FOLIA PARASITOLOGICA 39: 145–151, 1992.

A scanning electron microscope study of *Raillietascaris varani* (Baylis et Daubney, 1922) (Nematoda: Ascaridioidea)

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Key words: Nematoda, scanning electron microscope, surface morphology

Abstract. The *Raillietascaris varani* (Baylis et Daubney, 1922), parasitic in the Indian monitor lizard, *Varanus monitor* (L.), was studied by scanning electron microscopy (SEM). A surface topography of the worm, especially the head and male tail, were described, illustrated and discussed with regard to the available data on this species, and also other species of ascaridoid nematodes. The present study confirms the previous observations from Sprent (1985), and also provides some additional information concerning the microtopography of the worm which might be useful in comparative studies on the Ascaridoidea.

The existence of the *Amplicaecum varani* was established by Baylis and Daubney (1922) and based on specimens from the intestine of the *Varanus salvator* from Calcutta, India. Other Indian species, *A. monitor* Khera, 1954, and *A. iguaneae* Wahid, 1961, were reported in *V. monitor* and *Iguana* sp., respectively. In 1985, Sprent created a new genus, *Raillietascaris*, to accommodate the existence of *A. varani.* He redescribed the *R. varani* on the basis of light microscope (LM) and scanning electron microscope (SEM) studies, and treated *A. varani, A. iguanae, A. monitor, O. varani,* and *A. mackerrasae* Thomas, 1959 as its junior synonyms.

The present SEM study of specimens collected from the *V. monitor* from India, provides detailed information regarding the morphology (including the microtopography) of this species which might prove of value in understanding its relationships with other ascaridoids.

MATERIALS AND METHODS

Five nematodes (three males and two females) of *Raillietascaris varani* (Baylis et Daubney, 1922) were recovered from the stomach and intestine of an Indian monitor lizard *Varanus monitor* (L.), caught alive in the Kalyani University campus, Kalyani, West Bengal, India. The worms were cleaned thoroughly in 0.85 % NaCl-saline and then fixed in 10 % formalin. Two males and one female were processed for scanning electron microscopy. The methods adopted by De (1990) were followed. A Phillips 500 scanning electron microscope (PSEM 500) was used.

For comparison of morphological details, the rest of the worms collected, i.e. one male and one female, were thoroughly washed in distilled water and transferred to 70 % ethanol through graded series of ethanol. They were then put in a solution of 5 parts glycerol and 95 parts 70 % ethanol and examined in glycerine after the alcohol had evaporated, the worms were ultimately conserved in 70 % ethanol for future use.

Abbreviations: al, ala; am, amphid; art, artifact; aur, auricular ridge; cb, cuticular band; ck, central knob; cl, cloacal opening; col, collar; cs, cuticular striation; dl, dorsal lip; dp, double papilla; ep, excretory pore; fc, folded cuticle; il, interlabium; ilp, internal labial papilla; m, mouth; p, papilla; ph, phasmid; sp, single papilla; svl, subventral lip.

RESULTS

Raillietascaris varani (Baylis et Daubney, 1922)

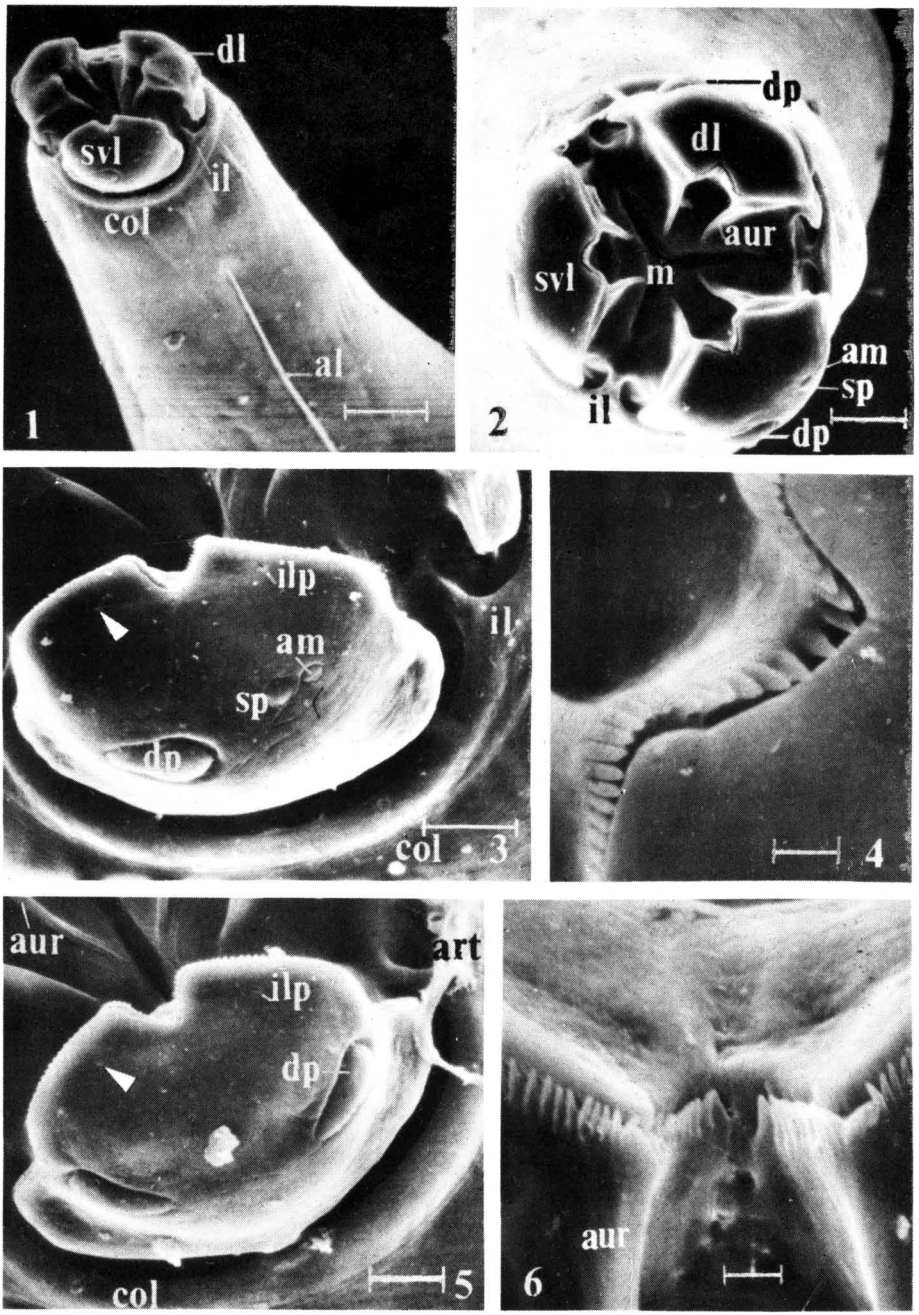
Host: *Varanus monitor* (Linnaeus)
Localization: Stomach and intestine
Locality: Kalyani University campus, Kalyani, West Bengal, India
Deposition of specimens: Kalyani University, Helminthology Laboratory, West Bengal, India, Reg. No. KUHL 1988 G/1–2.

The nematode studied conforms with the *R. varani* in the general morphology described by Sprent (1985).

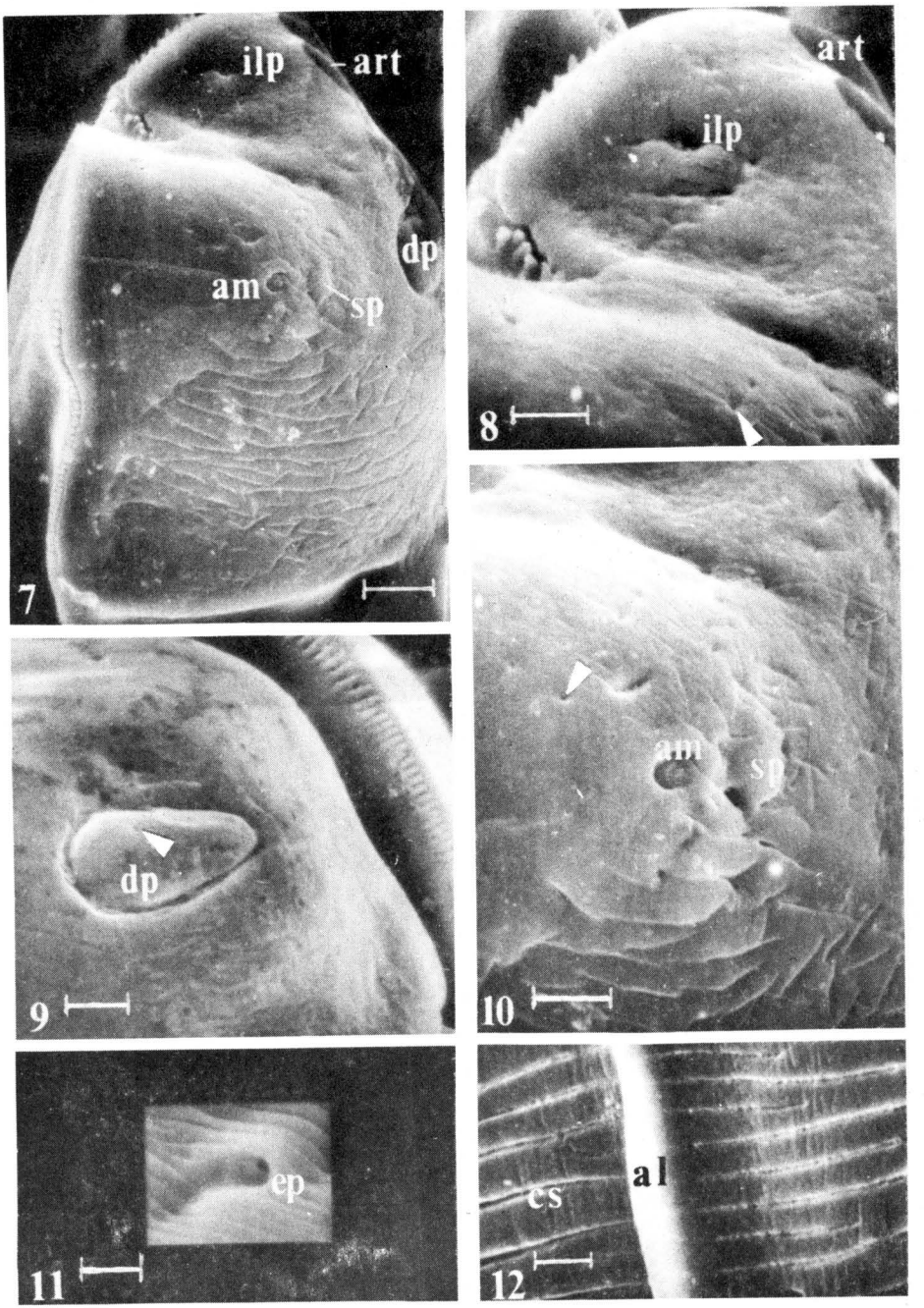
At lower magnification, the three large lips (one dorsal and two subventrals) characteristic of ascaridoid nematodes were observed (Fig. 1) as surrounding a triradiate stoma (Fig. 2). The lip cuticle was extended to form two posterolateral flanges (Figs. 3 and 5). Two distinct ridges rose from the protostome region and proceeded towards the anterior inner surface of each lip (Fig. 2). A single row of denticles separates the outer and inner surfaces (Fig. 4). The denticles were arranged along the margin of the inner labial surface (Fig. 4). Narrow grooves were external to the rows of denticles (Fig. 4). The denticles were almost of equal size, typically unicuspid and with broad bases and sharp distal extremities (Fig. 4); their arrangement was, however, different for each lip: on the dorsal lip they were arranged continuously (Fig. 4), but on the subventral lips, there were some small gaps, one at the inner apical notch and two just outside it (Fig. 6). In the SEM photomicrographs (Fig. 7) the outer surface of each lip showed two distinct regions, smooth apical and reticulated basal.

The external ring of papillae was represented by four large papillae – 2 dorsolateral on the dorsal lip and 1 ventrolateral on each subventral lip (Fig. 2). Under the light microscope these papillae seemed to be doubled and there were two nerve endings (this last from our own unpublished data). Under the SEM, however, they appeared as single structures separated from the cuticular surface by a distinct surface groove all around with a pore on their broader side (Fig. 9). Each subventral lip also possessed an externolateral papilla and an amphid. The externolateral papillae were typical to ascaridoid nematodes, consisting of a narrow cuticular rim surrounding a central pore (Fig. 10). The inner circle of labial papillae were revealed as two distinct pits in the smooth apical part of each lip (Figs. 3 and 5, 7, 8). A few other small slits were found nearby (Fig. 10).

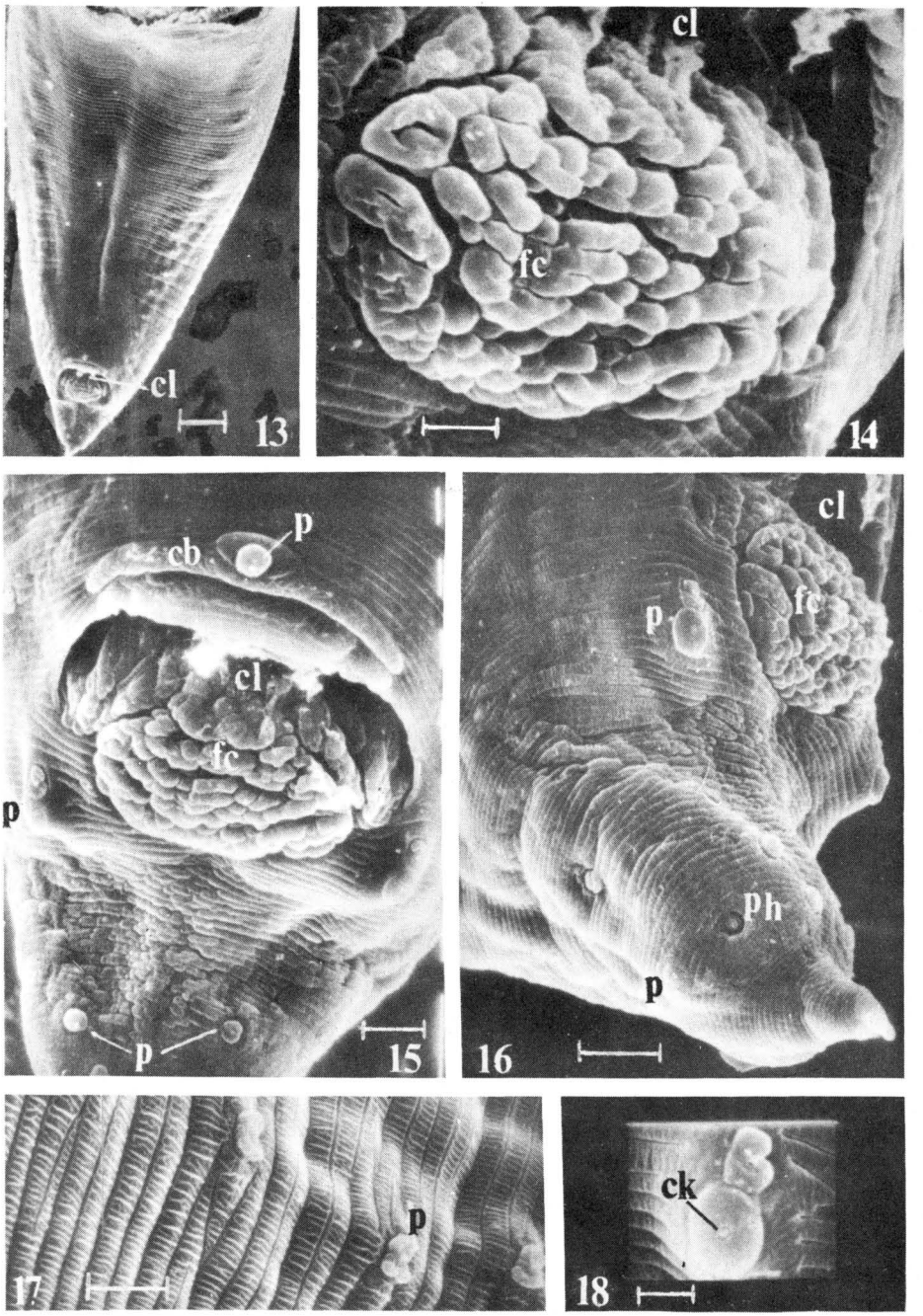
The lips were separated from body by a distinct postlabial groove followed by a cuticular collar (Figs. 1, 3). The posterior lip margins usually, although not always, extend as pillars to join the collar (Fig. 5). Shallow interlabia were connected by a



Figs. 1–6. *Raillietascaris varani*, SEM micrographs. **Fig. 1.** Anterior end of male, ventrolateral view; bar: 120 μm. **Fig. 2.** *En face* view of male; bar: 40 μm. **Fig. 3.** Subventral lip, ventrolateral view; bar: 28 μm. **Fig. 4.** Portion of dorsal lip showing denticles on inner labial surface, enlarged apical view; bar: 5 μm. **Fig. 5.** Dorsal lip, dorsal view; bar: 20 μm. **Fig. 6.** Portion of subventral lip showing denticles on inner labial surface, enlarged apical view; bar: 10 μm.



Figs. 7–12. *Raillietascaris varani,* SEM micrographs. **Fig. 7.** Subventral lip, enlarged dorsolateral view; bar: 20 μm. **Fig. 8.** Portion of subventral lip, enlarged dorsolateral view; bar: 12 μm. **Fig. 9.** Portion of subventral lip showing double papilla, enlarged ventrolateral view; bar: 10 μm. **Fig. 10.** Portion of subventral lip showing single papilla and amphid, enlarged dorsolateral view; bar: 14 μm. **Fig. 11.** Portion of body surface showing excretory pore, enlarged ventral view; bar: 13 μm. **Fig. 12.** Portion of body surface showing cervical ala, enlarged lateral view; bar: 12 μm.



Figs. 13–18. *Raillietascaris varani*, SEM micrographs. **Fig. 13.** Tail end of male, ventral view; bar: 140 μm. **Fig. 14.** Rugose area behind the cloacal opening, enlarged ventral view; bar: 15 μm. **Fig. 15.** Tail end of male, enlarged ventral view; bar: 18 μm. **Fig. 16.** Tail end of male, enlarged lateral view; bar: 20 μm. **Fig. 17.** Body surface showing preanal papillae, enlarged ventral view; bar: 20 μm. **Fig. 18.** Paracloacal double papilla, enlarged ventral view; bar: 12 μm.

collar basally, and the apex of each interlabium was continued inwardly as a narrow ridge and connected to the protostom region (Fig. 2 and 3). Narrow, but distinct lateral cervical alae rose closely behind the collar (Fig. 12). The excretory pore was in the form of a simple small slit (Fig. 11). The male tail had a series (32 pairs) of linearly arranged precloacal (Fig. 13), one double paracloacal (Figs. 15 and 16) and two subventral and two subdorsal postcloacal (Fig. 16) papillae on each side. Each of the precloacal papillae had a central knob surrounded by 3–4 small petaloid cuticular projections (Fig. 17). The double paracloacal papilla consisted of one large posterior and a smaller anterior papillae which were clearly set apart from the surrounding cuticle and had a distinct central knob (Fig. 18). The postcloacal papillae were almost of equal size (Fig. 16). An arch-shaped cuticular band (Fig. 15) with a median papilla was evident on the anterior lip of the cloaca. The ventral body cuticle, immediately posterior to the cloacal opening, exhibited a rugose area where the cuticle became densely folded with the appearance of villi (Fig. 14). Phasmids were found laterally at the level of posterior subdorsal papilla and marked by a distinct semicircular groove (Fig. 16).

DISCUSSION

Sprent (1985) redescribed the *Raillietascaris varani* via light and scanning electron microscope studies. The data obtained from the present SEM study of the *R. varani* conforms with that given by Sprent (1985) and also provide some new and important information about the microtopography of the worm. Two distinct cuticular ridges extending along the inner surface of each lip were seen in the SEM photomicrographs of the present worm which were not mentioned in any of the available literature concerning the *R. varani.* Soleim (1974), however, reported the presence of such ridges in another ascaridoid nematode, *Contracaecum aduncum* (Rudolphi, 1802). Sprent (1985) did not describe in detail the structure of the large papillae present on the lips. In the present study each of the large papillae was externally seen as a single structure separated from the cuticular surface by a distinct groove and bearing a pore on its broader side.

As observed in the current study, the inner circle of labial papillae (in the form of two distinct pits) was identified through SEM studies of *Ascaris suum* by Madden et al. (1970) and Kazacos and Turek (1982). Sprent (1985), however, did not mention the presence of such papillae in the *R. varani.*

As to the male tail of the *R. varani*, the existence of 3–4 small petaloid cuticular projections surrounding the central knob of each of the precloacal papillae has been recorded for the first time by the current SEM study. Sprent (1985) reported that there was no ornamentation on the ventral surface anterior to cloaca. But this study found an arch-shaped cuticular band with a median papilla on the anterior cloacal lip of the worms. In addition the rugose area immediately posterior to the cloacal opening revealed that the cuticle became densely folded with the appearance of villi. This was noted as cuticular bosses by Sprent (1985).

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Received 3 July 1991

Accepted 23 January 1992

FOLIA PARASITOLOGICA 39: 151–152, 1992.

G. A. Schad, K. S. Warren, (Editors): Hookworm Disease: Current Status and New Directions. *Taylor & Francis, London, New York, Philadelphia, 1990. 438 pp. Cloth Price £ 60.00, US $ 120.00*

This highly informative volume is representative of the series of monothematic monographs issued by Taylor and Francis Publishers which relate the proceedings of international conferences dealing with important parasitic diseases. An identically entitled meeting was held in Bellagio, Italy on September 1988. It commemorated the 75th anniversary of the Rockefeller Foundation's initial involvement in promoting global hookworm control and related research. This volume represents work of a team of 30 international experts and consists of eight parts divided into 27 chapters.

The first part is intended to give a historical introduction and discusses the role of the Rockefeller Foundation in hookworm research and control. The second part is concerned with the regional status of hookworm infection and disease in Africa, the Middle East, in Southeast Asia, Oceania, Australia, China, Latin America and in the Caribbean. The third part reviews the advances made in biological knowledge of hookworms and concentrates on hypobiosis, i.e. arrested development. In some regions, prolonged survival of *Ancylostoma duodenale* larvae in host tissues is seasonal. Some larvae acquired during the rainy season of one year become dormant, maturing before the rainy season of the next year. This results in the pre-monsoon rice in faecal egg excretion. It represents an adaptation phenomenon important for the spreading of the infection and also for the treatment, since dormant larvae resist anthelmintics. Larval dormancy also occurs in the skeletal muscles of some experimentally infected animals such as calves, lambs and pigs (but not chickens). It suggests a possible meat-borne infection.

Following chapters inform about the ecology of the free-living stages and the laboratory animal models. Thus, in the fourth part they introduce the epidemiology and population ecology and discuss hookworms as geohelminths and analyse