

The Surface Structure of Sense Organs of *Toxocara cati* (Schrank, 1788) viewed with the Scanning Electron Microscope

SHIGEHICO UNI and SUEHISA TAKADA

Department of Medical Zoology, Osaka City University, Medical School, Osaka, Japan

(Received for publication; Sep. 9, 1975)

Morphological and taxonomical studies of *Toxocara cati* were reported by some investigators using common microscope (Sprent, 1956; Yamaguti, 1935, 1961; York and Maplestone, 1962; Warren, 1971).

Recently, McKee (1973) and Kikuchi (1974) reported the scanning electron microscope (SEM) images of the general morphology of this nematode.

This paper deals with SEM observations of the fine surface structures and the detailed arrangements specifically of the sensory organs in the anterior and posterior regions of *Toxocara cati*.

Materials and Methods

Toxocara cati were recovered from the small intestine of stray cats in Osaka by the way of Iseki *et al.* (1974).

Live adult nematodes were washed several times in saline and killed in hot alcohol (70%). Then they were exposed to 5% glutaraldehyde in 0.1 M Millonig's phosphate buffer at pH 7.2. After 1 hour in this solution they were rinsed with the buffer and postfixed in 1% OsO₄ in the buffer for 1 hour. A brief rinse in the buffer was followed by dehydration with ethyl alcohol. The preparations were carried through a graded series of isoamyl acetate in alcohol up to 100% isoamyl acetate. Then they were transferred to liquid CO₂ in a critical point drying apparatus (HCP-1). The resulting

dry specimens were coated with carbon and gold-palladium by evaporation or with gold by sputtering in an ion bombardment apparatus (IB-3). A JEOL JSM-50A scanning electron microscope, operated at 15kV, was used in all of these examinations.

Results

The anterior region: The arrangement of the papillae and amphids on the lips and the lateral cervical alae basically agreed with the description by Sprent (1956) with some exceptions as follows (Fig. 1):

Stereo viewing of the apical views of the anterior end showed precisely that the lateral papilla and amphidial pore, recognizable a bit more distinctly, were situated antero-laterally to the ventral papilla on the anterior surface of the subventral lip. Each lip, one dorsal and two subventral, was equipped with numerable minute denticles at the inner surface just below the anterior margin, the dentigerous ridge, and was widely and deeply separated in the central part of the triradiate separation. The mouth was recognizable as the center of the triradiate crevice, representing the esophageal front. At the inner summit of the dentigerous ridge a small cleft was present, and at the corresponding position a distinct cleavage was near the mouth opening at the inner surface of the lip.

Thus the mouth region looked as if with a hexaradiate crevice (Figs. 1, 2a, 2b, 3 and 5).

Partially financed by a grant from the Ministry of Education of Japan.

The lateral papilla of the subventral lip showed only one invagination on its surface, while the ventral and dorsal papillae contained two invaginations, each being a bit different in size, on their surfaces (Figs. 4 and 6). Internally, the ventral papilla contained two nerve endings, the cephalic and outer labial nerve endings, shown by light microscope observation. At least one of the invaginations seemed to connect the nerve ending with a blind canal within the cuticle (Fig. 7). The ventral, dorsal and lateral papillae were surrounded by an invaginated ring zone of the cuticle (Figs. 3, 4 and 6). The amphid opened exteriorly through an amphidial pore about 2.3μ in diameter, surrounded with the elevated ring zone of the cuticle (Fig. 4).

There were no topographical differences at the apical view of the anterior end between male and female adults. The total number of denticles fluctuated between 424–542, when examined precisely on 10 specimens. The male and female of body length 2–3 cm possessed about 430, and those of 4–5 cm long possessed 470, irrespective of sex, but big females of 6–7 cm long had 530. This result seems to suggest that the difference in the number of denticles was due to the body length rather than the difference of sex.

The posterior region: The number and location of the papillae were basically similar to those described by Warren (1971) on the genus *Toxocara* with some exceptions as follows (Fig. 8):

The pre-cloacal central papilla was present just before the cloaca. It consisted of the transversely elongated cuticular inflation, to the posterior of which the small round papilla was attached. Just behind the cloaca there was a cuticular inflation. This can be regarded as a post-cloacal central papilla (Fig. 8).

The location of the phasmid of the male was confirmed clearly in this examination. The phasmidial pore, 0.93μ in diameter, was situated on both lateral lines, a bit anterior to the center of four post-cloacal papillae of the terminal appendage, at

79.2μ (the mean value of 5 males, ranging between $65\text{--}95 \mu$) from the terminal tip (Figs. 9, 10 and 11). A pair of phasmids of the female, examined by transverse serial sections stained with haematoxylin and eosin, was recognized as a formation with the minute lumen (20μ in maximum diameter), having direct contact to the exterior on the lateral line through the cuticle. Figs. 13a and 13b show the lumens of phasmid. They were tapering anteriorly and had a length of about 50μ at both sides, calculated from the transverse sections of a female individual. The position of the phasmidial pore in female was estimated at 123.6μ (the mean value of 5 females, ranging between $97.9\text{--}150.0 \mu$) from the terminal tip on the SEM images (Fig. 12).

Numerous bacteria were quite frequently found near the phasmidial pores in both male and female (Figs. 11 and 12).

Discussion

The stereo images provided more detailed information on the arrangement of cephalic sensory organs and the fine surface structure of the mouth region. The internal labial papillae, already observed with SEM by Kikuchi (1974) as pits, were considered to constitute altogether the inner ring of labial papillae. Both invaginations of the ventral papilla were assumed to have connection to the inner nerve endings through canals within the cuticular inflation. Some SEM images on the amphidial pore showed that some substance, probably mucous, could be released from the internal lumen.

These findings may offer additional information to support de Coninck's hexaradiate pattern (Bird, 1971) on the generalized arrangement of cephalic sensory organs in nematodes.

The pre-cloacal central papilla, lying closely anterior to the cloaca, has not been described in *T. cati*, so far as the available literature is concerned. Puylaert (1967) illustrated a small papilla corresponding to this organ just before the cloaca in *Toxocara vincenti*, but there was no explanation about it in that text. The surface structures as

well as positions of the pre- and post-cloacal central papillae were markedly different from those of other ventral papillae in pair.

The presense or absense of phasmid is considered to be of great taxonomic significance (Chitwood and Chitwood, 1950), but until now no exact data about it of the genus *Toxocara* has been published.

The position of the phasmidial pore in both male and female of *Setaria* spp. was located by SEM and they were recognized as a formation with a small lumen by sections (Shoho and Uni, 1974, Shoho *et al.*, 1975).

Muller and Ellis (1973) reported in their electron microscopic study that the phasmid of *Dracunculus medinensis* was a paired cell, having a lumen connected to the exterior.

Our findings demonstrated the phasmid of the male and female of *T. cati*.

Summary

The anterior and posterior regions of the adult *T. cati* were examined with the scanning electron microscope.

The stereo viewing of the apical view of the anterior region provided more detailed information on the arrangements of sensory organs and of the mouth region. The ventral papilla as well as dorsal papilla showed two invaginations on their surfaces, while lateral papilla showed only one invagination.

The SEM images on the posterior region of the male made it easier to understand the complicated arrangement of the many papillae before and behind the cloaca. The pre- and post-cloacal central papillae were situated just before and behind the cloaca respectively. The phasmidial pore of the male was situated on the lateral line of the terminal appendage at about 79.2μ from the terminal tip. A pair of phasmidial pores of the female was found on the lateral line and this was recognized as a formation with a minute lumen by transverse sections.

Acknowledgement

The authors are grateful to Dr. Chuzaburo

Shoho for his stimulus and encouragement during this investigation, and would like to thank Mr. Isao Kimata for the histological preparation.

References

- 1) Bird, A. F. (1971) : The structure of nematodes, Academic Press, New York and London, 318 pp.
- 2) Chitwood, B. G. and Chitwood, M. B. (1950) : An introduction to nematology, Monumental Printing Co., Baltimore, Maryland, 213 pp.
- 3) Iseki, M., Tanabe, K., Uni, S., Sano, R. and Takada, S. (1974) : A survey on *Toxoplasma* and other protozoal and helminthic parasites of adult stray cats in Osaka area. Jap. J. Parasit., 23, 317-322.
- 4) Kikuchi, S. (1974) : (Morphological studies on nematode parasites of mammals and birds by scanning electron microscope. (I) Ascaridae (2).) J. Veterinary Medicine, 629, 1297-1301. (in Japanese.)
- 5) McKee, Jr. A. E. (1973) : Scanning electron microscopy in pathologic diagnosis of mammalian parasitic diseases. Scanning electron microscopy, IIT Res. Inst. Chicago, 549-556.
- 6) Muller, R. and Ellis, D. S. (1973) : Studies on *Dracunculus medinensis* (Linnaeus). III. Structure of the phasmids in the first-stage larva. J. Helminthol., 47, 27-33.
- 7) Puylaert, F. A. (1967) : Un nouvel ascaride *Toxocara vincenti* sp. n., parasite de *Civettictis civetta* Schreber. Bull. Mus. natn. Hist. nat., Paris 39, 736-739.
- 8) Shoho, C. and Uni, S. (1974) : Fine morphological studies on *Setaria digitata* and some other *Setaria* spp. by the scanning electron microscope (JSM-50A). Third International Congress of Parasitology. Proceedings (1), 449.
- 9) Shoho, C., Uni, S. and Takada, S. (1975) : Light microscopic and scanning electron microscopic studies on *Setaria* spp. Jap. J. Parasit., 24 (suppl.), 48.
- 10) Sprent, J. F. A. (1956) : The life history and development of *Toxocara cati* (Schrank 1788) in the domestic cat. Parasitology, 46, 54-78.
- 11) Warren, G. (1971) : Studies on the morphology and taxonomy of the genera *Toxocara* Stiles, 1905 and *Neoscaris* Travassos, 1927. Zoologischer Anzeiger, 185, 393-442.
- 12) Yamaguti, S. (1935) : Studies on the helminth fauna of Japan. Part 13. Mammalian nematodes. Jap. J. Zool., 6, 433-457.

- 13) Yamaguti, S. (1961): Systema Helminthum, Vol. III, The nematodes of vertebrates, Part 1, Interscience Publishers, New York, London, 679 pp.
- 14) York, W. and Maplestone, P. A. (1962): The nematode parasites of vertebrates, Hafner Publishing Company, 536 pp.

走査電子顕微鏡によるネコ回虫感覚器官の表面構造

宇仁茂彦・高田季久

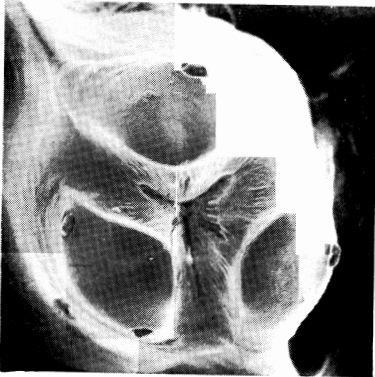
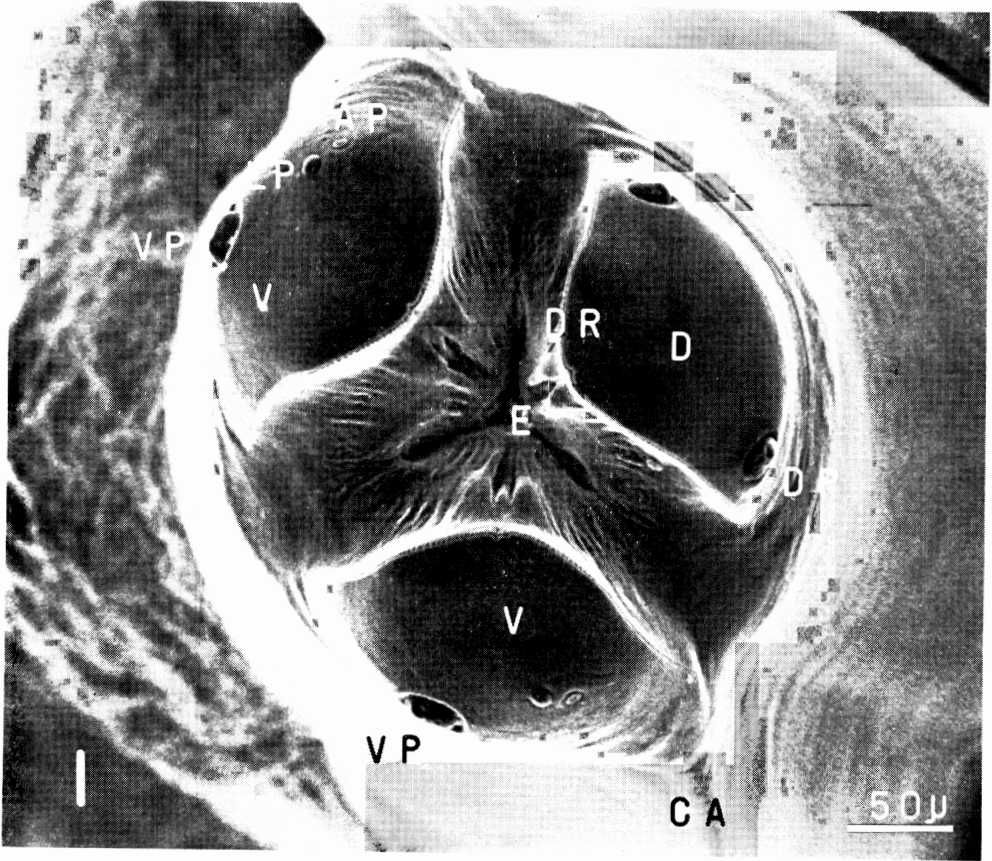
(大阪市立大学医学部医動物学教室)

ネコ回虫成虫の頭部および尾部の感覚器官の配列と表面構造を走査電子顕微鏡によつて観察した。

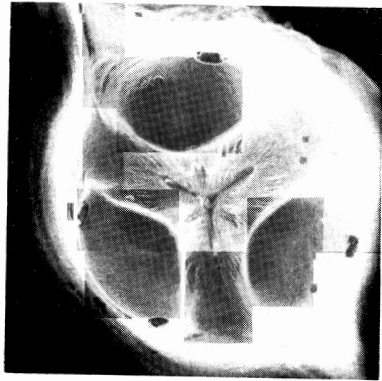
頭部頂端の立体顕微鏡像によつて、口唇、口部域、感覚乳頭、amphidの立体的な配列が明らかになつた。特に口唇頂上部に位置する6個の陥入した乳頭によつてlabial papillaの内側の輪を形成していると考えられる。さらに3方にひろがった食道起始部にそつた3口唇内壁の中央に深い切れ込みが新たに認められた。また亜腹唇のventral papilla、およびlateral papillaの表面には2個、および1個の陥入がそれぞれに認められた。

一方、尾部において、乳頭の配列およびphasmidの

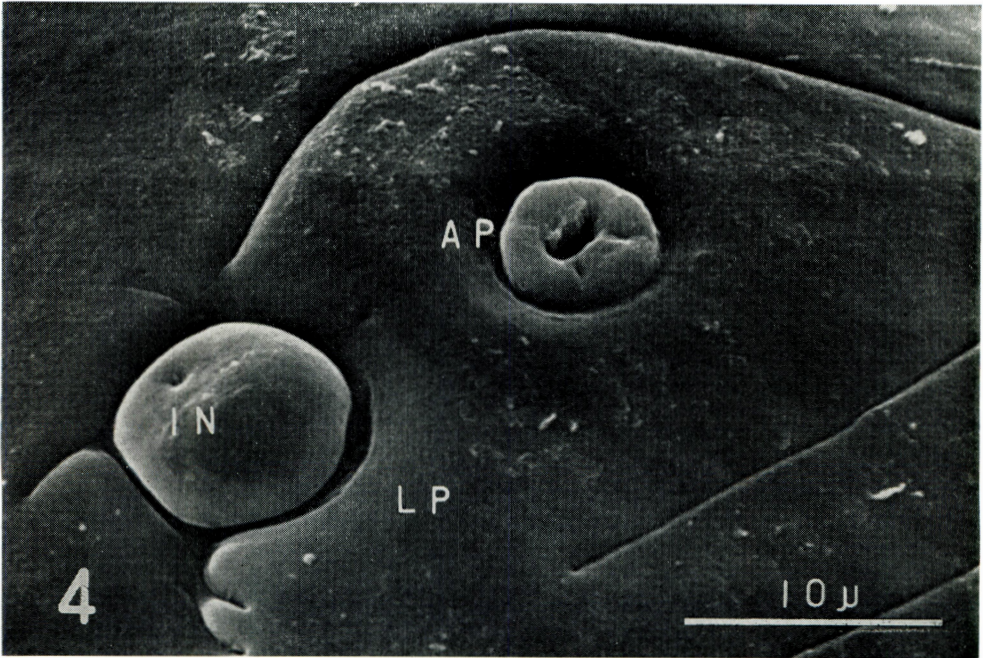
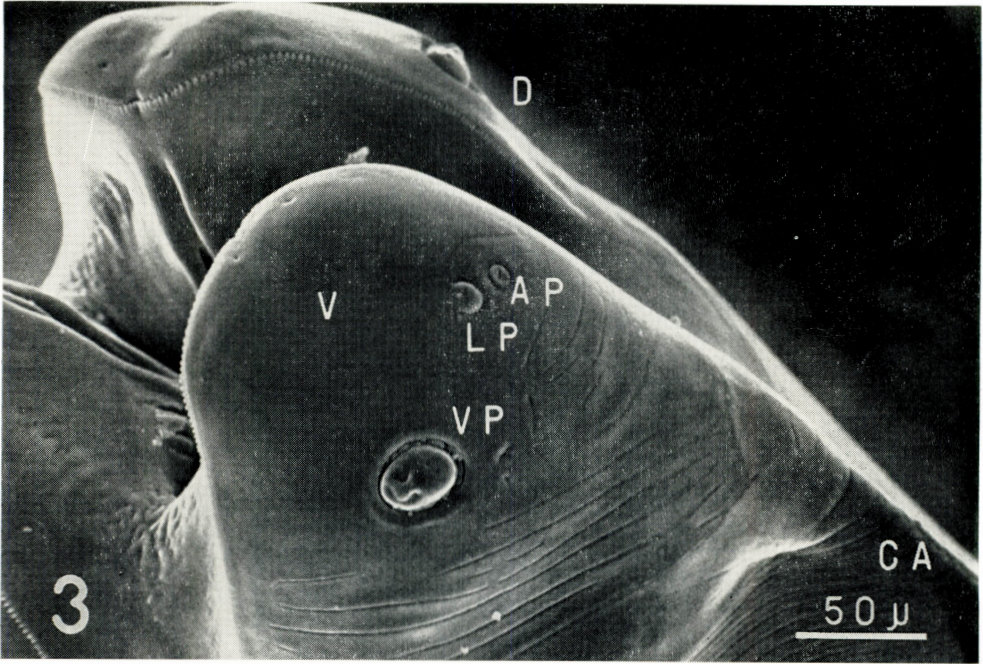
位置を明確にした。特に総排泄腔の直前に、しかも中央に位置する乳頭(pre-cloacal central papilla)は本線虫において新たな記載である。この乳頭は他の対をなす尾部の乳頭とは、その位置と同様表面構造においても顕著な相違がみられた。phasmidに関して、雄成虫ではterminal appendageの左右の側面にある4個の乳頭の中央、側線上に、尾端より平均79.2 μ においてファスミッド孔が認められた。雌成虫では尾端より平均123.6 μ に、左右の側線上に、ファスミッド孔が認められた。さらにその内部には切片によるとそれぞれ1個の内腔を持つ構造物が認められた。

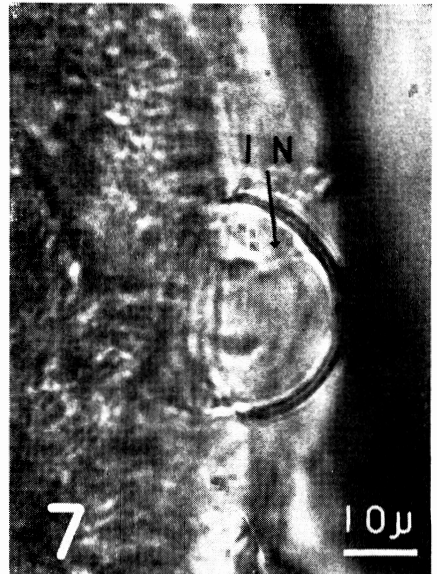
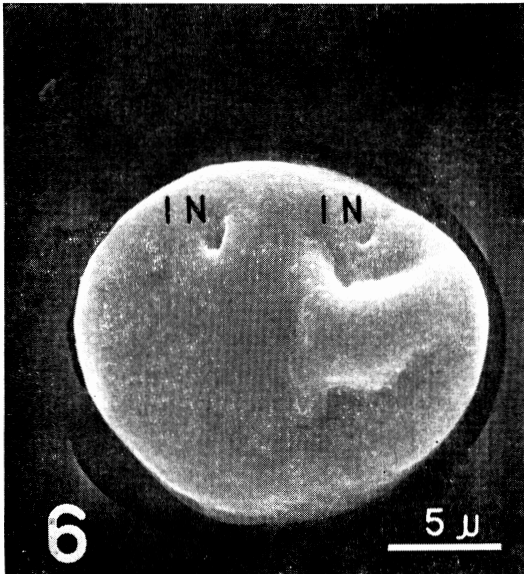
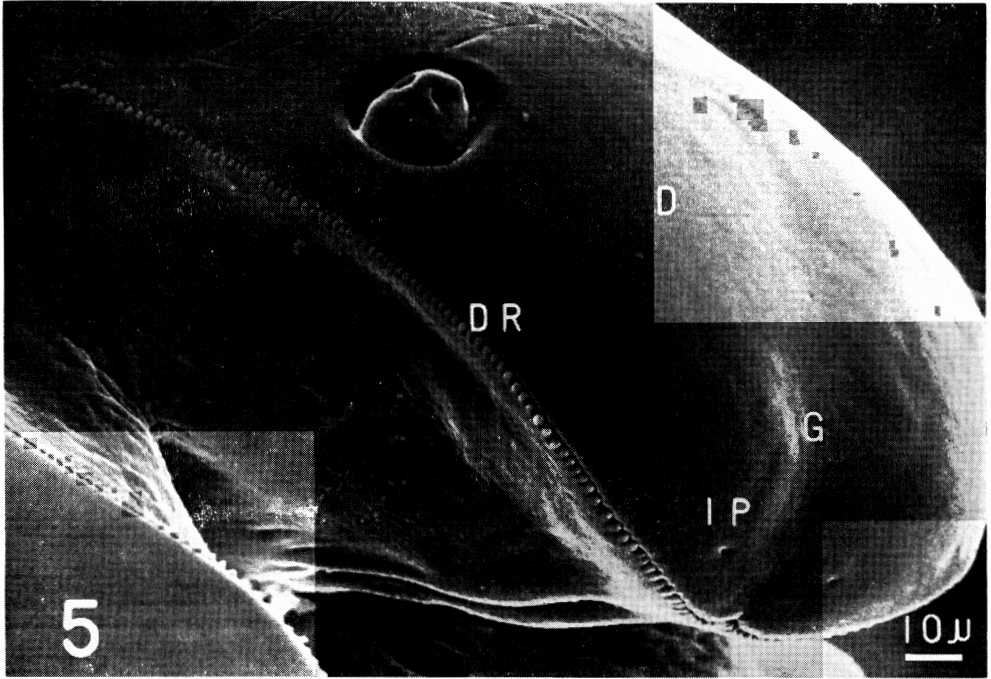


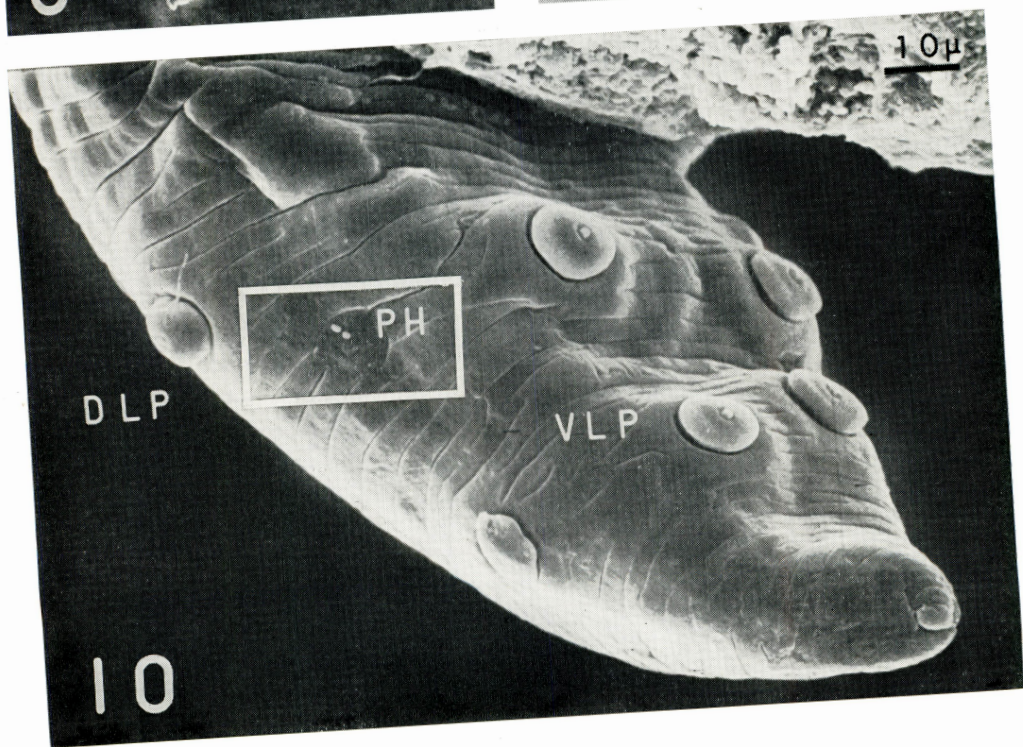
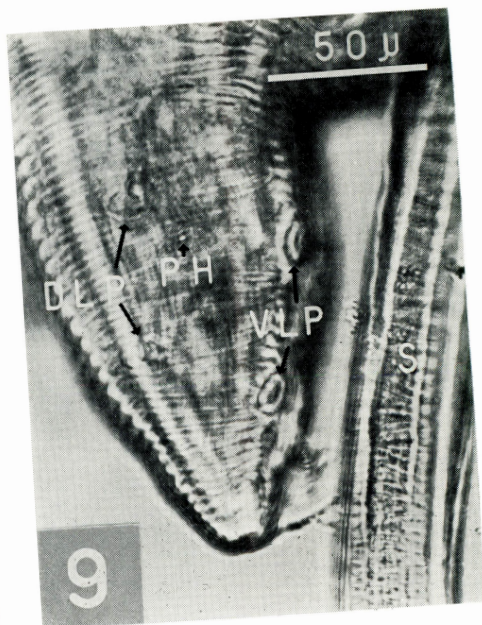
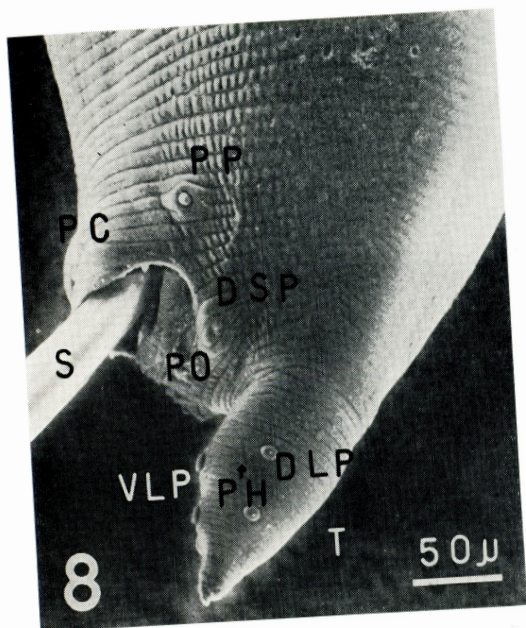
2 a

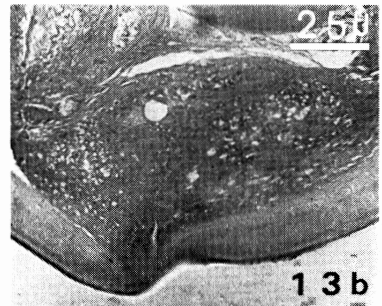
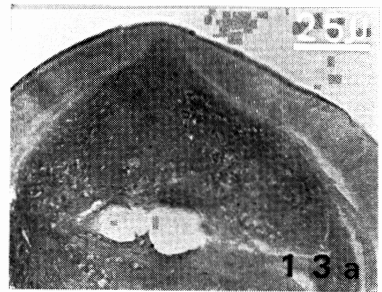
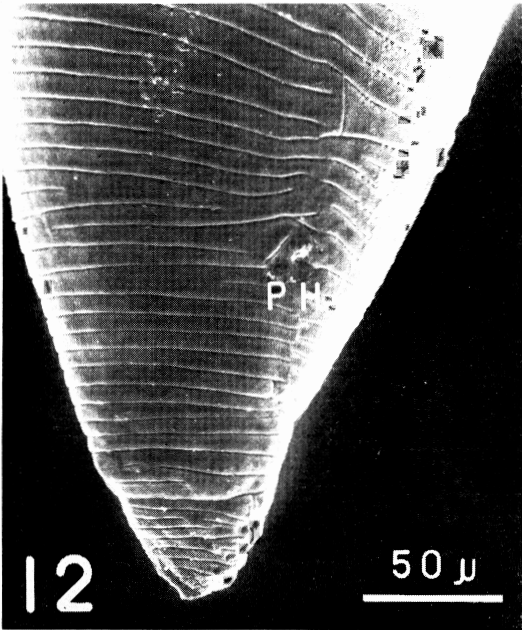
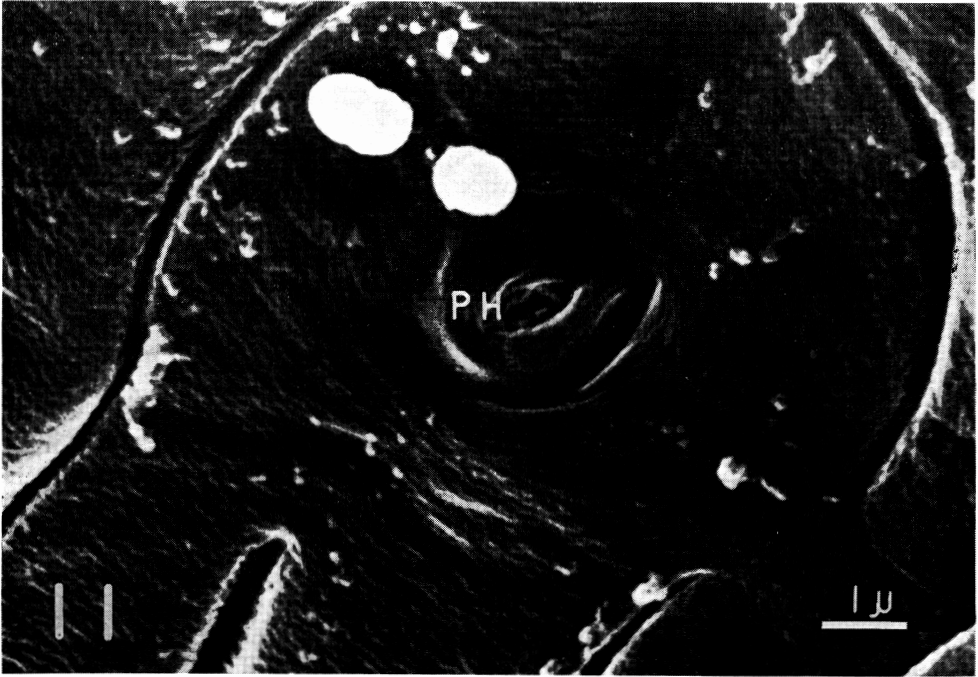


2 b









Explanation of figures

Figs. 1-6, 8, 10, 11 and 12; scanning electron micrographs.

Figs. 7, 9, 13a and 13b; light photomicrographs.

Fig. 1: Apical view of anterior end of the female ($\times 270$).

Figs. 2a and 2b: Stereo views of Fig. 1 ($\times 120$).

Fig. 3: Subventral and dorsal lips of anterior region ($\times 340$).

Fig. 4: Amphidial pore and lateral papilla of subventral lip ($\times 3,400$).

Fig. 5: A half part of a dentigerous ridge of the dorsal lip ($\times 650$).

Fig. 6: Ventral papilla of subventral lip showing two invaginations ($\times 2,800$).

Fig. 7: Ventral papilla of subventral lip ($\times 940$).

Fig. 8: Lateral view of posterior region of the male ($\times 220$).

Fig. 9: Lateral view of terminal appendage ($\times 400$).

Fig. 10: Terminal appendage ($\times 1,200$).

The area enclosed in rectangle indicates the phasmidial area.

Fig. 11: Phasmidial pore of the area (rectangle) in Fig. 10, at higher magnification ($\times 11,000$).

Fig. 12: Posterior region of the female ($\times 320$).

Figs. 13a and 13b: Transverse sections of phasmids of the female ($\times 440$).

Abbreviations

A P	amphidial pore
CA	cervical ala
D	dorsal lip
D L P	dorso-lateral post-cloacal papilla
D P	dorsal papilla of dorsal lip
DR	dentigerous ridge
D S P	double subventral papilla
L P	lateral papilla of subventral lip
E	entrance of esophagus
G	groove
I N	invagination
I P	internal labial papilla
P C	pre-cloacal central papilla
P H	phasmidial pore
P O	post-cloacal central papilla
P P	pre-cloacal papilla
S	spicule
T	terminal appendage
V	subventral lip
V L P	ventro-lateral post-cloacal papilla
V P	ventral papilla of subventral lip