of cervical papillae , located at a distance of about 375 µm are present on the lateral sides of the body in both the sexes (Fig. 1).

Digestive System:

The alimentary canal of *Haemonchus contortus* is divisible into three regions: the stomodeum, the mesenteron and the proctodeum. The stomodael region includes the buccal cavity, the buccal lancet and the oesophagus. The mouth is surrounded by three lips bearing adhesive papillae. It opens into a cuticle lined moderate sized buccal cavity measuring 13.3 µm long and 6.9 µm wide. It contains a buccal lancet and tapers at posterior end to meet the oesophagus. The buccal lancet is 13 µm long and 3 µm wide. The oesophagus is 870 µm long and has a maximum width of 98 µm. Oesophagus extends through the anterior 1/5 of the body and shows a gradual increase in its size from anterior to posterior. A thick nerve ring measuring 16 µm is present around the oesophagus (Figs. 2, 3 and 4).

The opening of oesophagus to the intestine is guarded by a moderately developed oesophago-intestinal valve (Fig. 5). The intestine is highly coiled with reproductive organs. The opening of intestine into rectum has an intestino-rectal junction to which are attached three rectal glands. The rectum is small in size measuring only 93 µm in length and lined by an invagination of the outer cuticle on the luminal side. The number of rectal glands is three in both the sexes. The rectal glands are elongated and reticular in appearance. The size of rectal glands in males is larger than that of females. In case of the males, each rectal gland cell measures 60 µm in length and has a maximum width of 26 µm at its base. In females the rectal glands are rounded in appearance and measure 2.0 µm in size. In females, the rectum opens to outside through an anus at a distance of about 450 µm from the tip of the tail. In males, the rectum along with the ejaculatory duct opens to outside through a cloaca (Fig. 13).

Excretory System:

The excretory system of *Haemonchus contortus* is a combination of glandular and tubular types. A pair of sub-ventral excretory glands opens into a common sinus which communicates anteriorly in the form of a duct and opens to outside by an excretory pore. The excretory pore is present at a distance of 300 µm from the anterior end of the body (Figs. 2 and 14).

Male Reproductive System:

The male worm is monarchic and telogonic. The male reproductive system consists of a single set of organs including a long coiled tubular testis, a dilated seminal seminal vesicle and a glandular vas deferens opening into cloaca along with the rectum. In the cloacal region, some accessory copulatory structures i.e. a pair of spicules and a single median gubernaculum are also associated with the male reproductive system. The telogonic testis lies coiled around the intestine. The testis is succeeded by a seminal vesicle. At the posterior extremity the seminal vesicle communicates with the vas deferens by a narrow obliquely placed tube just like the oviduct in females. This narrow portion measures 90 µm in length and is only 10 wide. Vas deferens extends nearly in 2/3rd of the body. A pair of spicules measuring

420-440 µm in length is present. The gubernaculum is accessory copulatory structure associated with the spicules. It is 200 µm long and 25-30 µm wide (Fig. 6, 7, 8 and 15).

Female reproductive System:

The female reproductive system of *Haemonchus contortus* is diorchic i.e. the presence of two sets of reproductive organs, which open externally through a common vulva at a distance of about 930-960 µm from the tip of the tail. The reproductive system is amphidelphic with uteri opposed, the anterior uterus extends anteriad and the posterior uterus makes a U-turn at some distance from the vulva and then runs anteriad. Each set of reproductive organs include a long tubular highly coiled ovary, a narrow oviduct followed by a uterus and an ovijector leading into a common short vagina which opens to outside through a common vulva covered by a vulvar flap. The ovaries are tightly coiled around the intestine suggesting the direct trans-membrane flow of nutrients from the gut to the gonads. The oviduct is a narrow tube measuring 46.6 µm in diameter. It extends between the ovary and anterior part of uterus, the seminal receptaculum. The ovo-uterine junction is provided with a sort of sphincter. The ovijector is a muscular organ measuring 40 µm in length and 25 µm in diameter. The ovijectors from both the uteri meet to form a common vagina. The vagina extends ventrally to open to outside at the base of a long vulvar flap (Fig. 9,10, 11, 12 and 13).

In spite of the widespread distribution of *Haemonchus contortus*, notwithstanding its profound impact on animal husbandry, this nematode has not received much attention in connection with its anatomical studies. There have been no meticulous descriptions of this roundworm for a long time except Veglia (1915). Present investigation on the study of the anatomy of different organ-systems have brought up finer details of the anatomy of this economically important gastrointestinal nematode of ruminants

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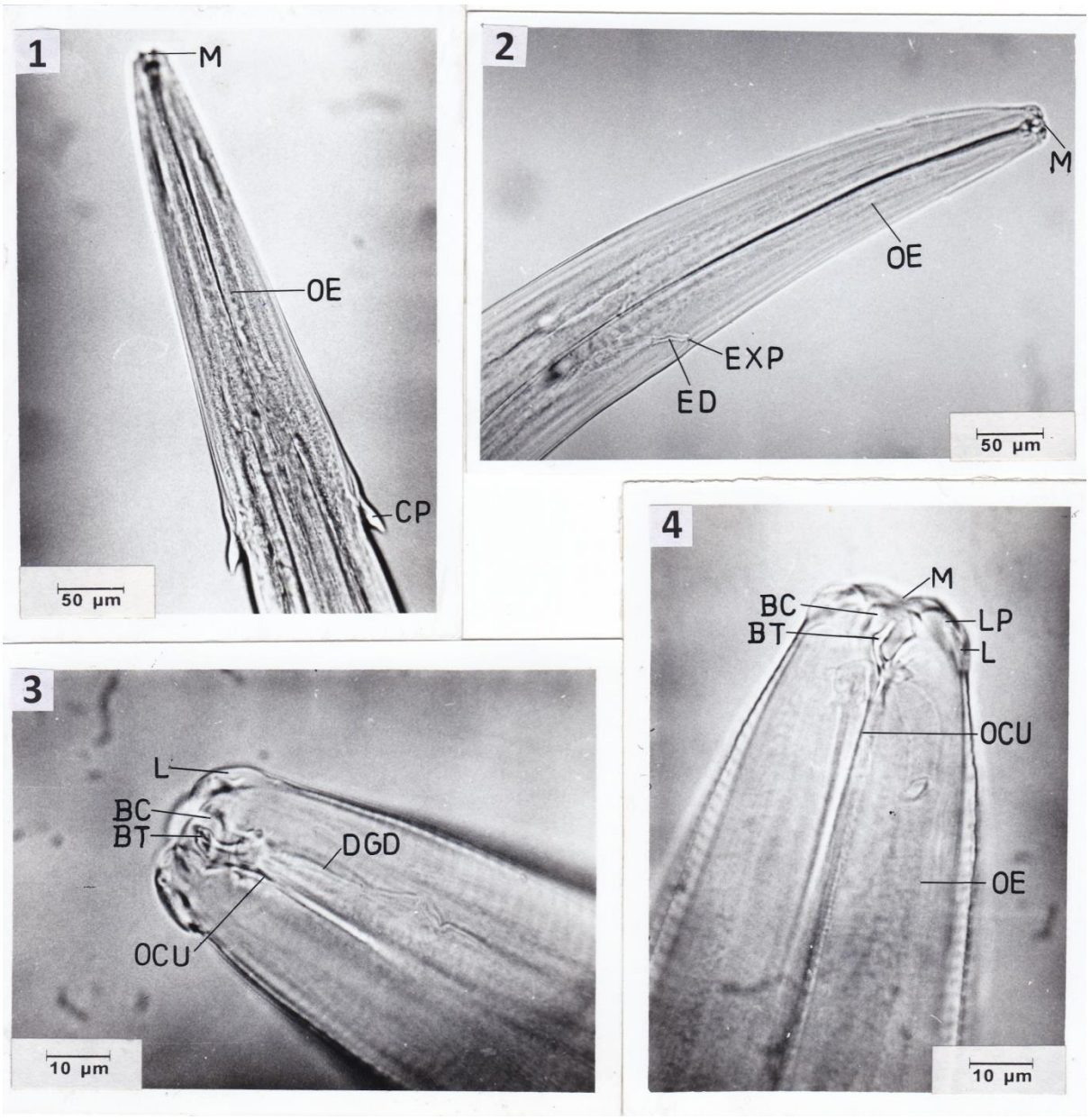

PLATE I: Fig. 1 to 4: *Haemonchus contortus* (All stained with methylene blue, mounted in lactophenol)

Fig. 1: Anterior region showing cervical papilla (CP), mouth (M) and oesophagus (OE).

Fig. 2: Anterior region showing excretory duct (ED), excretory pore (EXP), mouth (M) and oesophagus (OE).

Fig. 3: Anterior end revealing the presence of buccal lancet (BT), buccal cavity (BC), lip (L), oesophageal cuticular lining (OCU), dorsal oesohageal gland duct (DGD).

Fig. 4: Anterior region showing mouth (M), lip (L) bearing lip papilla (LP), buccal lancet (BT), buccal cavity (BC), oesophageal cuticular lining (OCU) and oesophagus (OE).

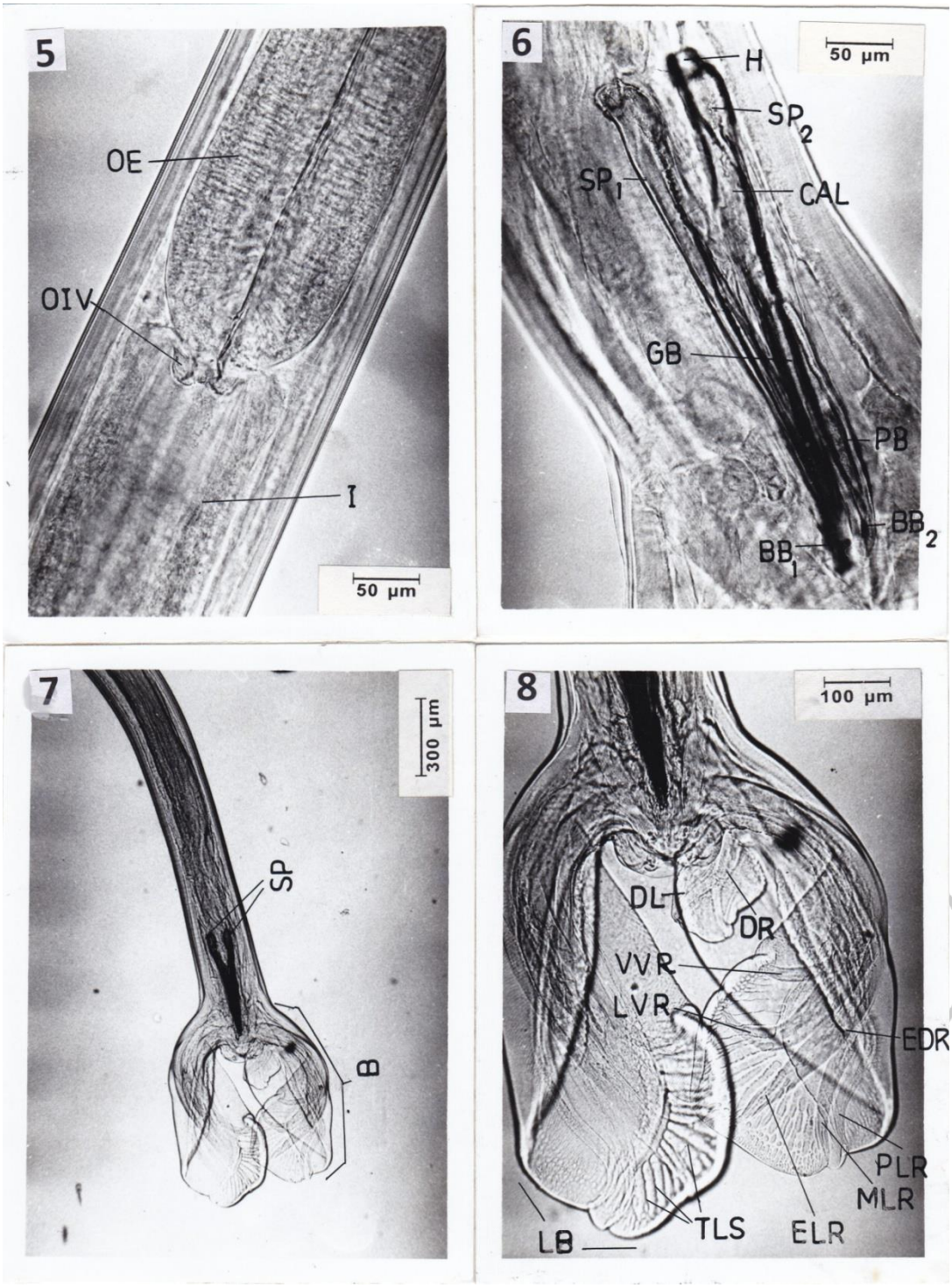

PLATE II: Fig. 5 to 8: *Haemonchus contortus* (All stained with methylene blue, mounted in lactophenol)

Fig. 5: Anterior region showing oesophagus (OE), oesophago-intestinal valve (OIV) and intestine (I).

Fig. 6: Posterior end of male showing spicules (SP_1 and SP_2), head of spicule (H), calamus (CAL), padded blade (PB), barb of first spicule (BB_1), barb of second spicule (BB_2), gubernaculum (GB).

Fig. 7: Posterior end of male showing copulatory bursa (B) and spicules (SP).

Fig. 8: Bursa of male showing rectrangular lateral lobe (LB) having externo dorsal ray (EDR), externo-lateral ray (ELR), latero-ventral ray (LVR), medio-lateral ray (MLR), postero-lateral ray (PLR), ventro-ventral ray (VVR) and a small dorsal lobe (DL) having dorsal ray (DR), fine tube like structures (TLS).

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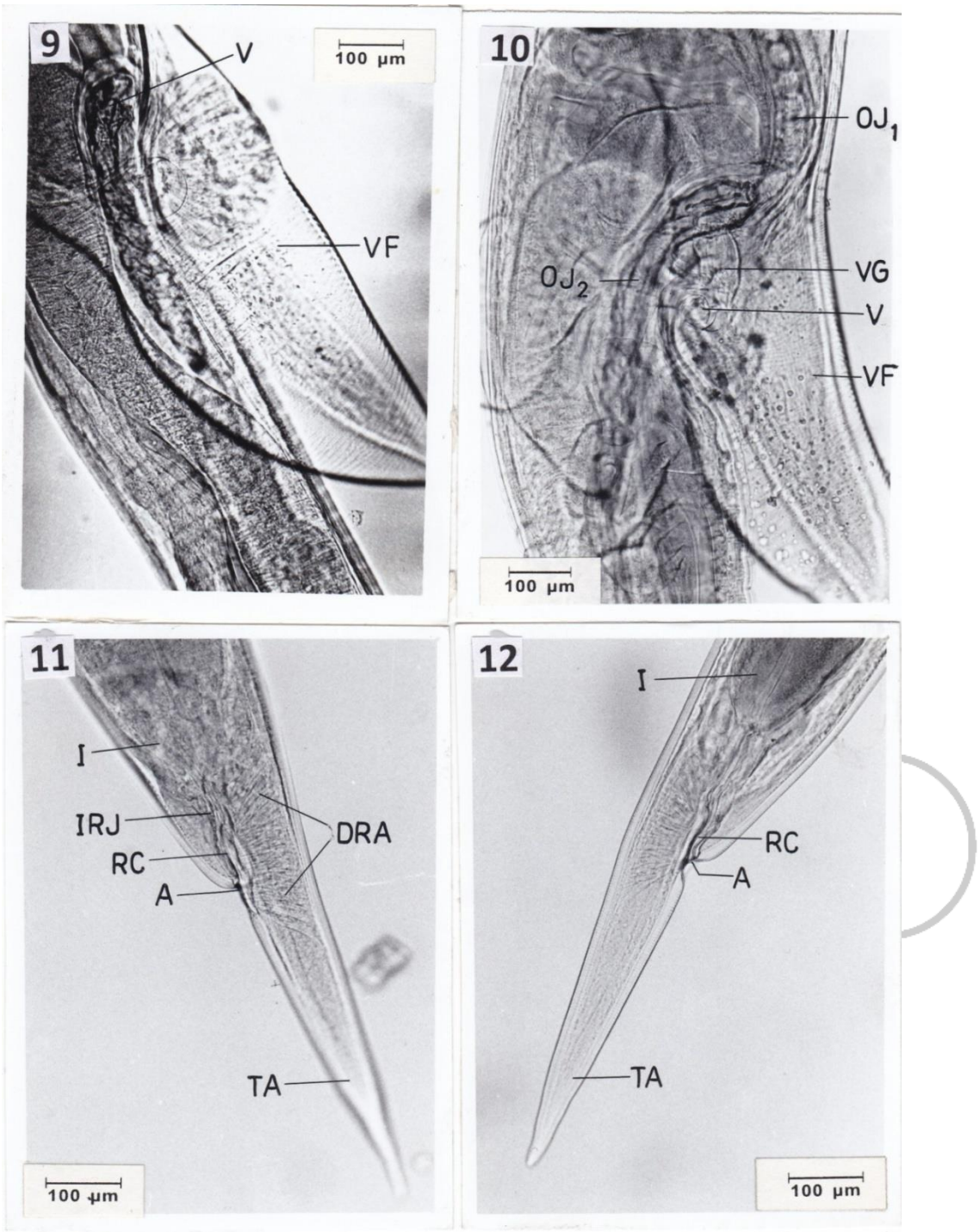

PLATE III: Fig. 9 to 12: *Haemonchus contortus* (All stained with methylene blue, mounted in lactophenol)

Fig. 9: Vulvar region of female showing vulva (V) and vulvar flap (VF).

Fig. 10: Vulvar region of female showing ovijectors from the anterior set (OJ_1) and posterior set (OJ_2) to form a common vagina (VG), vulva (V) and vulvar flap (VF).

Fig. 11: Posterior region of female worm showing tapering tail (TA), intestine (I), rectum (RC) and anal opening (A), intestino-rectal junction (IRJ), depressor ani muscles (DRA).

Fig. 12: Posterior region of female worm showing tapering tail (TA), intestine (I), rectum (RC) and anal opening (A).

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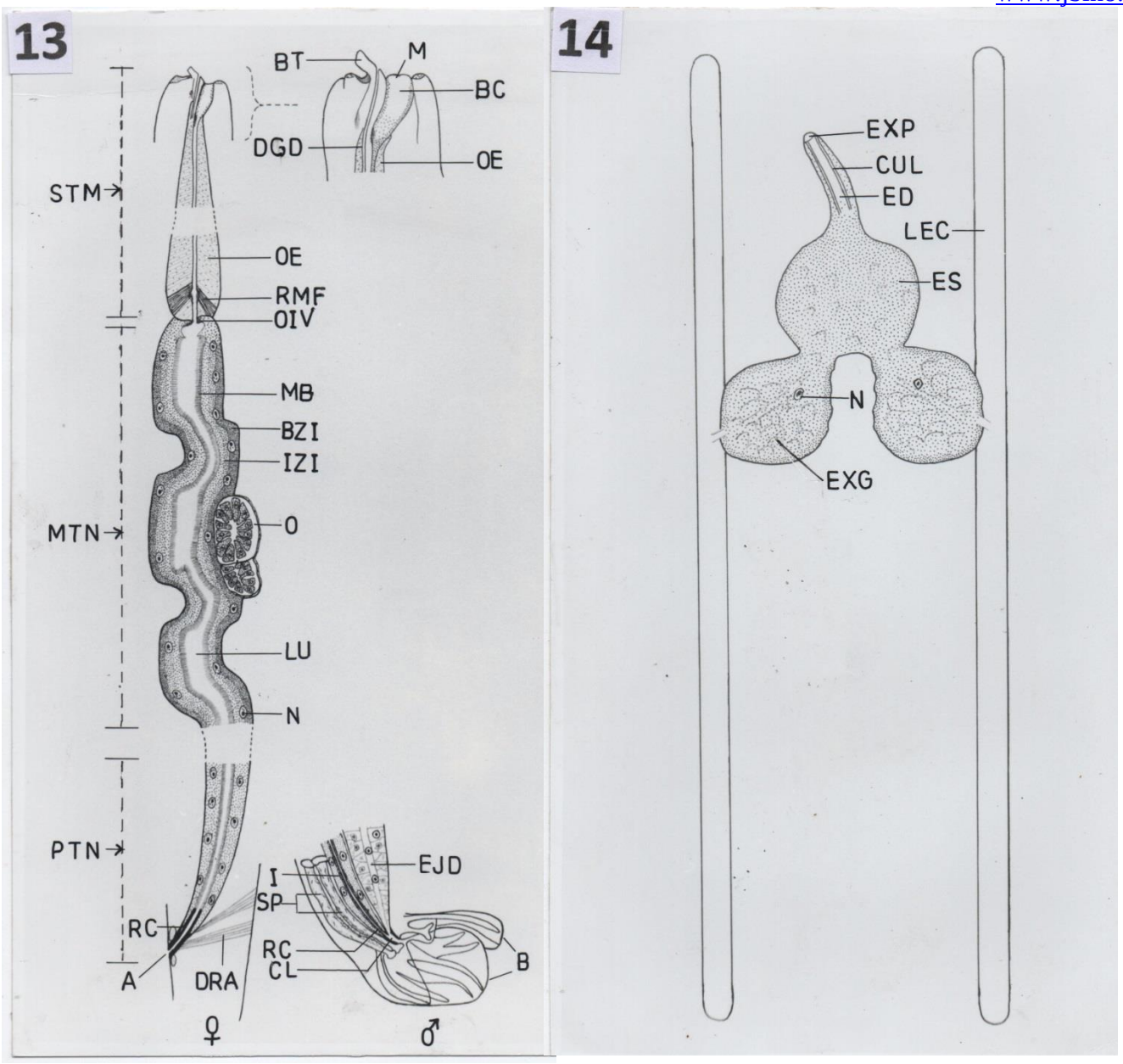

Fig. 13: A diagrammatic representation (reconstructed with the help of transverse and longitudinal sections) of digestive system of *Haemonchus contortus* showing stomodeum (STM), mesenteron (MTN) and proctodeum (PTM) portions, mouth (M), buccal cavity (BC), buccal lancet (BT), dorsal oesophageal gland duct (DGD), oesophagus (OE), radial muscle fibres (RMF), oesophago-intestinal valve (OIV), basal dense zone of intestinal epithelium (BZI), inner lighter zone of intestinal epithelium (IZI), nucleus (N), microvillar border (MB), lumen (LU), intestine (I), rectum (R), depressor ani (DRA), cloaca (CL), spicule (SP), and bursa (B).

Fig. 16: A diagrammatic representation (reconstructed with the help of transverse and longitudinal sections) of excretory system of *Haemonchus contortus* showing lateral excretory canal (LEC), excretory gland (EXG), nucleus (N), excretory sinus (ES), excretory duct (ED), its cuticular lining (CUL), and excretory pore (EXP).

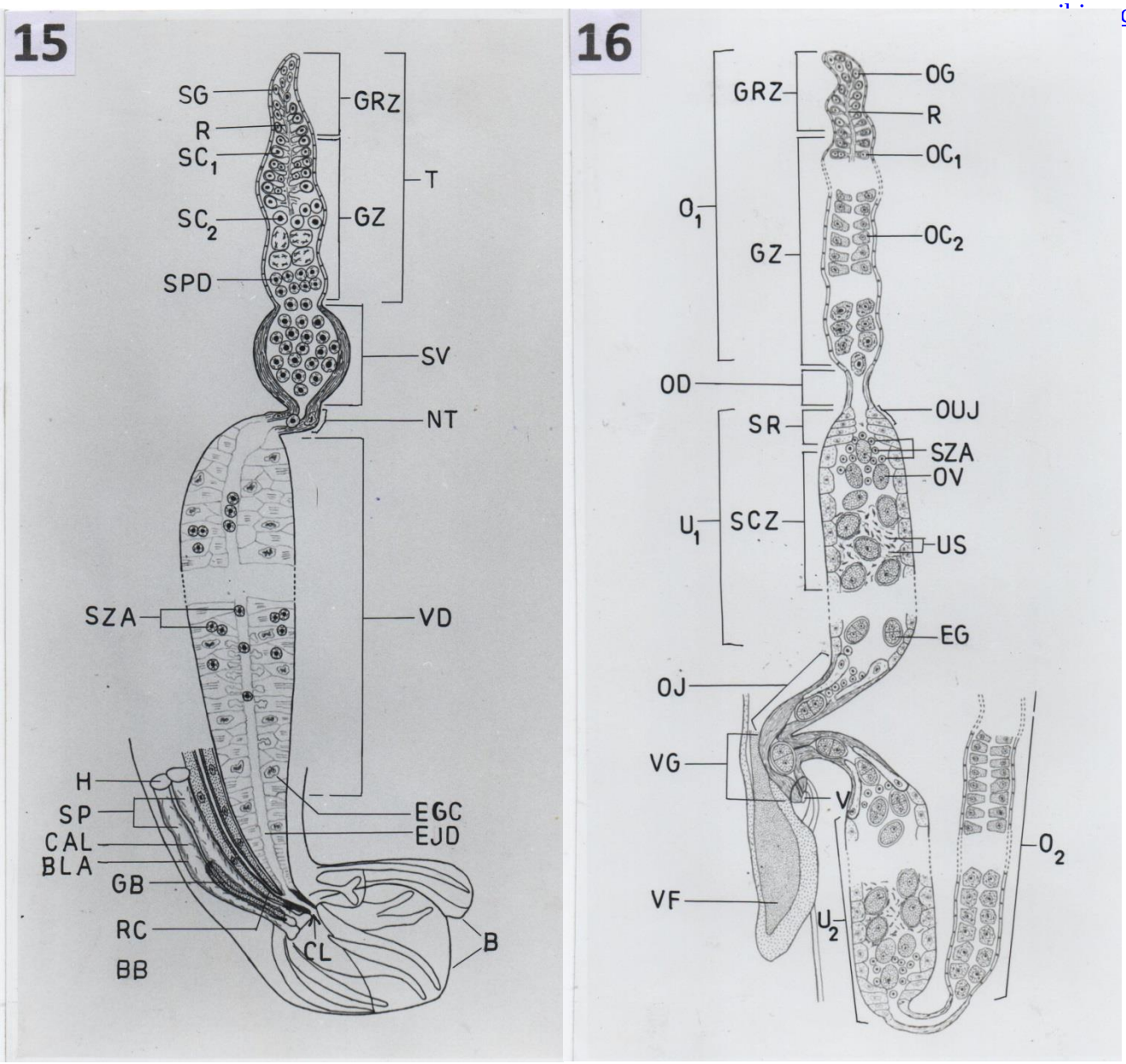

Fig. 15: A diagrammatic representation (reconstructed with the help of transverse and longitudinal sections) of male reproductive system of *Haemonchus contortus* showing germinal zone (GRZ) and growth zone (GZ) of testis (T), seminal vesicle (SV), narrow tube (NT) between seminal vesicle and vas deferens (VD), ejaculatory duct (EJD), ejaculatory gland cell (EGC), spermatogonium (SG), rachis (R), primary spermatocyte (SC_1), secondary spermatocyte (SC_2), spermatid (SPD), spermatozoon (SZA), spicules (SP), head of spicule (H), blade (BLA), barb of spicule (BB), gubernaculum (GB), bursa (B), cloaca (CL) and rectum (RC).

Fig. 16: A diagrammatic representation (reconstructed with the help of transverse and longitudinal sections) of female reproductive system of *Haemonchus contortus* showing germinal zone (GRZ) and growth zone (GZ) of anterior ovary (O_1), posterior ovary (O_2), oviduct (OD), ovo-uterine junction (OUJ), seminal receptaculum (SR), secretory zone of uterus (SZ), anterior uterus (U_1), posterior uterus (U_2), ovijector (OJ), vagina (VG), vulva (V), vulvar flap (VF), oogonia (OG), rachis (R), primary oocyte (OC_1), secondary oocyte (OC_2), ovum (OV), spermatozoa (SZA), uterine secretion (US) and fertilized egg (EG).

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