

Cactodera evansi sp. n. and *Meloidodera astonei* sp. n. (Tylenchida: Heteroderidae) from Mexico

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Abstract. *Cactodera evansi* sp. n. and *Meloidodera astonei* sp. n. are described from specimens obtained from roots of carnation (*Dianthus caryophyllus* L.) and *Solanum rostratum* Dunal from Mexico, respectively. *Cactodera evansi* is characterized by the small size of the female body and the conspicuous labial disc in the second stage juvenile. *Meloidodera astonei* is characterized by the structure of the cuticular blocks in the lip region of the males, the shape of the submedian lips and the conical-round tail of the juveniles. Morphometric and morphological data and descriptions of females, second stage juveniles and males of both species are provided.

Keywords. *Cactodera evansi*, carnation cyst nematode, *Meloidodera astonei*, Mexico, morphology, new species, *Solanum rostratum*, taxonomy.

INTRODUCTION

A new cyst nematode species of the genus *Cactodera* Krall & Krall, 1978 was found during a survey conducted during 1997 in the horticultural crop area of México State; cysts, males and second stage juveniles were collected from several plant species and a few lemon-shaped cysts of typical *Cactodera* shape were isolated from soil and roots collected from a carnation (*Dianthus caryophyllus* L.) field in "Las Parvas," Villa Guerrero County, México. Preliminary morphological observation of the cyst perineum indicated that the cysts isolated from the carnation plants and the white females attached to the roots were a new species of *Cactodera*, and this species is described here as *Cactodera evansi* sp. n. This brings the known number of *Cactodera* species up to twelve (Evans and Rowe, 1998). The nematode specimens collected during 1998 from *Solanum rostratum* Dunal plants in the locality of La Purificacion, Texcoco, were found to represent a new species of *Meloidodera* Chitwood, Hannon & Esser, 1956. Detailed morphological examination revealed significant differences from other species and it is therefore proposed and described here as *Meloidodera astonei* sp. n.

MATERIALS AND METHODS

Various stages of both *Cactodera evansi* sp. n. and *Meloidodera astonei* sp. n., obtained from the respective plant roots, were heat-relaxed in hot water, fixed in FA 4:1, processed to glycerine by the slow method of Thorne (1961)

and permanently mounted in dehydrated glycerine. Specimens were measured with the aid of a camera lucida. For scanning electron microscopy, specimens were fixed in 2% sodium phosphate-buffered glutaraldehyde, washed with sodium phosphate buffer pH 6.8, and put into 1% osmium tetroxide overnight. They were then dehydrated through an ethanol series from 10% to 100% and critical point dried. After coating with gold they were observed in a Hitachi scanning electron microscope at 10kv accelerating voltage.

Cactodera evansi sp. n.

(Figs 1-3)

Females and Cysts

Measurements

Holotype female: Length with neck=390 µm; maximum width=200 µm; length/width ratio=1.9; vulva-anus distance=36 µm.

Paratype females white (n=15): Length with neck=433±3.4 (356-560) µm; maximum width=239±3.9 (148-395) µm; length/width ratio=1.88±4.1 (0.66-3.8); neck length=83±1.3 (52-128) µm; vulva-anus distance=43±8.1 (32-80) µm.

Paratype females cysts (n=31): Length with neck=459±10.7 (416-528) µm; maximum width=334±9.3 (284-384) µm; length/width ratio=1.4±0.4 (1.2-1.7); neck length=98.3±1.8 (92-116) µm; vulva-anus distance=43±8.1 (32-80) µm.

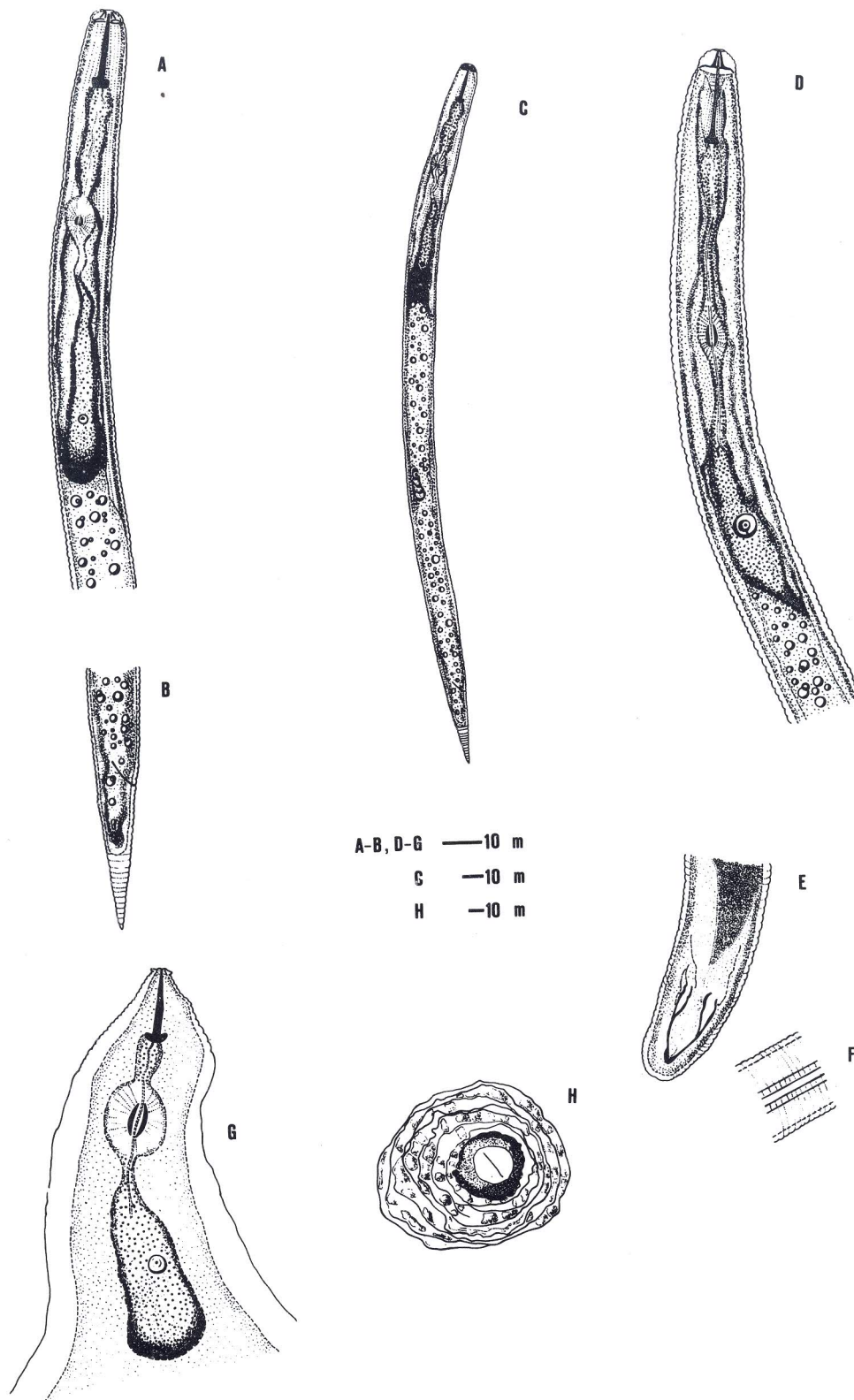


Fig. 1. *Cactodera evansi* sp. n. A-C: second stage juvenile. A- Anterior region; B- Tail; C- Body in toto. D-F: male. D- Oesophageal region; E- Posterior end (ventral); F- lateral field; G-H: female. G- Anterior region; H- Circumfenestra.

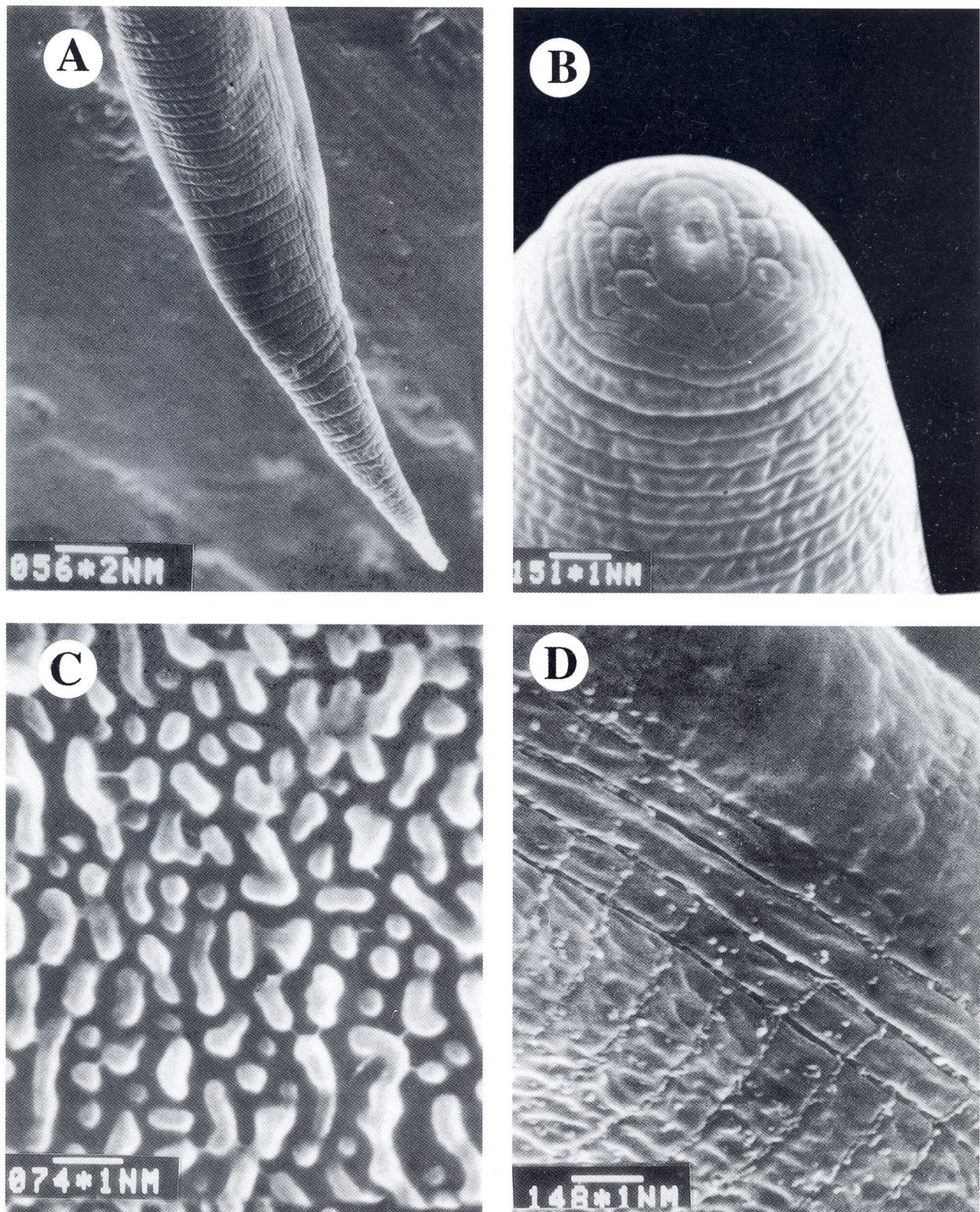


Fig. 2. *Cactodera evansi* sp. n. SEM of second stage juvenile and egg. A- Tail; B- Anterior end with en face view of head; C- Egg surface showing microvilli; D- Lateral field.

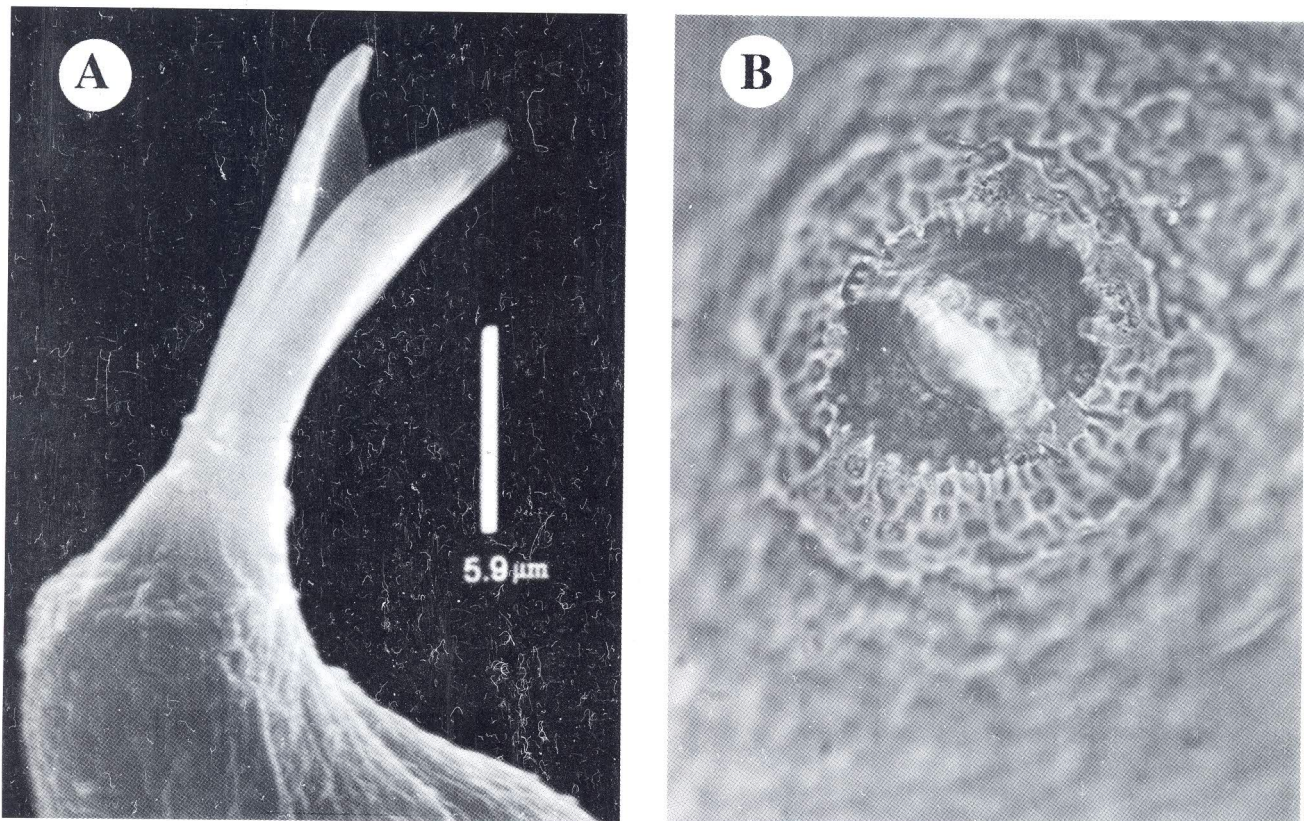


Fig. 3. *Cactodera evansi* sp. n. A- SEM of male tail, spicules; B- Light microscopy of female fenestration.

Body lemon-shaped, a few females almost spherical, others more longitudinally oval in shape; the neck is generally short and covered with a yellow material often referred to as cement. The vulval cone is small but distinct. Cuticular annulation distinct, in some areas there are irregular annulations. The excretory pore is difficult to see, localized almost at the end of the oesophageal gland lobe, 86 to 96 μm from the anterior of body. Subcrystalline layer absent. Labial disc distinct and the first cephalic annule is wider than the rest. The stylet including knobs 20 to 25 μm in length; knobs well developed with anterior projections;

median oesophageal bulb oval in shape and 23 (19-25) μm in length; oesophageal gland bulb 42 μm in length (n=20). In lateral view the vagina is short and the uterus oval to round with wall one cell thick. Cyst fenestra diameter 18.0-22.8 μm and vulval slit 17.1-19.0 μm .

Males

Allotype male: Length=1010 μm ; width=26 μm ; lip region height=5.6 μm ; lip region width=10.8 μm ; stylet length=26 μm ; stylet knobs width=3.8 μm ; oesophagus length=160 μm ; excretory pore 142 μm ; hemizonid 136 μm ; a=38.8; b=8.7;

b'=6.3; c=280; spicules 30 µm.

Paratype males (n=11): Length=979±6.5 (780-1090) µm; width=26±1.6 (24-28) µm; lip region height=5.6±5.5 (4.8-6.4) µm; lip region width=10.6±9.7 (8.6-12.4) µm; stylet length=24.9±2.1 (20.8-26.4) µm; stylet knob width=4.3±5.2 (3.6-5.6) µm; oesophagus length=159±1.1 (152-180) µm; DGO=3.4±1.0 (2.8-4.0) µm; excretory pore 128±1.4 (88-144) µm; hemizonid 131±4.6 (126-136) µm; a=36.7±3.5 (26.4-46.1); b=9.2±1.0 (8.3-11.3); b'= 6.6±5.1 (5.8-8.0); c=266±3.2 (166-340); o=13.5±1.3 (12.1-15.1); tail 3.8±6.3 (2.8-4.4) µm; spicules 24.7±2.8 (20.0-30.0) µm.

Body vermiform and slightly curved ventrally. Lip region separated from the body by a constriction. Labial disc distinct in lateral view. Head region with six or seven lip annules; labial disc protruding in lateral view. Stylet less robust than in second stage juveniles; stylet knobs with anterior surface rounded and slightly sloped posteriorly. Hemizonid two to three annules anterior to excretory pore. Lateral field with four incisures, outer bands with incomplete areolation (Fig. 1F). Spicules slightly curved, tip slightly bifid (Fig. 3A). Gubernaculum and phasmids not observed. Tail twisted, short (less than one body width) and rounded. Cloacal tubus present. Bursa absent.

Second stage juveniles

Measured in glycerine-water solution (n=10): Length=422±3.3 (360-505) µm; a=22.9±2.9 (20.0-29.3); b=4.6±1.2 (3.2-6.0); b'=2.8±0.8 (2.3-3.1); c=9.9±9.2 (8.2-11.5); stylet length=22.1±9.2 (19.9-24.0) µm; DGO=3.4±8.7 (2.0-4.0) µm; o=17.9±3.8 (10.5-22.7); excretory pore 83.2±8.1 (60-103) µm.

Measured in dehydrated glycerine mounts (n=8): Length=387±1.3 (358-420) µm; a=22.1±6.9 (21.1-23.3); b=4.9±0.2 (4.8-5.2); b'=2.6±0.6 (2.2-2.9); c=9.6±6.9 (8.9-11.5); stylet length=21.9±1.1 (20.0-24.0) µm; stylet knob width 4.1±2.7 (3.6-4.8) µm; DGO=3.0±1.1 (2.8-4.0) µm; o= 13.7±5.3 (9.8-18.8); tail 40.4±2.8 (34-44) µm; hyaline tail 21.1±2.0 (16.4-23.2) µm.

Body small, tapering at extremities (Fig 1C); lip region with four annules; labial disc slightly protruding; the face pattern has two submedian lateroventral and laterodorsal lips which are separated by a fissure in the dorsal and ventral position; the two lateral lips are reduced (Fig. 2B). Lateral fields with four incisures, outer bands with incomplete areolation and the internal band not areolated (Fig. 2D). Stylet robust; knobs well developed; anterior surface of dorsal knob rounded with slight anterior projection, subventral knobs almost rounded. Hemizonid immediately anterior to the excretory pore. Oesophageal glands filling the body cavity. Genital primordium with four cells, posterior to the middle of the body. Tail conical with acute terminus; hyaline portion occupying 48.2 to 52.7% of the tail length. Phasmids pore-like, posterior to anus, lacking lens-like

ampulla.

Eggs

Embryonated eggs (n=14): Length=89±2.4 (82-94) µm; width=35±9.2 (32-38) µm; L/W=2.5±1.3 (2.1-2.8)

Eggs with J2 (n=15): Length=100.2±2.1 (93.1-104.5) µm; width=42.7±1.2 (38-48.4) µm; L/W=2.3±8.3 (2.1-2.6).

Exterior of the shell with small, distinct punctations. Using the light microscope and scanning electron microscope, a distinct pattern of small microvilli can be seen (Fig. 2C).

Type habitat, host and locality: roots and rhizosphere of carnation (*Dianthus caryophyllus* L.), at Predio las Parvas, Villa Guerrero, México state, latitude N 19° 02'.118, longitude W 98° 38'.262, altitude 9400 feet.

Type specimens: Holotype (female, slide No. A-055-1) deposited in the Colegio de Postgraduados, Colección de nematodos (CPCN), México. Paratypes (females, males and juveniles) deposited as follows: CPCN slides A-055-2, México; Colección Helmintológica, Instituto de Biología, UNAM, México; Nematode Collection, University of California, Davis, USA; USDA Nematode Collection, Beltsville Maryland, USA; and International Nematode Collection of the Entomology and Nematology Department, IACR-Rothamsted, Harpenden, Herts, UK.

Diagnosis and relationships

Cactodera evansi sp. n. is morphologically distinct from all other species of the genus by the following diagnostic features: the cyst is light to dark brown in colour, is small in size, and has slight vulval cone projections. The lip region of the female is distinct; the basal head annule is wider than the first annule of the neck; distance of the dorsal gland orifice from the base of the stylet in the second stage juvenile is 2.0-4.0 µm; shape of the stylet knob; labial disc distinct in second stage juveniles and males.

Cactodera evansi sp. n. differs from *C. cacti* (Filipjev & Schuurmans-Stekhoven, 1941) Krall & Krall, 1978 in the size of the female body: 356-560 µm in *C. evansi* sp. n. and 532-765 µm in *C. cacti*; in the size of the stylet in the J2, 20-24 µm long in *C. evansi* and 24-26 µm in *C. cacti*; in the position of the excretory pore in the J2, 60-103 µm in *C. evansi* sp. n. and 112-119 µm in *C. cacti*; in the height of the lip region, 2.9-4.4 µm in *C. evansi* sp. n. and 4.4-4.6 µm in *C. cacti*; and in the width of the lip region, 7.6-10 µm in *C. evansi* sp. n. and 9.9-10.5 µm in *C. cacti*. The face pattern of the second stage juvenile is close to *C. milleri* Graney and Bird, 1990, as is the ornamentation of the egg shell and the shape of the submedian and lateral lips. It differs from it in the size of the female body; the length of the stylets of the female, male and J2; the size of the eggs and their L/W ratio; and the diameter of cyst fenestra.

Remarks

The species name is in honour of Prof. Kenneth Evans for his contributions to biology and control of cyst nematodes.

Meloidodera astonei sp. n.

(Figs 4-6)

Females

Measurements

Holotype female: Length with neck = 457 μm ; neck=116 μm ; width=303 μm ; median bulb 23.1 μm (width and length); vulva-anus distance=228 μm ; $V=64.7$; cuticle thickness at neck base=6.2 μm .

Paratype females (n=10): Length=522 \pm 47.4 (328-448) μm ; width=241 \pm 41.1 (176-308) μm ; stylet (n=1) 24 μm ; median bulb width 19.4 \pm 4.03 (16-22) μm ; median bulb length 18.8 \pm (16-22) μm ; length/width=0.98 \pm 0.24 (1.1-0.8); vulva-anus distance=195 \pm 25.9 (150-260) μm .

Body without capsule cover and subcrystalline layer but, in some specimens, the old cuticle is still present. The body protrudes from the root surface; mature females are spherical to pyriform in shape (Fig. 4G). The neck is often covered by a yellow secreted material. The labial disc is inconspicuous, slightly protruding. The lip region is continuous with the rest of the body, formed by two annules of the same width. The cuticle is completely annulated. The stylet is curved, in one specimen 24 μm long. The oesophagus with a procorpus wider in the posterior half, very close to the metacarpus, which produces large amounts of secretion from the dorsal oesophageal gland; it is separated from the metacarpus by a constriction. The metacarpus is spherical with a conspicuous valve; a short connection links to the elongate posterior bulb. The vulva is in a post-equatorial position with protruding lips; in lateral view it presents an incisure in the middle giving the appearance of two small lips at each side. The anus is terminal, found in a slight depression within a slight cuticular prominence.

Males

Paratype males (n=10): Length=522 \pm 42.5 (421-604) μm ; stylet length=22 \pm 1.1 (18-23) μm ; DGO=3.6 \pm 0.51 (2.4-4.4) μm ; oesophagus length=126 \pm 7.8 (108-144) μm ; distance from excretory pore to anterior end=87 \pm 8.3 (67-102) μm ; tail length=5.4 \pm 0.63 (4.4-7.2) μm ; testis length=174 \pm 25.9 (117-246) μm ; spicules=20 \pm 3.2 (13-28) μm ; a=30 \pm 2.6 (23-25); b=5.3 \pm 0.2 (4.8-5.6); o=17 \pm 3.1 (10-22).

Body slightly curved and twisted through 90 degrees at the posterior end. The lip region is separated from the rest of the body by a constriction and is compound, having three conspicuous annules. The labial disc is prominent, elevated

and circular to ovoidal in shape. The head is comprised of a single layer of rectangular cuticular blocks (Fig. 5A, B), in some specimens the cuticular blocks are irregular in size and shape. Pseudolips are present, the laterodorsal and lateroventral are clearly separated and almost circular in shape, the lateral slightly bigger and having an oblong shape. The stylet is the same size as that of the second stage juveniles, but less robust. The stylet knobs have slight anterior projections. The metacarpus is reduced and oval in shape. The hemizonid is eight annules anterior to the excretory pore, at the level of half of the total length of the oesophageal glands which almost fill the body cavity. The lateral field has four incisures which are areolated along its length to the end of the tail (Fig. 5C). The tail is short, cloacal tubus absent (Fig. 5D).

Second stage juveniles

Second stage juveniles (n=12): Length=321 \pm 13.9 (292-344) μm ; stylet length=21 \pm 2.1 (13-25) μm ; DGO 4.3 \pm 0.45 (3.2-6.0) μm ; oesophagus length 122 \pm 5.2 (107-136) μm ; distance from excretory pore to anterior end 83 \pm 3.3 (76-89) μm ; tail length 37.6 \pm 2.7 (32.4-49.6) μm ; hyaline tail 16.7 \pm 1.9 (14-26) μm ; distance from genital primordium to the tail end=102 \pm 5.1 (83-111) μm ; a=20 \pm 0.88 (17.4-21.6); b=3.4 \pm 0.08 (3.2-3.6); b'=2.6 \pm 0.08 (2.4-2.9); c=8.6 \pm 0.6 (6.6-10.5); c'=3.4 \pm 0.33 (2.9-5.0); o=21.4 \pm 2.7 (17.7-30.3).

The body is short and slightly curved after death. The head is separated from the body by a constriction of two conspicuous annules; labial disc distinct and elongate, not elevated; ventral and dorsal submedian lips divided into two elongate parts, the lateral lips are rounded (Fig. 6A). The stylet is robust with large knobs and conspicuous anterior projections, particularly on the ventral knob. The hemizonid is immediately posterior to the excretory pore and anterior to the position of the oesophageal-intestinal union. Oesophageal glands filling the body cavity. Lateral field with four incisures, irregularly areolated and reduced to three posterior to the phasmid position (Fig. 6CD). The tail is conical with a rounded terminus, hyaline portion occupying slightly more than half of the tail length. Phasmids pore-like, lacking lens-like ampulla, seven to nine annules from the anus.

Type habitat and locality: Roots and rhizosphere soil of *Solanum rostratum* Dunal at La Purificaci3n, Municipio de Texcoco, M3xico state, Mexico. Latitude N 19° 31'.185; longitude W 98° 49'.598; altitude 7 600 feet.

Type specimens: Holotype (female slide number A-056-1) deposited in the Colegio de Postgraduados, Coleccion de nematodos (CPCN), Mexico. Paratypes (males, juveniles and females) deposited as follows: CPCN slides A-056-2, Mexico; Coleccion Hemintologica, Instituto de Biologia, UNAM, Mexico; Nematode Collection, University of California Davis, USA; USDA Nematode Collection, Beltsville, Maryland, USA; and International Nematode

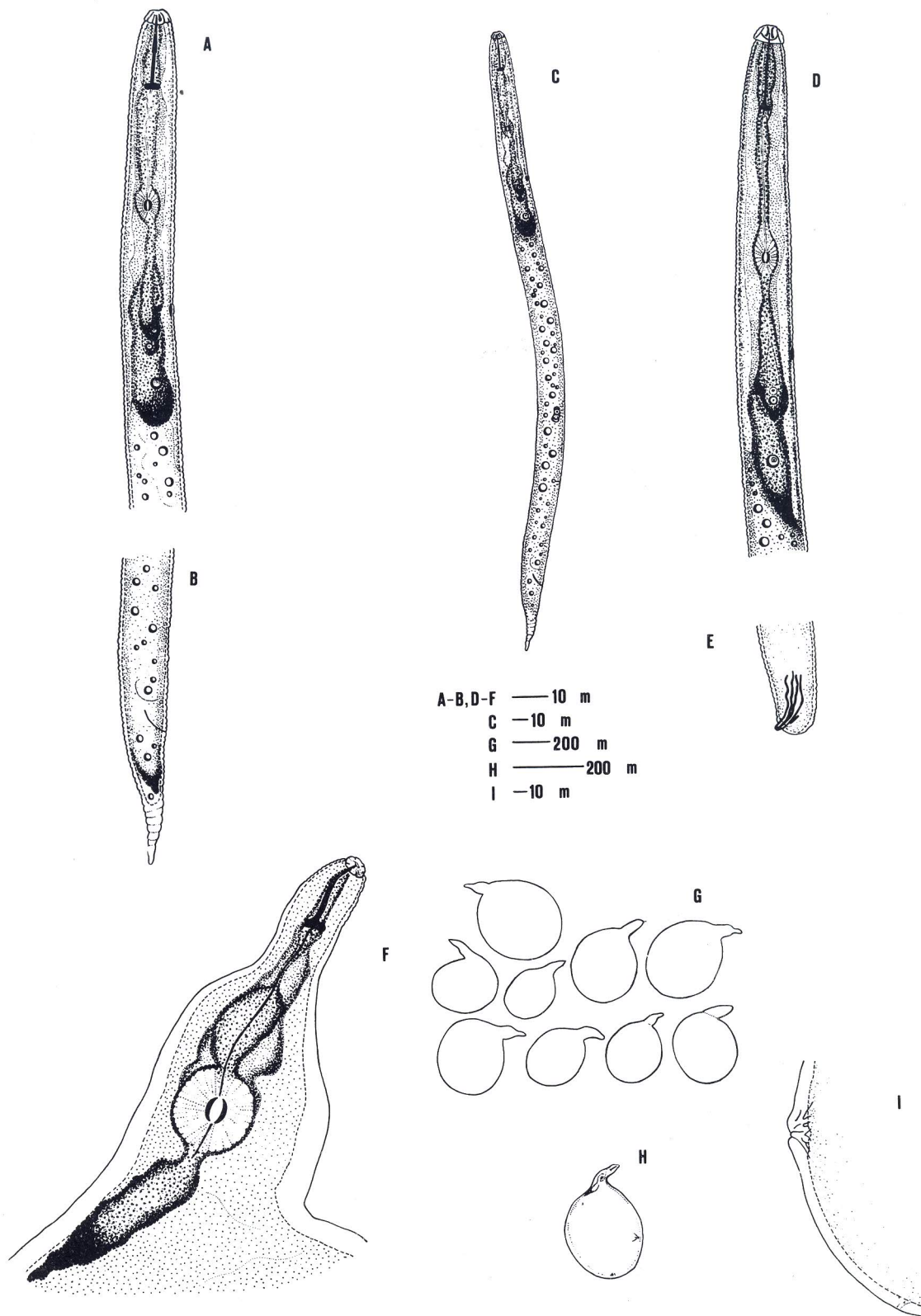


Fig. 4. *Meloidodera astonei* sp. n. A-C: second stage juvenile. A- Anterior region; B- Tail, lateral view; C- Body in toto. D-E: male. D- Oesophageal region; E- Tail in lateral view. F-I: female. F- Anterior region; G & H- Entire females; I- Vulva and anus.

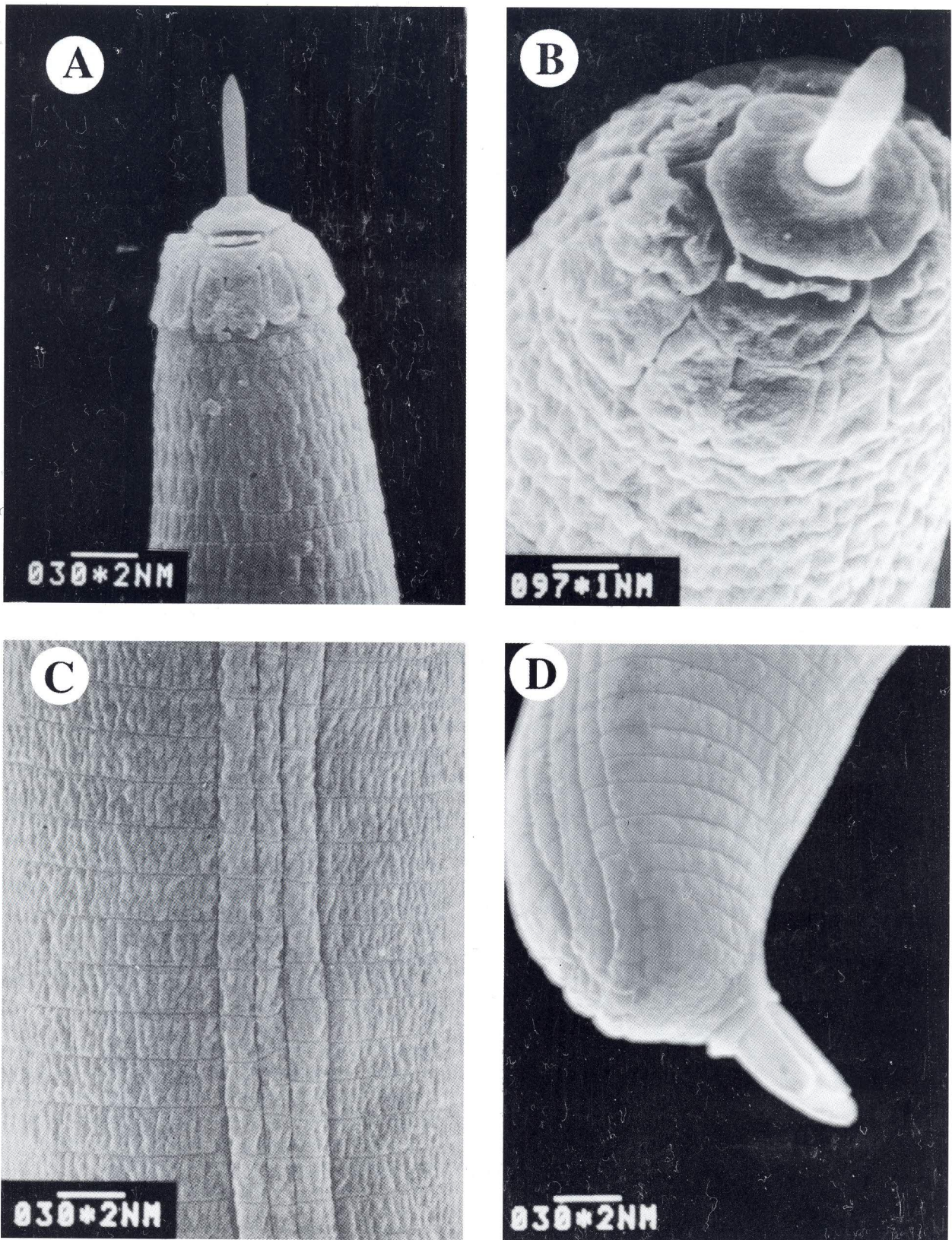


Fig. 5. *Meloidodera astonei* sp. n. SEM of male. A- Anterior end; B- Face; C- Lateral field at mid-body; D- Posterior end.

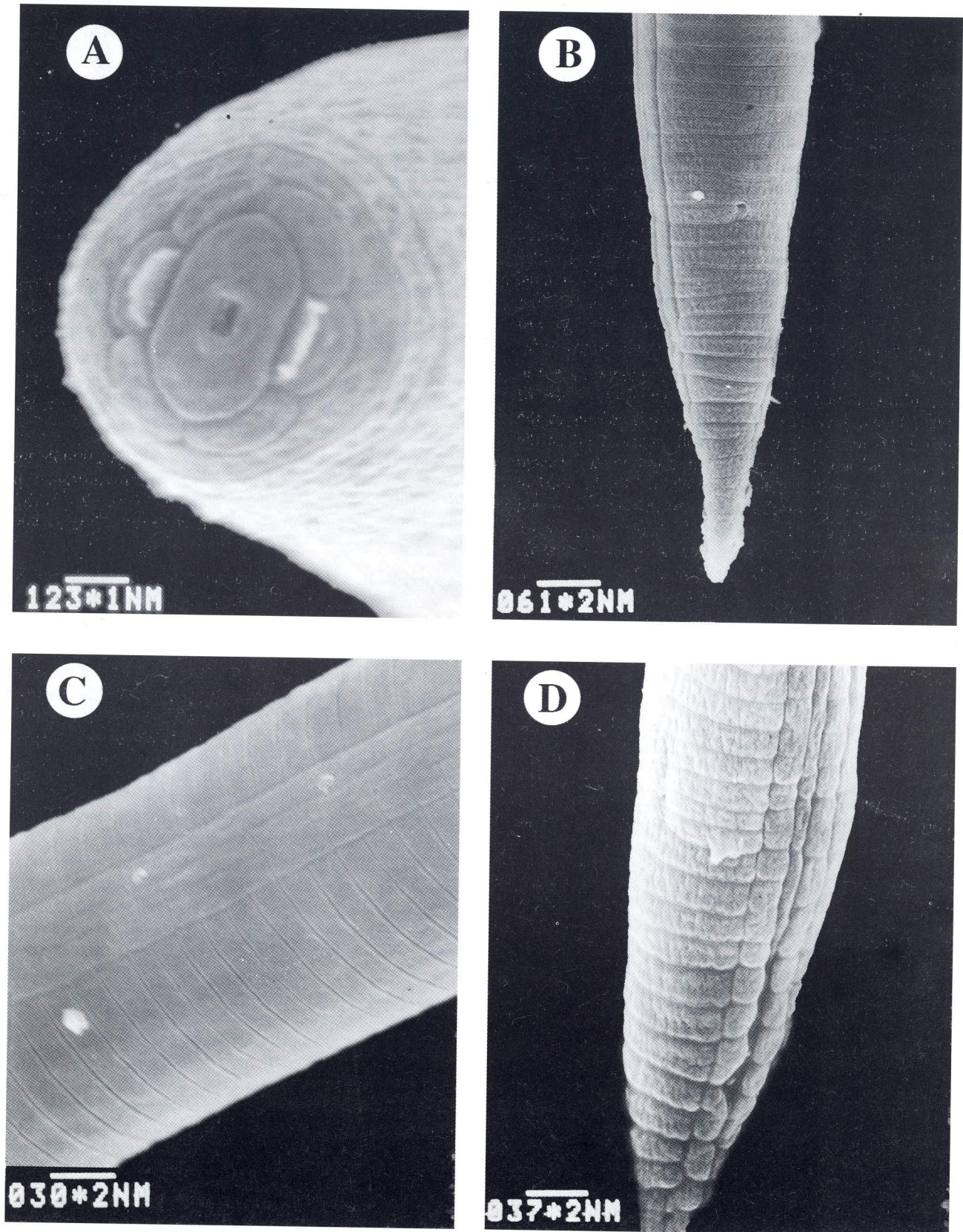


Fig. 6. *Meloidodera astonei* sp. n. SEM of second stage juvenile. A- Face view; B- Tail in ventral view; C- Lateral field at mid-body; D- Tail lateral, ventral view.

Collection of the Entomology and Nematology Department, IACR-Rothamsted, Harpenden, Herts, UK.

Diagnosis and relationships

Meloidodera astonei sp. n. second stage juveniles are characterized by the elongate shape of the submedian lips; the two conspicuous annules of the lip region; lateral field completely areolated almost to the end of the tail; phasmids pore-like, without lens structure, situated at six annules posterior to the anus level; tail with conical rounded terminus. Males are characterized by the head with two sets of cuticular blocks; lateral field completely areolated with four incisures continuing to the end of the tail, which is twisted through 90°.

M. astonei n.sp. is close to *M. charis* Hopper, 1960 in the size of the tail and in the length of the hyaline tail area of the second stage juvenile. It differs from this species by the number of the annules in the lip region; in the length of the stylet; and the labial disc is not elevated in *M. astonei* specimens. It resembles *M. mexicana* Cid del Prado, 1991 in the irregular cuticular blocks present in the lip region and twisted tail of the males. However, it differs from *M. mexicana* in the absence of a capsule covering the female body; in the shape of the tail and number of annules in the lip region of the second stage juvenile; and in the shape of the submedian and ventral oral lips. It also differs in the absence of phasmids in the male tail.

Remarks

The name of the species is in honour of Dr. Alan Stone, who through his extensive development of cyst nematology opened many gateways, particularly in Mexico, where his work still continues.

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