SCANNING ELECTRON MICROSCOPY OF HOOKWORMS 2. ADULTS AND INFECTIVE-STAGE LARVAE OF *ANCYLOSTOMA DUODENALE* (DUBINI, 1843)

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INTRODUCTION

As the second report on scanning electron microscopy of hookworms, the present paper describes the detailed surface morphology of adult worms and infective-stage larvae of *Ancylostoma duodenale*. On this hookworm, Ishii (1971) has graphically shown the mouth parts, cervical papilla and excretory pore with the scanning electron microscope.

MATERIALS AND METHODS

Some of the adult worms of *Ancylostoma duodenale* used for the present study were obtained from a patient by anthelmintic treatment with tetrachlorethylene followed by purgation, and some were obtained from a puppy which had been experimentally infected with this hookworm (Yoshida and Okano, 1959; Okamoto, 1961).

The infective-stage larvae were obtained by cultivation (Harada-Mori method) of eggs in faeces from a patient having a pure infection with this hookworm.

The procedure of fixation, dehydration and coating of adult worms and infective-stage larvae was the same as mentioned in the first report (Yoshida *et al.*, 1974). Two types of scanning electron microscope (JSM-U3 and JSM-S1) were used for this investigation.

RESULTS

The morphology of the mouth parts of *A. duodenale* has been well studied with light microscope by many authors. Fig. 1 is a scanning electron micrograph of the mouth parts of this hookworm showing two pairs of stout ventral teeth, large outer ventral teeth (OVT) and somewhat smaller inner ventral teeth (IVT) with a rudimentary accessory toothlet (AT) at the inner base of the inner ventral tooth. The incision (I), dorsal teeth (DT) and orifice of an amphid (OA) are also seen in the same figure. The mouth opening (MO) is bordered with a thickening of the cuticle. In Fig. 2, the accessory toothlet and inner ventral tooth are well recognized under higher magnification.

Fig. 3 shows one of the cervical papillae which are conical, round at the top, and have wide skirts. The papilla itself does not bend like that of *N. americanus*. There are many fine wrinkles and some cyclical lines on the surface of the papilla.

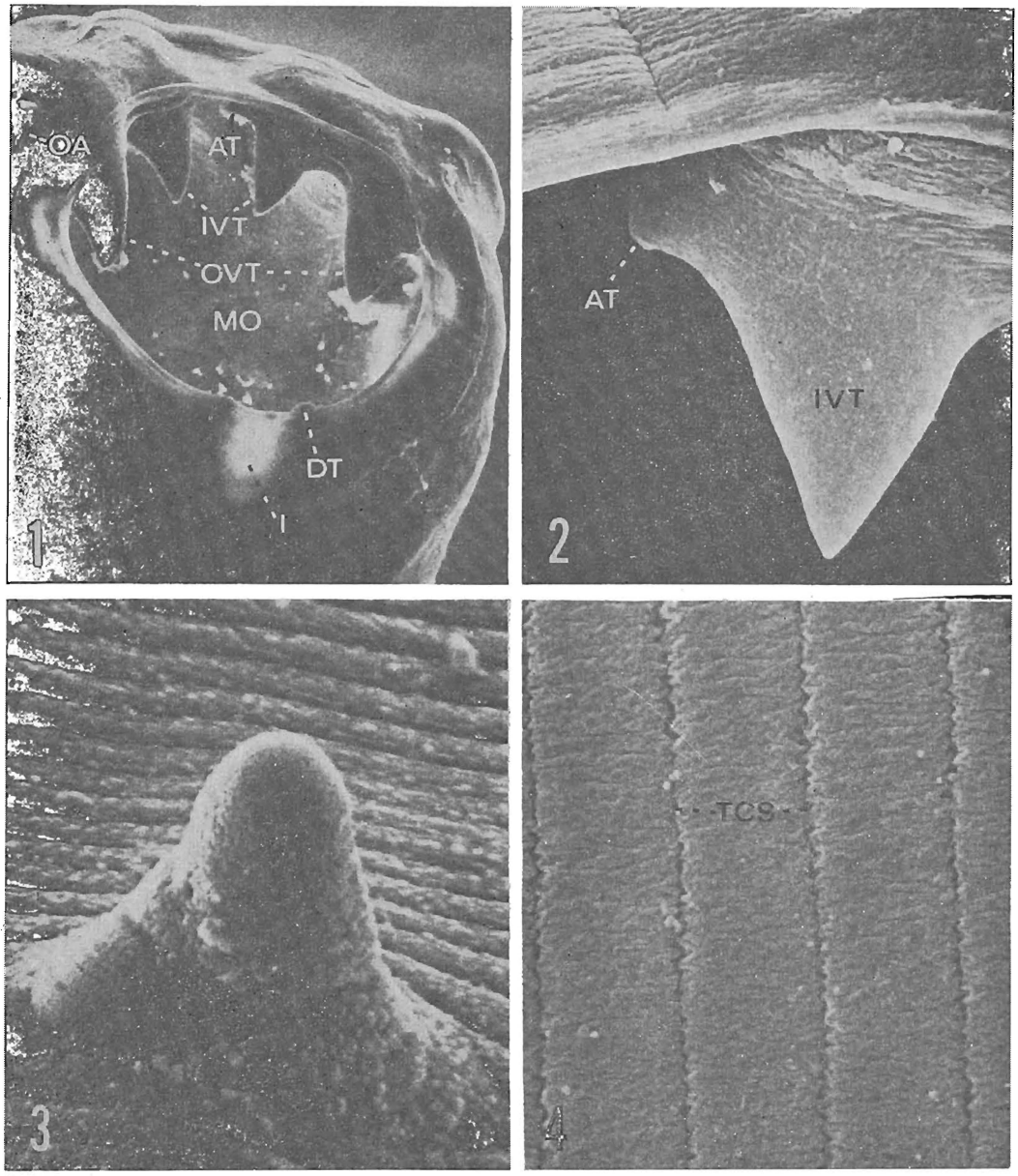
The transverse cuticular striations of *A. duodenale* are distinctive among hookworms. As shown in Fig. 4, the striations are deep and zigzag in shape. Many fine wrinkles are seen on the surface between them. The distance between the striations is 5.0-6.0 μ.

The copulatory bursa is shown in Fig. 5. The bursa of *A. duodenale* is longer in the direction of the dorsal ray than the lateral ray. The dorsal lobe (DL), lateral lobe (LL) and the pointed end of the externo-dorsal ray (EDR) are seen in the figure.

The tail end of an adult female is shown in Fig. 6. At the tip of the tail there is a

sharp mucron (M), which bends and touches the body in this figure. The mucron is about 21 μ long.

Figs. 7 and 8 show the surface structure of the sheath of an infective-stage larva of *A. duodenale*. The distance between the



Figs. 1, 2—Mouth parts of adult *A. duodenale* showing mouth opening (MO), inner ventral teeth (IVT), outer ventral teeth (OVT), accessory toothlet (AT), dorsal teeth (DT), incision (I), and orifice of amphid (OA) (Fig. 1, 845 X; Fig. 2, 2300 X).

Fig. 3—Cervical papilla (2760 X).

Fig. 4—Transverse cuticular striations (TCS) of adult worm (4320 X).

striations is about 1.0 μ. The lateral line (LL) is band-like, not concave in the middle, and about 2.6 μ wide. Owing to the presence of many fine transverse striations on the lateral line, it looks like a tapeworm (Fig. 7).

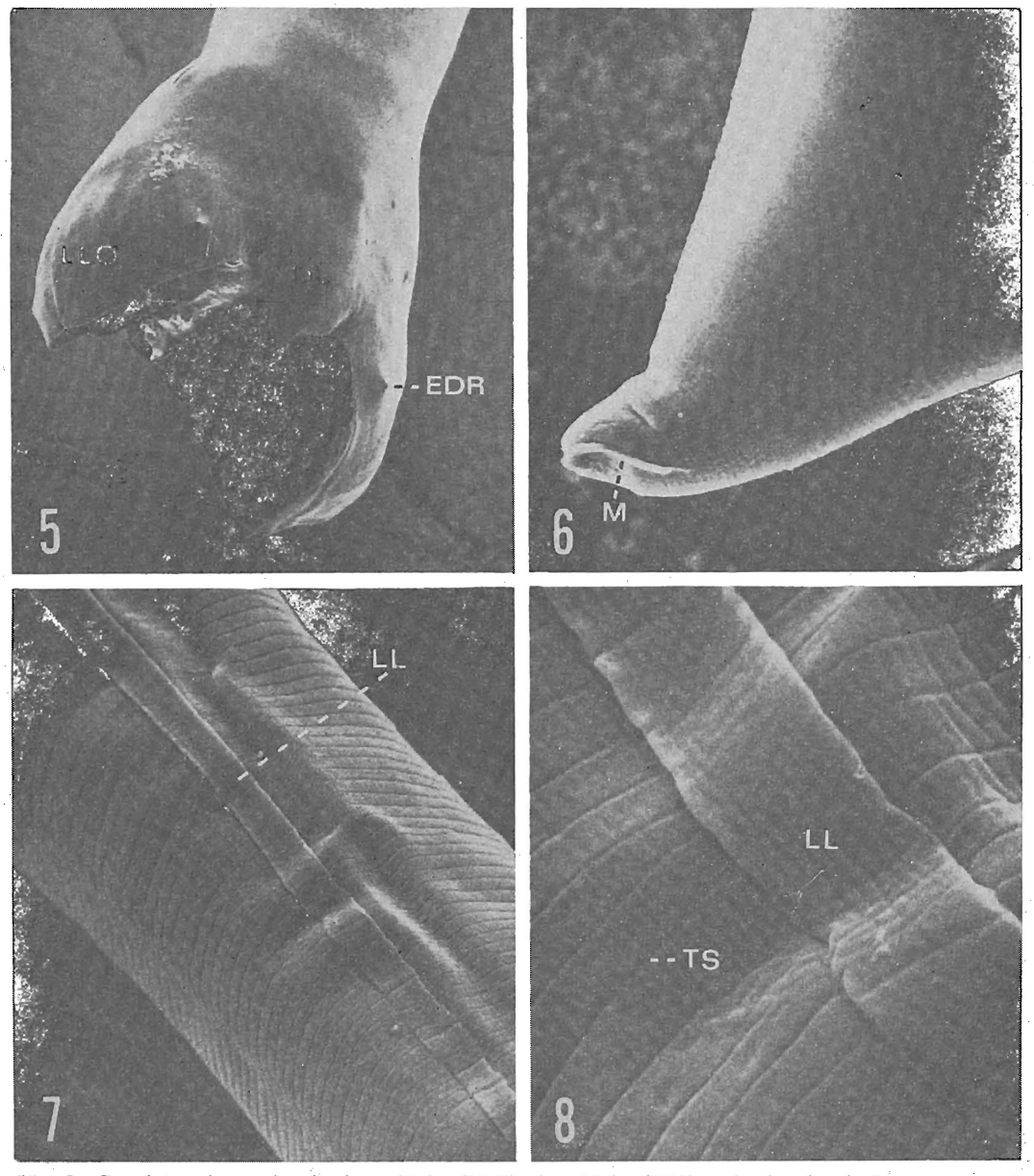


Fig. 5—Copulatory bursa showing lateral lobe (LLO), dorsal lobe (DL), and pointed end of externo-dorsal ray (EDR) (175 X).

Fig. 6—Tail of female adult which has the mucron (M) at the tail end (900 X).

Figs. 7, 8—Surface of sheath of the infective-stage larva of *A. duodenale* showing lateral line (LL) and transverse striations (TS) (Fig. 7, 2600 X; Fig. 8, 8810 X).

DISCUSSION

In 1971, Ishii published scanning electron micrographs of the mouth parts, cervical papillae and excretory pores of *A. duodenale*. The accessory toothlet, which was hardly seen in his figure, was shown in detail in the present investigation. The shape of the cervical papilla obtained in this study coincided well with that shown by Ishii. The cervical papilla of *A. duodenale* was distinguishable from that of *N. americanus* which bends posteriorly and has sharp point (Yoshida *et al.*, 1974).

The transverse cuticular striations were also characteristic in this hookworm; they were zigzag in shape whereas those of *N. americanus* were straight (Yoshida *et al.*, 1974).

The female adult worm had, at the tail end, a sharp mucron which was not seen in *N. americanus* (Yoshida *et al.*, 1974).

Although the lateral line on the sheath of the infective-stage larva of *A. duodenale* was somewhat different from that of *N. americanus* in which the lateral line was concave in the middle, it was still difficult to distinguish one from the other even by scanning electron microscopy.

SUMMARY

The surface structures of adult worms and infective-stage larvae of *A. duodenale* were studied with the aid of the scanning electron microscope. At the cephalic end of the adult worm, the mouth opening, inner and outer ventral teeth, accessory toothlets, dorsal teeth, incision, and amphid orifice were three-dimensionally demonstrated. The cervical papilla was conical, round at the top, and had wide skirts. The papilla did not bend like that of *N. americanus*. The transverse cuticular striations of the adult worm were zigzag in shape and 5.0-6.0 μ apart. A sharp mucron was seen at the tail end of the female adult worm. The lateral line on the sheath of the infective-stage larva was band-like and about 2.6 μ wide.

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