



Descriptions of six known species of *Plectus* Bastian, 1865 (Nematoda, Plectida, Plectidae) from India with a discussion on the taxonomy of the genus

QUDSIA TAHSEEN¹ & MALKA MUSTAQIM

Nematode Research Laboratory, Department of Zoology, Aligarh Muslim University, Aligarh

¹Corresponding author. E-mail:qtahseen@yahoo.com

Abstract

Detailed descriptions of six species of *Plectus* reported for the first time from India are given on the basis of LM and SEM observations. *Plectus geophilus* de Man, 1880, *P. aquatilis* Andr ssy, 1985, *P. parvus* Bastian, 1865, *P. minimus* Cobb, 1893, *P. magadani* Kuzmin, 1979 and *P. communis* B tschli, 1873 are described and illustrated. The salient morphological characters of the species are given. The taxonomy of the genus has been discussed along with the status of species presenting a great degree of morphometric overlap and continuous variation. An emended diagnosis of the genus is provided with incorporation of relatively consistent and less variable characters.

Key words: Description, LM, SEM, taxonomy, *Plectus aquatilis*, *P. communis*, *P. geophilus*, *P. magadani*, *P. minimus*, *P. parvus*.

Introduction

The genus *Plectus* was described by Bastian in 1865. Its species are largely continental, with a few reportedly found in extreme environments showing anhydrobiosis (Timm, 1971; Hendriksen, 1983; Adhikari *et al.*, 2010). The individuals are bacterivores and good colonizers having a value of 2 on the *c-p* scale (Bongers & Bongers, 1998). Usually males are rare and most species reproduce through parthenogenesis. In the past, several authoritative publications (Maggenti, 1961; Paramonov, 1964; Andr ssy, 1985; Zell, 1993, De Ley & Coomans, 1994) have been devoted to the genus due to its species richness. Andr ssy (1985) synonymised the genera *Plectoides* (de Man, 1904) Chitwood, 1951; *Pycnolaimus* Cobb, 1920 and *Proteroplectus* Paramonov, 1964 with *Plectus* Bastian, 1865. This cosmopolitan genus has 78 species on record *sensu* Andr ssy (2005) and Holovachov & De Ley (2006), however, the latter considered *Ceratoplectus* Andr ssy, 1984 as a subgenus of *Plectus*. The authors (l. c.) also synonymised *Chiloplectus* that was raised by Andr ssy (1984).

During a survey of nematodes from North India six species of *Plectus* were identified that are described here-under with LM and SEM details along with a discussion of their relationships.

Material and methods

Nematodes were extracted using Cobb's (1918) sieving and decantation method and the modified Baermann funnel technique. For light microscopy, nematodes were fixed in 4% formaldehyde, dehydrated (Seinhorst, 1959) and later mounted on slides using the wax ring technique. The nematodes were measured with an ocular micrometer and drawn using a drawing tube. LM photographs were taken with an Olympus DP-11 digital camera mounted on an Olympus BX-51 DIC microscope. For Scanning Electron Microscopy (SEM), the specimens were fixed in 2% glutaraldehyde, post-fixed in 2% osmium tetroxide, dehydrated in alcohol series and critical point dried using CO₂. The mounted nematodes were coated with 10 nm gold before viewing at 10 kV under an XL30 FEG scanning electron microscope.

Systematics

Plectus geophilus de Man, 1880

(Figs. 1, 2)

Measurements. Table 1.

Description. Adult: Body slightly arcuate upon fixation, regularly tapering towards extremities, more towards posterior end. Cuticle 1.0–1.5 μm thick; outer cuticle very finely striated, inner cuticle smooth; inter-striae distance *ca* 0.6–0.8 μm ; tail striae relatively discernible in LM. Hypodermis devoid of glands. Lateral fields with two slightly-spaced cuticular alae. Somatic setae very few projecting perpendicular to body surface, usually inconspicuous. Lip region continuous with adjoining body contour, low flattened to truncate. Lips triangular with tapering inner ends appearing bifid in SEM. Inner labial sensilla around oral opening and outer labial sensilla located in depressions. Cephalic sensilla setose, 1.0–1.5 μm long, outwardly directed usually perpendicular to longitudinal body axis. Amphidial fovea open circular, 2–3 μm wide, located at middle or posterior to middle level of stoma. Stoma plectoid, tubular; cheilostom not cuticularised, with walls diverging posteriorly; gymnostom cuticularised continuing into equally wider stegostom; posterior part of stegostom tapering towards base. Pharynx comprising of anterior cylindrical corpus continuing into a nearly indistinguishable isthmus and a round to ovoid basal bulb of 10–16 x 8–10 μm dimension with a simple grinder (= valvular apparatus); post-bulbar extension of variable length ranging from 4–8 μm . Cardia surrounding post-bulbar extension. Nerve ring encircling pharynx at *ca* 50–60% of its length. Secretory-excretory pore slightly posterior to nerve ring, at *ca* 65–70% of pharyngeal length; secretory-excretory duct inconspicuous, making two turns in one specimen (Fig.1C). A pair of pseudocoelomocytes present between cardia and anterior reflexed ovary measuring *ca* 1.2–1.6 corresponding body diameter in length. Intestine granular with wide lumen. Rectum 0.8–0.9 times anal body diameter in length. Anus a crescent-shaped slit.

Female: Reproductive system didelphic, amphidelphic, compactly built; ovaries reflexed antidromously with alternately arranged developing oocytes. Spermatheca absent. Crustaformeria not differentiated. Uterus occasionally with smooth-shelled intra-uterine eggs of 40–53 x 14–18 μm dimension; sperms absent in genital tract. Vagina 20–25% of the corresponding body diameter; provided occasionally with weak epiptygmata (vulva forming folds with inner vaginal wall) and a pair of sphincter muscles. Vulva nearly equatorial, a transverse slit; vulval lips usually slightly protruded. Tail cylindrical, slightly arcuate, regularly tapering to a bluntly rounded terminus. Caudal setae 5 including one subventral and one lateral pair pointing downward. Terminal seta 6–12 μm anterior to tail terminus. Three linearly arranged caudal glands opening to exterior through 1–2 μm long spinneret.

Male: Not found.

Locality and habitat. A sample containing *Plectus geophilus* was collected from a small ditch (alluvium soil) at Keoladeo National Park, Bharatpur, Rajasthan, India.

Voucher specimens. Seven females on slide *Plectus geophilus* de Man, 1880 KNP/ 1–5 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. One female deposited at USDANC, Beltsville, MD, USA. [One female was used for SEM study].

Salient characters. A small species having lip region continuous with adjoining body; lips amalgamated with bifid inner ends; cephalic setae perpendicular to main body axis, amphidial fovea circular, located at middle or posterior to middle level of stoma; secretory-excretory duct usually inconspicuous, pharyngeal bulb weak with simple grinder, vagina with weak epiptygmata and one pair of sphincter muscles; tail spinneret simple.

Remarks. *P. geophilus*, also described by Schneider (1937), Novikova and Gagarin (1971), Zell (1993) and Andr ssy (2005), has been reported for the first time from the Indian subcontinent. It has so far been reported from all continents except Antarctica (Andr ssy, 2005). The present population shows conformity to *P. geophilus* in most morphological and morphometric characteristics. However, some very minor differences were observed. The present specimens are relatively smaller in size (0.31–0.35 mm *vs* 0.34–0.52 mm) showing a smaller range of linear values besides having a relatively anterior vulva ($V= 44.2\text{--}50.7$ *vs* 49.7–55.6). The present population differs from closely related *P. intorticaudatus* Truskova, 1976 in having a relatively greater 'a' value (15.5–19.9 *vs* 15.5–17.0) that links the range of values of *P. intorticaudatus* with *P. geophilus*; a relatively larger tail (35–45 μm *vs* 32–39 μm); and greater distance of terminal seta from tail tip [6–12 μm *vs* 3.5–5 μm in *P. intorticaudatus* *apud* Zell (1993)]. The 'c' value (10.0–11.6) of latter, as indicated in the original description (Truskova, 1976), is much greater than that (7.9–9.1) estimated in the present population. On critically examining the allometric ratios and characteristics, *P. intorticaudatus* very much fits in *P. geophilus* except for the 'a' value and the position of terminal seta.

TABLE 1. Morphometrics of *Plectus geophilus*, *P. aquatilis*, *P. parvus*, *P. minimus*, *P. magadani* and *P. communis*. Measurements are in μm and in the form: mean \pm SD (range).

Characters (n)	<i>P. geophilus</i> (8)	<i>P. aquatilis</i> (9)	<i>P. parvus</i> (10)	<i>P. minimus</i> (10)	<i>P. magadani</i> (1)	<i>P. communis</i> (1)
Body length	329 \pm 15.9 (310-356)	986.1 \pm 179.8 (708-1237)	366.7 \pm 16.8 (338-386)	484.5 \pm 17.5(433-529)	565	542
Body diam.	19 \pm 1.3 (17-20)	42.7 \pm 5.6 (36-49)	22.6 \pm 1.5 (20-25)	20.5 \pm 2.2 (18-25)	23	25
a	17.4 \pm 1.5 (15.5-19.9)	22.9 \pm 2.2 (19.6-25.7)	16.2 \pm 1.0 (15.1-19)	23.4 \pm 1.9 (21.1-26.8)	24.5	21.6
b	4.2 \pm 0.9 (3.5-5.9)	4.2 \pm 0.4 (3.5-4.8)	3.9 \pm 0.1(3.7-4.0)	3.4 \pm 0.1 (3.3-3.7)	3.8	3.9
c	8.3 \pm 0.3 (7.9-9.1)	8.2 \pm 0.5 (7.7-9.6)	9.1 \pm 0.4 (8.6-9.8)	11.9 \pm 1.2 (10.8-14.2)	8.3	8.8
ć	4.1 \pm 0.2 (3.8-4.5)	5 \pm 0.7 (4-6)	3.8 \pm 0.3 (3.1-4.4)	3.5 \pm 0.3 (2.6-4.0)	4.8	3.3
V	48.6 \pm 2.5 (44.2-50.7)	48.1 \pm 1.9 (46.4-52.4)	49.7 \pm 0.7(48.2-51.0)	53.0 \pm 1.1 (51.7-54.9)	49.9	49.4
G1	21.2 \pm 2.9 (17.1-24.6)	20.2 \pm 1.3 (18.9-22.8)	21.1 \pm 4.5 (15.3-29.9)	21.3 \pm 2.8 (16.9-26.0)	15.7	18.8
G2	23.1 \pm 6.1 (12.5-33.3)	19.8 \pm 1.6 (17.7-22.3)	18.9 \pm 2.1 (14.7-23.2)	24.4 \pm 3.1 (21.5-30.0)	16.9	18.6
Amphid position	7.2 \pm 0.8 (7-10)	12 \pm 0.7 (11-13)	8.3 \pm 0.4 (8-9)	9.3 \pm 0.6 (8-11)	11	10
Amphid diameter	2.5 \pm 0.4 (2-3)	2.7 \pm 0.4 (2-3)	2 \pm 0 (2-2)	2.3 \pm 0.3 (2-3)	3	3
Lip height	2.5 \pm 0.4 (2-3)	5.1 \pm 0.6 (4-6)	3.2 \pm 0.4 (3-4)	3.2 \pm 0.3 (3-4)	3	4
Lip diam.	6.2 \pm 0.4 (5-7)	11.8 \pm 1.2 (11-14)	6 \pm 0 (6-6)	6.2 \pm 0.3 (6-7)	9	10
Stoma length	15 \pm 2.3 (14-20)	21 \pm 0.7 (20-22)	14.4 \pm 0.6 (13-15)	16.2 \pm 0.8 (15-17)	16	21
Stoma diameter	2.1 \pm 0.3 (2-3)	4.1 \pm 0.8 (3-5)	2 \pm 0 (2-2)	2.2 \pm 0.2 (2.0-2.5)	3	3
Pharynx length	79.5 \pm 12.6 (60-92)	230.1 \pm 21.8 (198-262)	93.2 \pm 2.8 (87-96)	137.5 \pm 8.2 (128-151)	147	137
Nerve ring	46.4 \pm 7.3 (34-52)	111.7 \pm 12.3 (94-133)	52.6 \pm 2.7 (47-55)	69.1 \pm 4.2 (65-77)	78	78
Secretory-excretory pore	54 \pm 8 (41-61)	125.1 \pm 12.6 (106-148)	62.4 \pm 2.9 (57-67)	78.8 \pm 4.7 (74-89)	87	87
Rectum length	11.5 \pm 0.7 (11-13)	25.7 \pm 4.2 (20-30)	12.9 \pm 0.7 (12-14)	12.5 \pm 1.2 (10-15)	15	20
ABD	9.4 \pm 0.7 (9-11)	23.6 \pm 3 (18-28)	10.4 \pm 0.8 (9-11)	11.3 \pm 0.4 (11-12)	14	18
Tail length	39.2 \pm 3.1 (35-45)	119.7 \pm 27.7 (73-160)	40.1 \pm 2.3 (35-44)	40.5 \pm 2.3 (32-45)	68	61
Vulva-anus distance	129.8 \pm 13.1 (116-150)	393.2 \pm 80.2 (264-491)	144.1 \pm 6.2 (133-151)	183.6 \pm 8.2 (173-210)	215	200

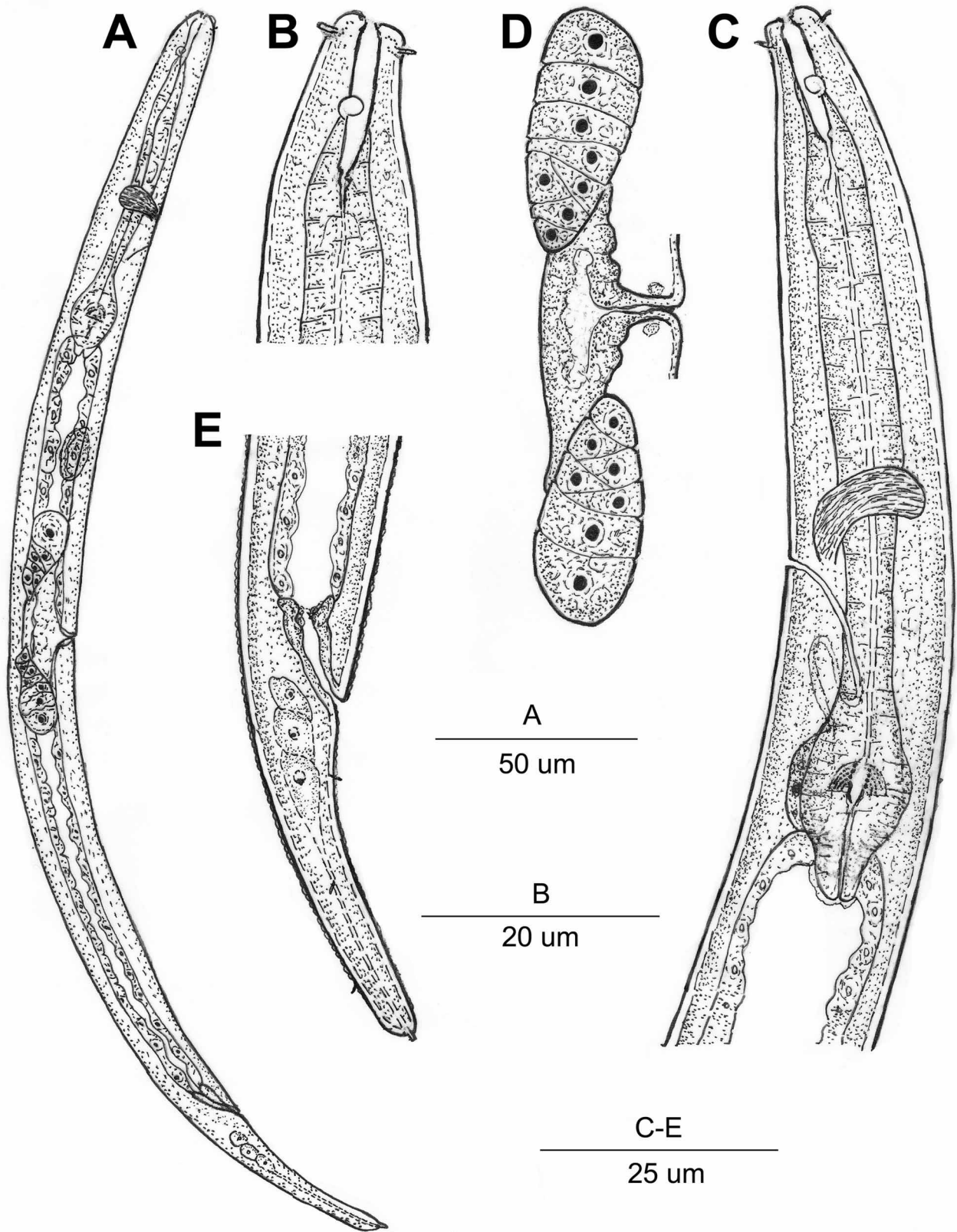


FIGURE 1. *Plectus geophilus* de Man, 1880. A: Female, entire. B: Anterior end. C: Pharyngeal region. D: Female reproductive system. E: Caudal region.

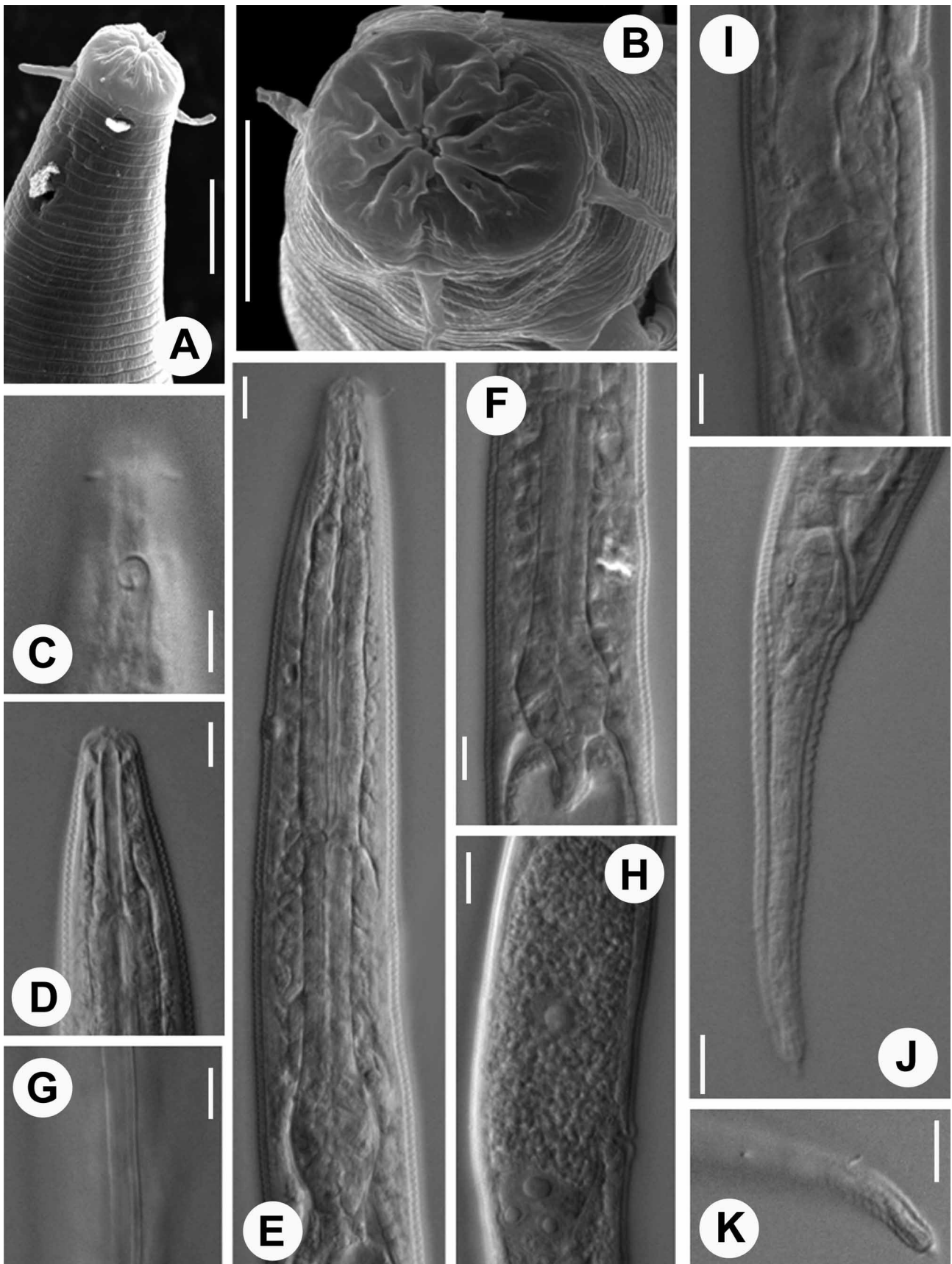


FIGURE 2. *Plectus geophilus* de Man, 1880. A, C, D: Anterior end. B: *En face* view. E: Pharyngeal region. F: Body region showing posterior pharynx. G: Lateral field region. H, I: Vulval region showing reflexed ovary. J: Caudal region. K: Tail tip showing subterminal seta (Scale bar = 5 μ m).

The present specimens differ from *P. minimus* Cobb, 1893 in having smaller 'a' (15.5–19.9 vs 24.4–32.1); 'b' (3.5–5.9 vs 3.1–3.6) and 'V' (44.2–50.7 vs 50.0–53.4) values; posterior amphid position, greater stoma length (14–20 μm vs 8.5–11.5 μm) and relatively greater tail length (35–45 μm vs 28–38 μm) and a simple [vs crooked spinneret in *P. minimus apud* Zell (1993) and De Ley & Coomans (1994)]. The present specimens of *P. geophilus* also differ from *P. communis* Bütschli, 1873 in having a smaller body (0.31–0.35 mm vs 0.43–0.74 mm) and consequently a smaller tail (35–45 μm vs 50–87 μm); continuous (vs setoff lip region); longer cephalic setae (1.0–1.5 μm vs 3–5 μm) and basal bulb with simple (vs *parietinus*-type) grinder in *P. communis apud* Zell (1993). The present population differs from *P. similis* Zell, 1993 in having smaller body (0.31–0.35 mm vs 0.44–0.64 mm); smaller 'a' value (15.5–19.9 vs 24.4–32.4); longer cephalic setae (1.0–1.5 μm vs 2.5–4 μm); continuous (vs setoff lip region) and a smaller tail (35–45 μm vs 46–75 μm) in *P. communis apud* Zell (1993).

***Plectus aquatilis* Andrásy, 1985**

(Figs. 3, 4)

Measurements. Table 1.

Description. Adult: Body straight, slightly arcuate to 'C'-shaped upon fixation, regularly tapering towards extremities, more towards posterior end. Cuticle 1.5–2.0 μm thick; outer cuticle smooth, inner cuticle finely striated. Lateral fields with two closely-placed cuticular alae. Hypodermis lacking glands. Somatic setae very sparse and small, 2–3 pairs of cervical setae observed in few specimens. Lip region continuous with adjoining body. Lips triangular with attenuated, cuticularised inner margins surrounding the oral aperture; inner labial sensilla inconspicuous, outer labials papilliform, often indistinct in SEM due to shrunk lips. Cephalic sensilla setose, 3–4 μm long, anteriorly directed. Amphidial fovea round with prominent, cuticularised *ductus amphidialis*, located middle or anterior to middle of stoma. Stoma cylindrical; cheilostom slightly arched with anterior refractive pieces, gynomostom thickly cuticularised, wide, cylindrical; stegostom slightly narrower, differentiated into anterior wider and posterior narrower region tapering at base. Pharynx comprising of anterior cylindrical corpus, a relatively undifferentiated isthmus and an ovoid, relatively weak basal bulb of 26–35 x 17–25 μm dimension with a *parietinus*-like grinder having 8–10 pairs of denticulate ridges. Post-bulbar extension about 12–15 μm long. Cardia obscured by post-bulbar prolongation. Nerve ring encircling pharynx at ca 47–51% of its length. Secretory-excretory pore slightly posterior to nerve ring, at ca 54–56% of pharyngeal length. Secretory-excretory duct cuticularised forming one and a half loop before finally connecting with renette cell. Intestine granular with wide lumen. One pair of pseudocoelomocytes present in the anterior region of intestine measuring less than corresponding body diameter in length. Rectum ca 0.7–0.9 anal body diameter long with exceptionally wide lumen and three rectal glands.

Female: Reproductive system didelphic, amphidelphic compactly built; ovaries reflexed antidromously with developing oocytes. Anterior ovary on right and posterior on left side of intestine. Spermatheca absent. Uterus with smooth-shelled intra-uterine eggs of 46–49 x 28–34 μm dimension. Vulva nearly equatorial representing an ovoid transverse slit; vulval lips protruded; anterior vulval lip with advulval papilla. Vagina 30–35% of the corresponding body diameter; with weak epiptygmata; two pairs of sphincter muscles appearing as elliptical pieces in cross section. Vulva-anus distance 264–491 μm . Tail cylindrical, slightly arcuate, regularly tapering to a bluntly rounded terminus. Caudal setae five including a lateroventral pair and a lateral pair pointing downward. Terminal seta 18–25 μm anterior to tail terminus. Three linearly arranged caudal glands opening to exterior through 2 μm long spinneret.

Male: Not found.

Locality and habitat. A sample containing *P. aquatilis* was collected from a pool at Nainital, Uttaranchal, India

Voucher specimens. Eight females on slide *P. aquatilis* Andrásy, 1985 NU/ 1–5 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. One female deposited at USDANC, Beltsville, MD, USA. [Two females were used for SEM study].

Salient characters. A medium- to large-sized species with lip region continuous to adjoining body; lips with attenuated and cuticularised inner ends; cephalic setae forwardly directed making an acute angle with main body axis; amphidial fovea small, circular, at middle or anterior to middle level of stoma; secretory-excretory duct conspicuous with turns, pharyngeal bulb weak with *parietinus*-like grinder, vagina with weak epiptygmata and two pairs of sphincter muscles; rectum with conspicuously dilated lumen and tail spinneret simple.

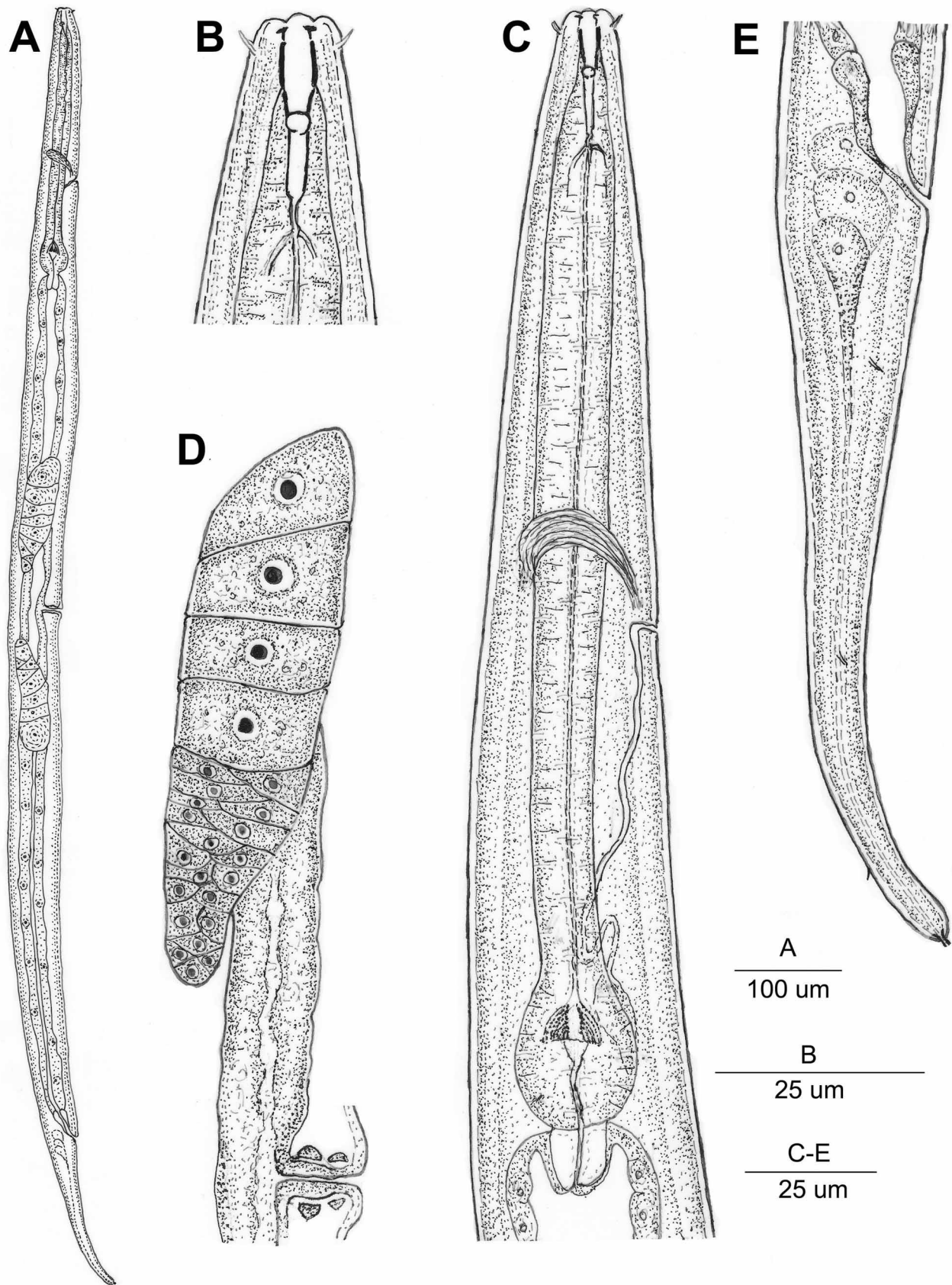


FIGURE 3. *Plectus aquatilis* Andrassy, 1985. A: Female, entire. B: Anterior end. C: Pharyngeal region. D: Female reproductive system. E: Caudal region.

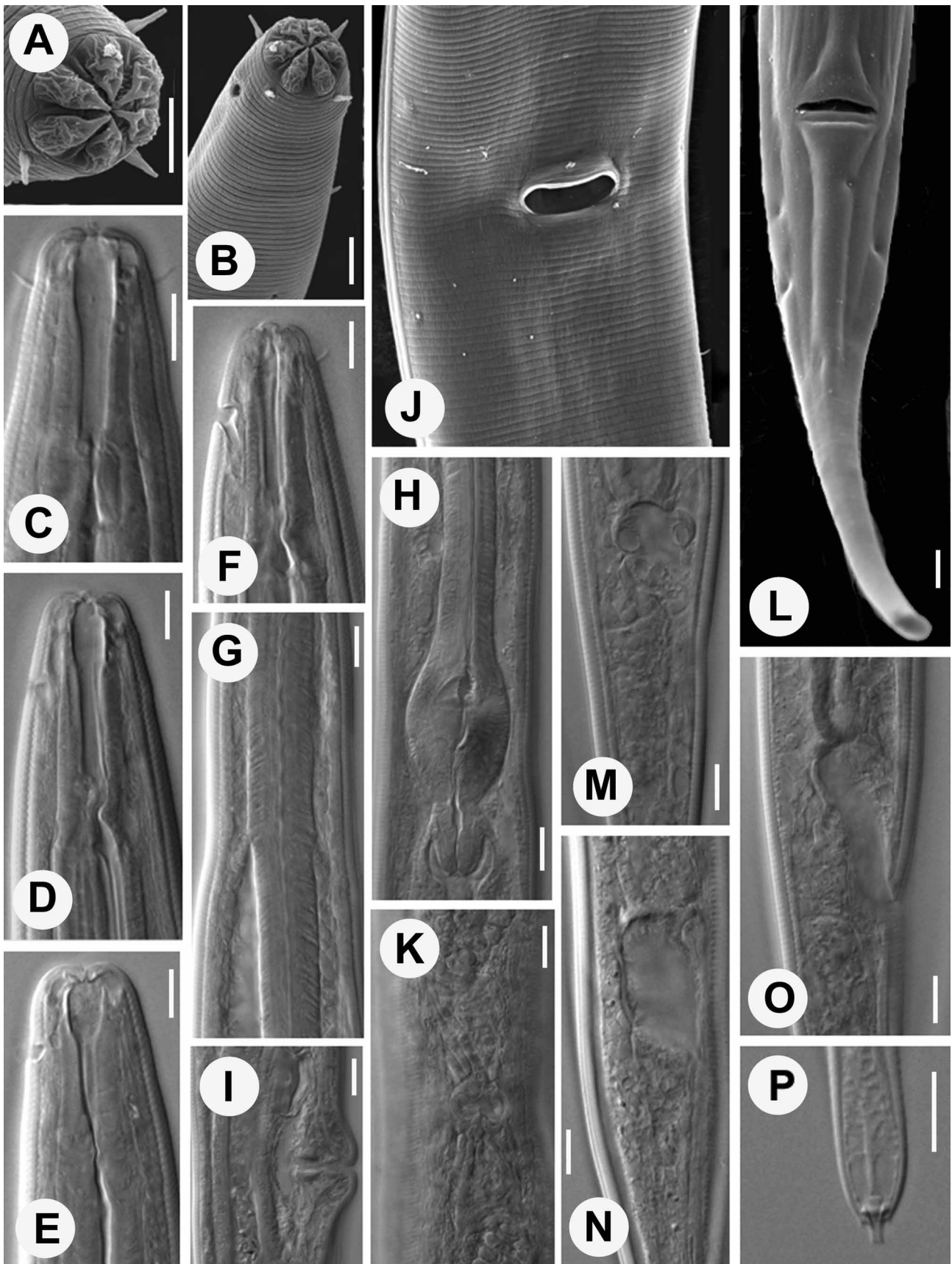


FIGURE 4. *Plectus aquatilis* Andrassy, 1985. A: En face view. B–F: Anterior end. G: Body region showing corpus-isthmus. H: Body region showing posterior pharynx. I: Vulval region (lateral). J, K: Vulval region (ventral). L: Caudal region. M–O: Anal region. P: Tail terminus (Scale bar = 5 μ m).

Remarks. *P. aquatilis* is a relatively common species that has been reported (Andrássy, 1990; 1992; 1997; 2002; 2005) primarily from aquatic habitats and occasionally from moist soil. The species has been widely reported (Andrássy, 2005) from all the continents except Antarctica and due to adaptive qualities, it has even been reported from the Driefontein Mine at a depth of 0.9 km (Borgonie *et al.*, 2011). The present population, the first report of the species from India, shows conformity to *P. aquatilis* in most morphological and morphometric characteristics. However, some minor differences were observed. The present specimens are relatively smaller in size (0.7–1.2 mm vs 0.8–1.4 mm) with a smaller stoma (20–22 μm vs 24–26 μm). The males could not be found in the present population as also stated in the original description (Andrássy, 1985), however, males have been described and illustrated later (Zell, 1993) with three conspicuous supplements. *P. aquatilis* most closely resembles *P. indicus* Khera, 1972, among the species placed under the ‘*aquatilis*’ group by Zell (1993), in most morphometric and morphological characteristics. However, one major difference observed between the two is the absence of supplements in males of *P. indicus*. Some other differences from *P. indicus*, largely observed in the present population (comprised of females only), are the thickly cuticularised and curved cheilostomal walls; gymnostom with parallel walls; vulva a relatively shorter ovoid slit and considerably dilated rectum [vs cheilostomal walls moderately cuticularised and straight; gymnostom with arched walls; vulval slit large, narrow and rectum not dilated in *P. indicus apud* Zell (1993) and Zullini, Loof & Bongers (2002)]. The present population of *P. aquatilis* differs from *P. communis* in having relatively larger body (0.70–1.23 mm vs 0.43–0.74 mm); greater ‘c’ value (7.7–9.6 vs 4.2–6.4); forwardly directed (vs anteriorly directed) cephalic setae; relatively larger stoma (20–22 μm vs 14.5–21.0 μm); weak (vs strong) basal bulb; relatively longer tail (73–160 μm vs 50–87 μm); dilated (vs normal) lumen of rectum and farther placed terminal seta from tail terminus [18–25 μm vs 8–15 μm in *P. communis apud* Zell (1993)]. The present population of *P. aquatilis* further differs from *P. magadani* Kuzmin, 1979 in having relatively larger body (0.70–1.23 mm vs 0.51–0.81 mm); wider (11–14 μm vs 8.5–10.5 μm) and continuous (vs offset) lip region; relatively larger stoma (20–22 μm vs 15–21.5 μm); weak (vs strong) basal bulb; dilated (vs normal) lumen of rectum; relatively longer tail (73–160 μm vs 54–92 μm) and farther placed terminal seta from tail terminus (18–25 μm vs 8–14 μm in *P. magadani apud* Zell (1993)).

***Plectus parvus* Bastian, 1865**

(Figs. 5, 6)

Measurements: Table 1.

Description. Adult: Body straight to slightly arcuate upon fixation, tapering towards extremities, more towards posterior end. Cuticle 0.8–1.0 μm thick; outer cuticle very finely striated, inner cuticle smooth. Striae relatively prominent in tail region. Hypodermis devoid of glands. Lateral fields with two cuticular alae. Deirids conspicuous, papilliform flanked by cuticular alae. Somatic setae sparse including 2–4 pairs in the cervical region. Lip region continuous with body contour. Lips triangular, amalgamated appearing radially ridged; inner labial sensilla inconspicuous; outer labials papilliform, not discernible in LM. Cephalic sensilla setose, 1.5–2.0 μm long, anteriorly directed. Amphidial fovea small, circular with prominent *ductus amphidialis*, located at posterior to middle level of stoma. Stoma largely cylindrical; cheilostom with conical or sloping walls, gymnostom wide with arched walls; stegostom cylindrical gradually tapering at base. Pharynx comprising of anterior cylindrical corpus, slightly narrow isthmus and an ovoid basal bulb of 11–15 x 8–10 μm , dimension with a simple grinder. Post-bulbar extension usually very reduced, often indistinguishable from glandular, conoid cardia. Nerve ring encircling pharynx at ca 54–57% of pharyngeal length. Secretory-excretory pore slightly posterior to nerve ring, at ca 66–70% of pharyngeal length. Secretory-excretory duct cuticularised, undergoing one and a half turns to finally join the renette cell. Intestine granular with wide lumen. Rectum ca 0.7–0.9 times anal body diam. long. Anus a crescent-shaped slit.

Female: Reproductive system didelphic, amphidelphic, compactly built; ovaries dorsally reflexed antidromously with developing oocytes. Anterior ovary on right and posterior on left side of intestine; occasionally crossing each other. Spermatheca absent. Uterus occasionally with two eggs of 42–46 x 15–18 μm dimension. Sperms absent in the genital tract. Vagina ca 20–25% of corresponding body diameter; usually with epiptygmata and one pair of sphincter muscles. Vulva nearly equatorial representing an ovoid, transverse slit; vulval lips slightly protruded. Vulva-anus distance 133–151 μm . Tail cylindrical, slightly arcuate, regularly tapering to a bluntly rounded terminus. Caudal setae seven including one subdorsal pairs, one lateral and one subventral pair, pointing down-

ward. Terminal seta 6–11 μm anterior to tail terminus. Three linearly arranged caudal glands opening to exterior through 1–2 μm long spinneret.

Male: Not found.

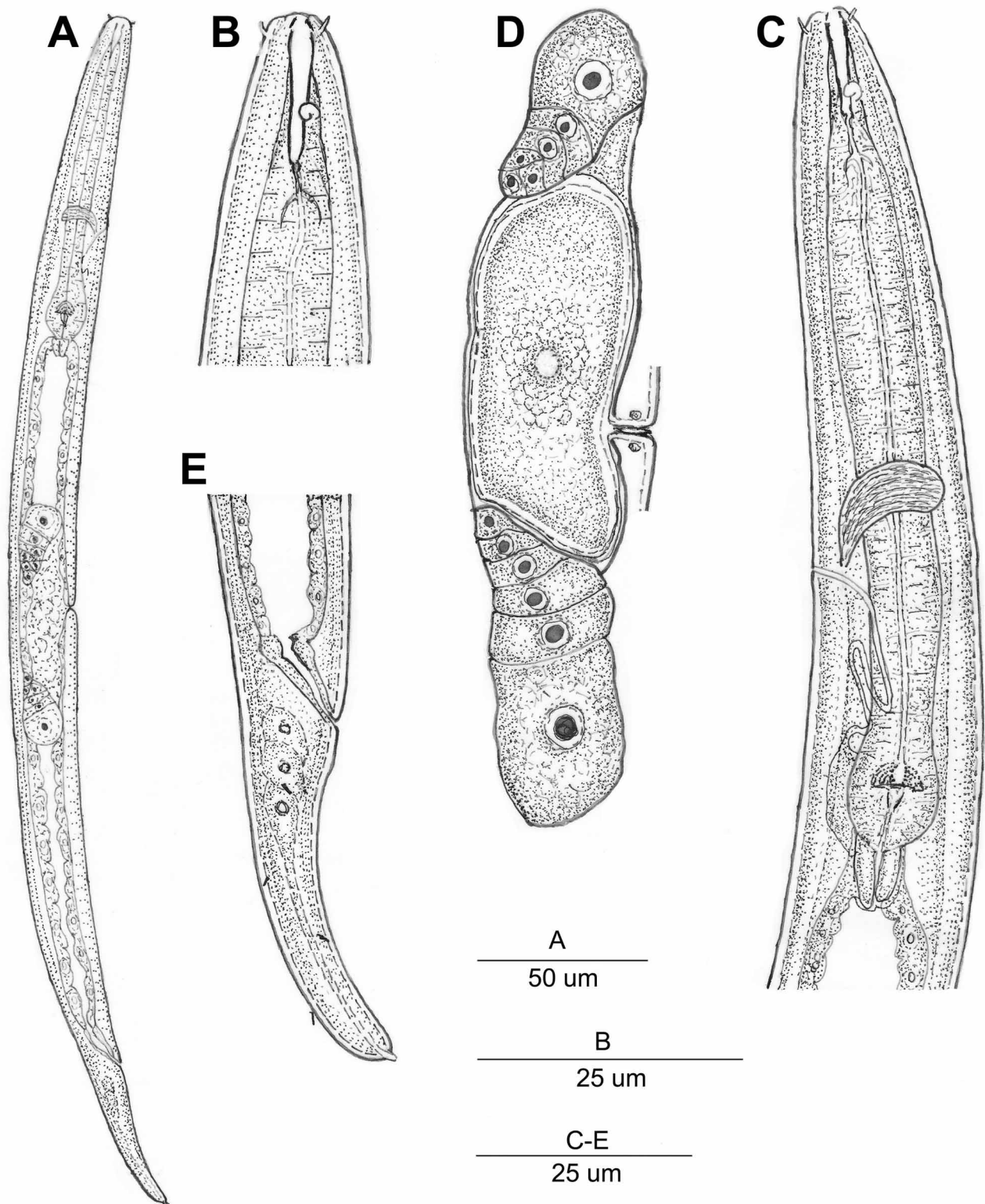


FIGURE 5. *Plectus parvus* Bastian, 1865. A: Female, entire. B: Anterior end. C: Pharyngeal region. D: Female reproductive system. E: Caudal region.

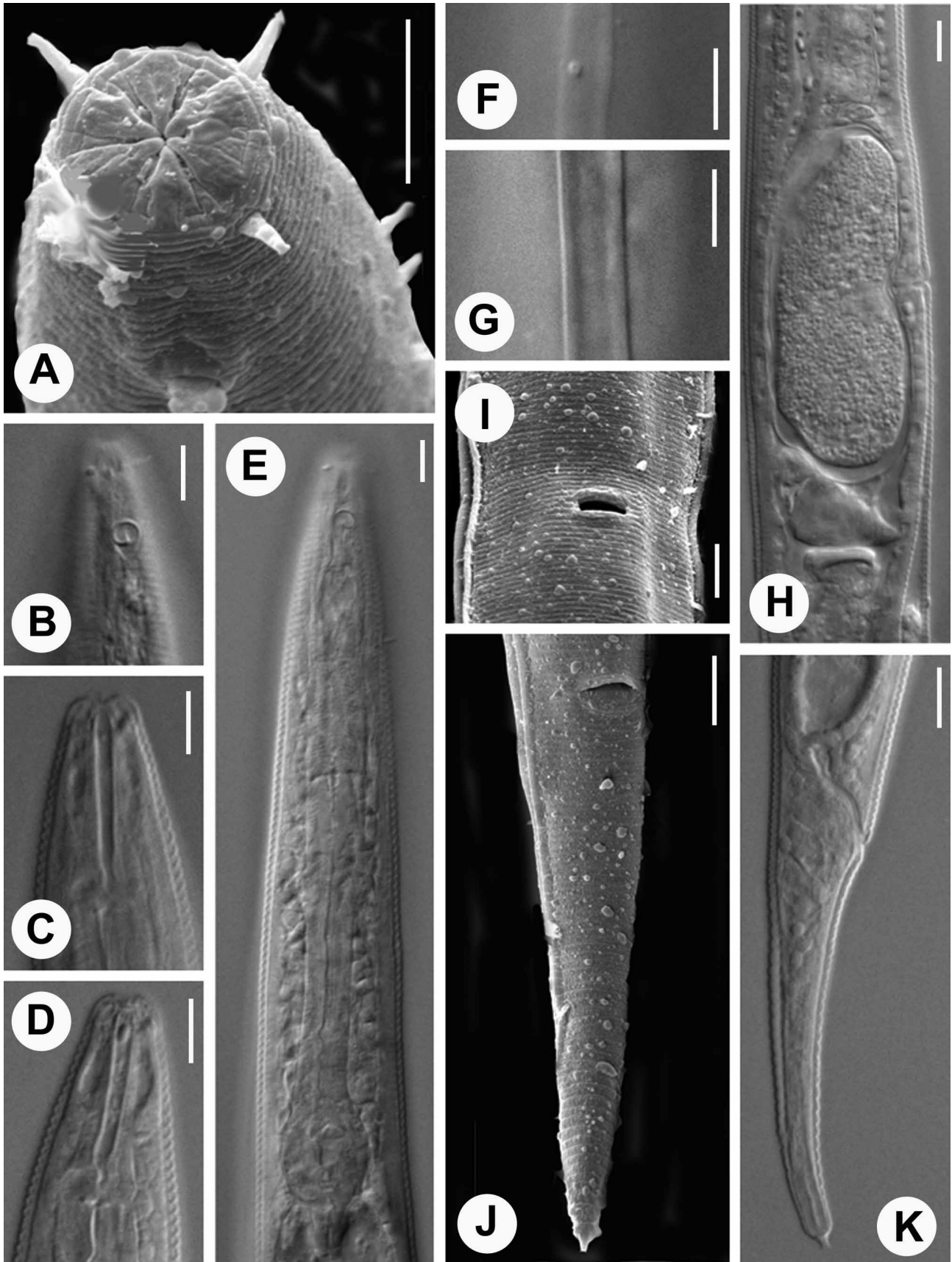


FIGURE 6. *Plectus parvus* Bastian, 1865. A: *En face* view. B–D: Anterior end. E: Pharyngeal region. F: Lateral fields with deirids. G: Body region showing lateral alae. H: Female reproductive system. I: Vulval region. J, K: Caudal region (Scale bar = 5 μ m).

Locality and habitat. A sample containing *Plectus parvus* was collected from a field in Meerut, Uttar Pradesh, India.

Voucher specimens. Nine females on slide *Plectus parvus* Bastian, 1865 MUP/1–6 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. One female deposited at USDANC, Beltsville, MD, USA. [One female was used for SEM study].

Salient characters. A small species with lip region continuous with main body contour; lips with simple, smooth inner ends; cephalic setae forwardly directed making an acute angle with main body axis; amphidial fovea usually ovoid, at posterior to middle level of stoma; secretory-excretory duct conspicuous with turns, pharyngeal bulb without or with a reduced post-bulbar extension and simple grinder, vagina with epiptygmata and one pair of sphincter muscles; tail spinneret simple.

Remarks. *P. parvus* has been reported mainly from terrestrial habitats and rarely occurs in aquatic habitats. The present population is the first report of the species from India; however, it has been reported widely across the globe (Andrássy, 2005). The present population shows conformity to the original and subsequently reported populations of *P. parvus* in all morphological and morphometric characteristics, with some minor differences observed. The present specimens are relatively smaller in size (0.33–0.38 mm vs 0.35–0.55 mm), showing a smaller range of linear measurements and absence of males [vs males described *apud* Maggenti (1961); Zell (1993) Andrásy (2005)]. The present population of *P. parvus* differs from *P. geophilus* in having relatively smaller ‘a’ (15.1–19.0 vs 19.2–34.8) and ‘c’ (3.1–4.4 vs 3.9–6.4) values; cephalic sensilla forming an acute (vs right) angle with main body axis and reduced [vs long] post-bulbar extension in *P. geophilus apud* Zell (1993)]. The present population differs from *P. communis* in having smaller body (0.33–0.38 mm vs 0.43–0.74 mm); wider lip region (6 µm vs 8.5–11 µm); cephalic setae parallel (vs at right angle) to body axis; smaller stoma (13–15 µm vs 14.5–21 µm); simple [vs *parietinus*-like grinder and reduced [vs long post-bulbar extension in *P. communis* Zell (1993)]. The present population differs from *P. minimus* in having smaller ‘a’ (15.1–19.0 vs 24.4–32.4), ‘b’ (3.7–4.0 vs 3.1–3.6) and ‘c’ (3.1–4.4 vs 4.1–5.8) values; grinder located in anterior (vs middle) region of basal bulb; reduced (vs long) post-bulbar extension and tail spinneret simple [vs crooked in *P. geophilus apud* Zell (1993) and De Ley & Coomans (1994)].

Plectus minimus Cobb, 1893

(Figs. 7, 8)

Measurements: Table 1

Description. Adult: Body small to medium-sized, slender, almost straight or slightly curved ventrally after fixation, tapering at both extremities, more towards posterior region. Outer cuticle with fine, transverse striations, inner cuticle smooth. Somatic setae fine and sparse, usually 3 pairs present in the cervical region. Lateral fields with weak cuticular alae. Lip region continuous with adjoining body contour. Lips amalgamated. Outer and inner labial sensilla papilloid, inconspicuous in LM; cephalic sensilla setose, 2.0–2.5 µm long, anteriorly directed, located at one lip diam. from anterior end. Amphids oval-shaped, situated at middle level of stoma. Stoma plectoid-type, tubular, thin-walled, weakly cuticularised, about three lip diam. long. Cheilostom rod-shaped slightly cuticularised with refringent dot-like anterior part; gymnostom cuticularised, parallel-walled; stegostom uniformly wide with abrupt narrowing at base. Pharynx comprising of a cylindrical corpus with indistinguishable isthmus and an elongate to ovoid muscular, basal bulb of 22–33 x 11–13 µm dimension, gradually tapering into a post-bulbar part; anterior part of basal bulb having a simple grinder. Nerve ring located at about 48–51% of pharyngeal length. Secretory-excretory pore posterior to nerve ring or at about 54–58% of pharyngeal length with the duct forming a loop before joining the renette cell. Body at pharyngeal end 3.0–3.5 lip diameters wide. Cardia 4–7 µm long with narrow lumen. Intestine transparent, with wide lumen. Rectum thin-walled, ca 0.8–1.0 times anal body diam. long. Anus a crescent-shaped slit.

Female: Reproductive system didelphic-amphidelphic. Ovaries dorsally reflexed. Anterior ovary on right and posterior on left side of intestine. Oocytes arranged in double rows at distal end of ovary followed by a single tile. Vagina at right angle to longitudinal body axis, 1/3 of corresponding body diameter without a distinct epiptygmata and with a pair of sphincter muscles. Vulva a transverse slit, almost equatorial. Tail ventrally arcuate, gradually tapering to a narrow tip provided with a crooked terminal spinneret. Caudal setae including two subdorsal pairs, one lateral pair and one subventral pair, pointing downwards. Terminal seta 8–10 µm anterior to tail terminus. Caudal glands linearly arranged with prominent nuclei.

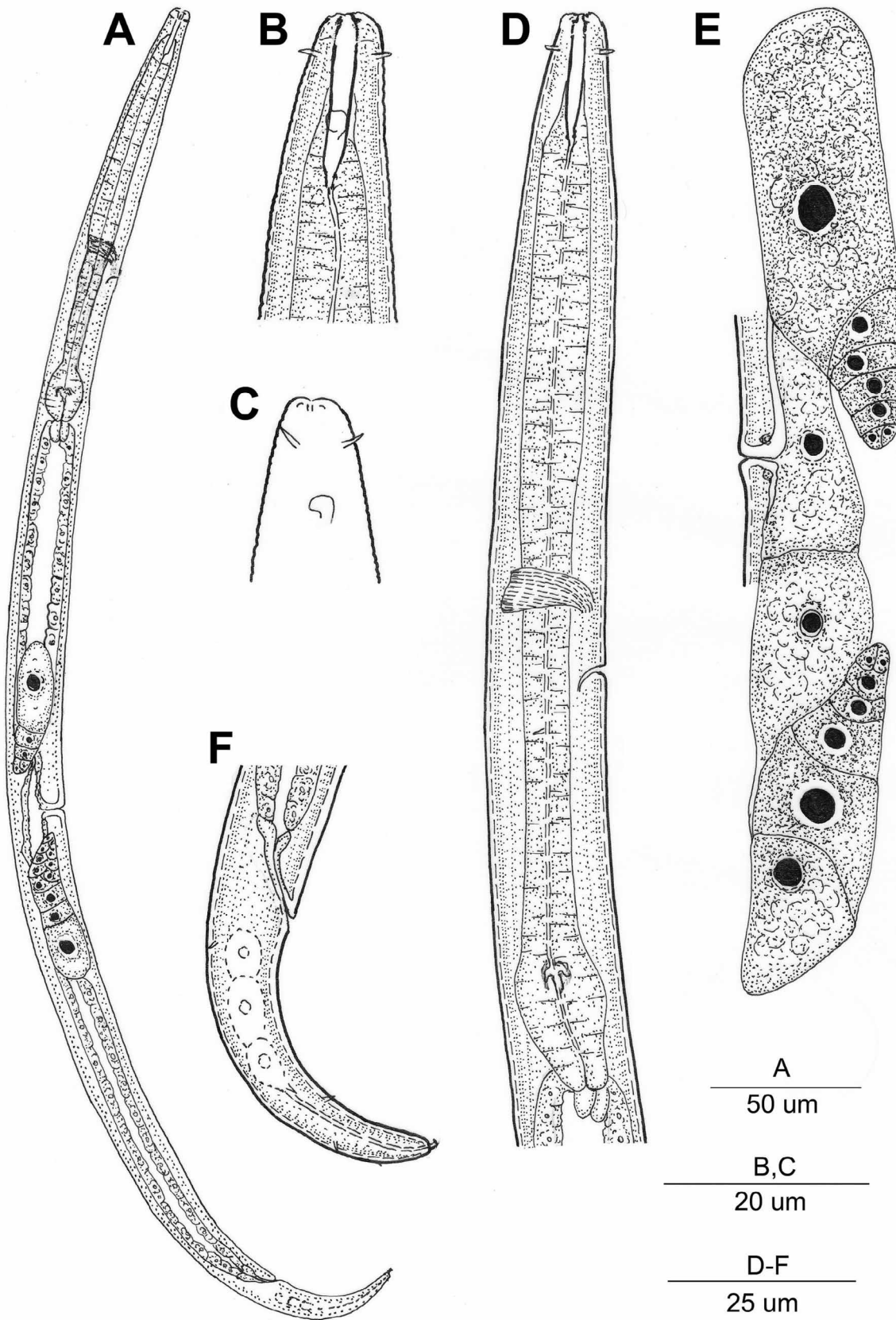


FIGURE 7. *Plectus minimus* Cobb, 1893. A: Female, entire. B, C: Anterior end. D: Pharyngeal region. E: Female reproductive system. F: Caudal region.

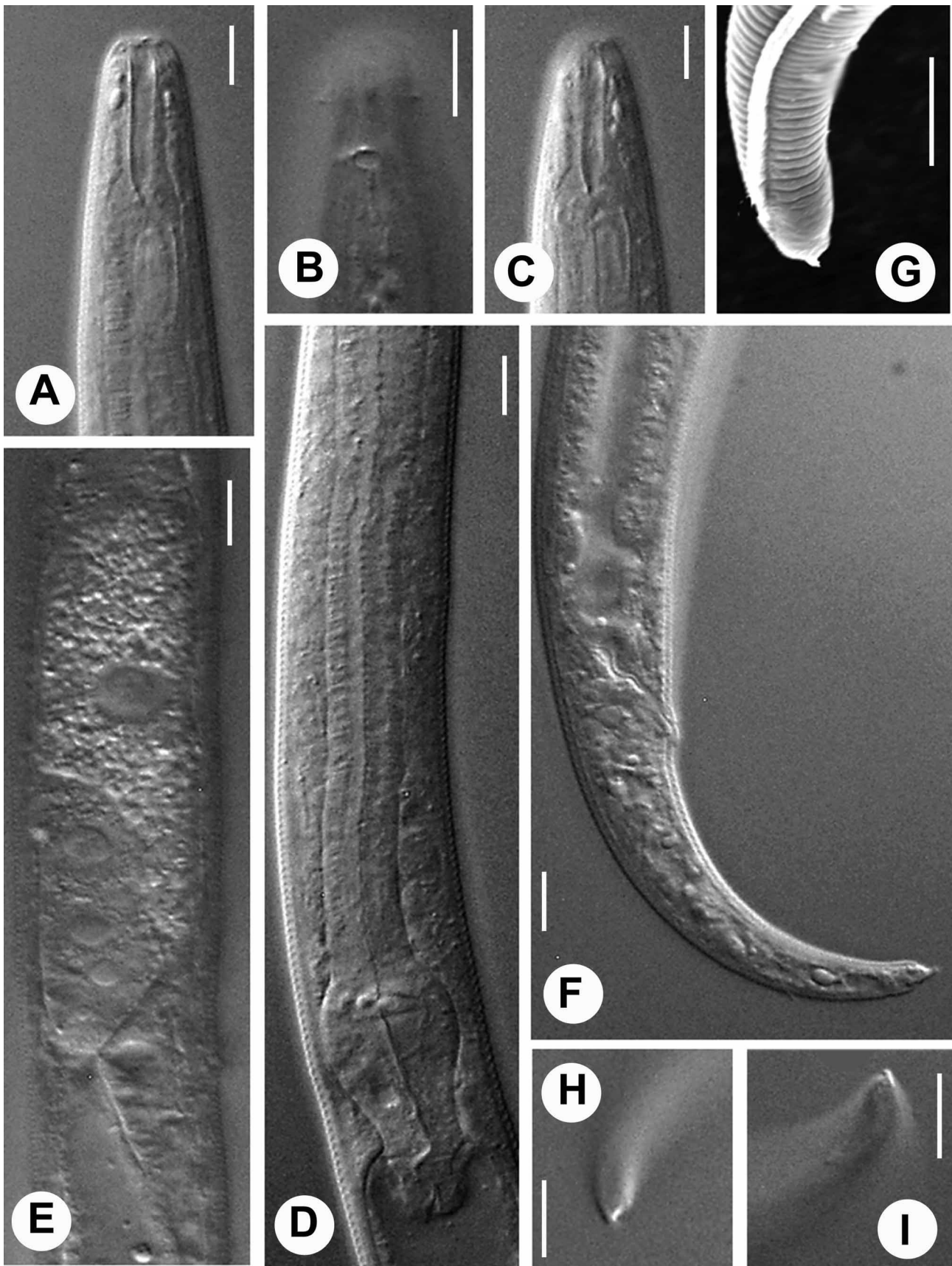


FIGURE 8. *Plectus minimus* Cobb, 1893. A–C: Anterior end. D: Body region showing posterior pharynx. E: Female reproductive system. F: Caudal region. G–I: Tail terminal region (Scale bar = 5 µm).

Male: Not found

Locality and habitat. A sample containing *Plectus minimus* Cobb, 1893 was collected from a small ditch (alluvium soil) at the outskirts of Aligarh, Uttar Pradesh, India.

Voucher specimens. Ten females on slide *Plectus minimus* Cobb, 1893 NOSR/ 1–6 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. One female deposited at USDANC, Beltsville, MD, USA. [One female was used for SEM study].

Salient characters. A small species with lip region continuous to adjoining body; lips with simple, smooth inner ends; cephalic setae forwardly directed making an acute angle with main body axis; amphidial fovea usually oval, occasionally circular, at middle level of stoma; secretory-excretory duct inconspicuous proximally, pharyngeal bulb weak with simple grinder, vagina simple without folded walls, provided with one pair of sphincter muscles, tail terminus having a crooked spinneret.

Remarks. *Plectus minimus*, although reported by various workers, namely Geraert (1962); Zell (1993); De Ley & Coomans (1994) and Khan and Araki (2001b), is recorded for the first time from the Indian subcontinent. The present population conforms well to the original population described by Cobb in 1893 in most morphological characteristics but differs in having larger females (0.4–0.5 mm vs 0.2–0.3 mm) with greater vulva-anus distance (4.1–5.6 vs 2–4) in terms of tail length. The present population also resembles the *P. minimus* population described by De Ley & Coomans (1994) in most morphometric and morphological details including crooked spinneret; however, it differs from latter in having larger females (0.4–0.5 mm vs 0.2–0.3 mm) and greater 'c' value (10.8–14.2 vs 7.4–9.7). The present population of *P. minimus* shows some minor differences from previously described populations of the species in having relatively larger body (0.43–0.52 mm vs 0.24–0.35 mm); greater 'c' value (10.8–14.2 vs 8.5–10.5); relatively larger stoma (15–17 μ m vs 8.5–11.5 μ m); weak (vs strong) basal bulb; relatively longer tail (32–45 μ m vs 28–38 μ m) and terminal seta placed farther from tail terminus [8–10 vs 7 μ m in *P. minimus apud* Zell (1993)]. The present population of *P. minimus* closely resembles *P. pusillus* Cobb, 1893, but shows some minor differences from the latter species in having a relatively larger body (0.43–0.52 mm vs 0.35–0.45 mm); greater 'c' value (10.8–14.2 vs 8.4–10.0); and more anteriorly placed amphids (8–11 μ m vs 13.5 μ m). The most conspicuous difference can be observed in the crooked vs simple spinneret in *P. pusillus apud* Zell (1993). Though the present population of *P. minimus* resembles *P. geophilus* in some respects, some differences could be observed viz., the relatively greater 'c' (10.8–14.2 vs 8.2–12.9) and smaller 'c' (2.6–4.0 vs 3.9–6.4) values; wider lip region (6–7 μ m vs 4.5–5.5 μ m) and above all a crooked [vs simple spinneret in *P. geophilus apud* Zell (1993)].

Plectus magadani Kuzmin, 1979

(Figs. 9, 10)

Measurements: Table 1.

Description. Adult: Body small to medium-sized, curved upon fixation, almost 'C'-shaped, tapering towards posterior end. Cuticle 1.0–1.5 μ m thick; outer cuticle with fine striations nearly indiscernible in LM, inner cuticle smooth. Somatic setae very few and sparse; 3 pairs in cervical region, projecting perpendicular to body surface. Lip region slightly elevated, continuous with adjoining body. Lips amalgamated; inner labial sensilla inconspicuous, outer labials papilliform not distinct in LM. Cephalic sensilla setose, 3 μ m long, anteriorly directed, parallel to longitudinal body axis. Amphidial fovea ovoid with prominent *ductus amphidialis*, about 3 μ m in diameter, located at 11 μ m from anterior end. Stoma plectoid-type, tubular. Cheilostom weakly cuticularised, arched; gymnostom longer, cuticularised, slightly arched. Stegostom tapering posteriorly, broader at the anterior end, gradually narrowing towards base. Pharynx comprising of a cylindrical corpus continuous with isthmus. Basal bulb elongate to ovoid, moderately muscular, 20x15 μ m in dimension having a *parietinus*-like grinder with six pairs of denticulate ridges; post-bulbar extension offset from basal bulb, 8 μ m long. Cardia inconspicuously separated from post-bulbar extension. Body at pharyngeal end ca 2.5 times lip diameters wide. Nerve ring located at about 53% of pharyngeal length. Secretory-excretory pore posterior to nerve ring or at about 59% of pharyngeal length with the duct forming a single loop before joining the renette cell. Intestine transparent, with wide lumen. A pair of oval-shaped pseudo-coelomocytes of slightly less than corresponding body diameter in length, present posterior to cardia. Rectum with heavily cuticularised walls, 0.9 times anal body diameter long. Anus a crescent-shaped slit.

Female: Reproductive system didelphic, amphidelphic, ovaries reflexed antidromously on the dorsal side. Spermatheca absent; crustaformeria not distinguishable. Vagina ca 1/3rd of corresponding body diameter in length with folded inner walls forming epiptygmata; two pairs of sphincter muscles. Vulva nearly equatorial, vulval lips

slightly protruded. Vulva-anus distance 215 μm . Tail 68 μm long, curved, about 5 times as long as the anal body diameter or 32% of vulva-anus distance. Caudal setae three pairs including two subdorsal pairs and one lateral pair pointing downward. Terminal seta 10 μm anterior to tail terminus. Three linearly arranged caudal glands opening to exterior through 2 μm long spinneret; setose papillae surround the spinneret.

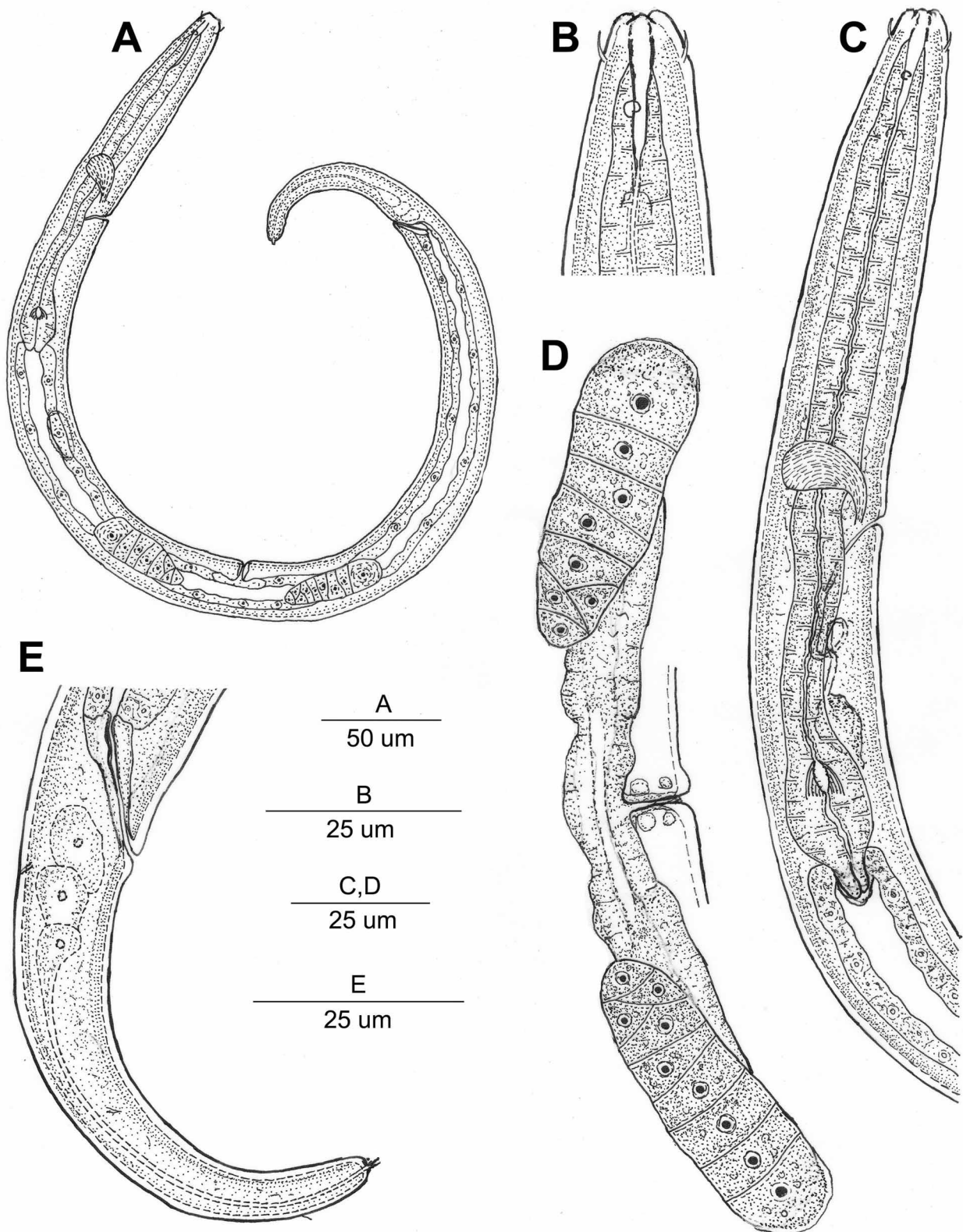


FIGURE 9. *Plectus magadani* Kuzmin, 1979. A: Female, entire. B: Anterior end. C: Pharyngeal region. D: Female reproductive system. E: Caudal region.

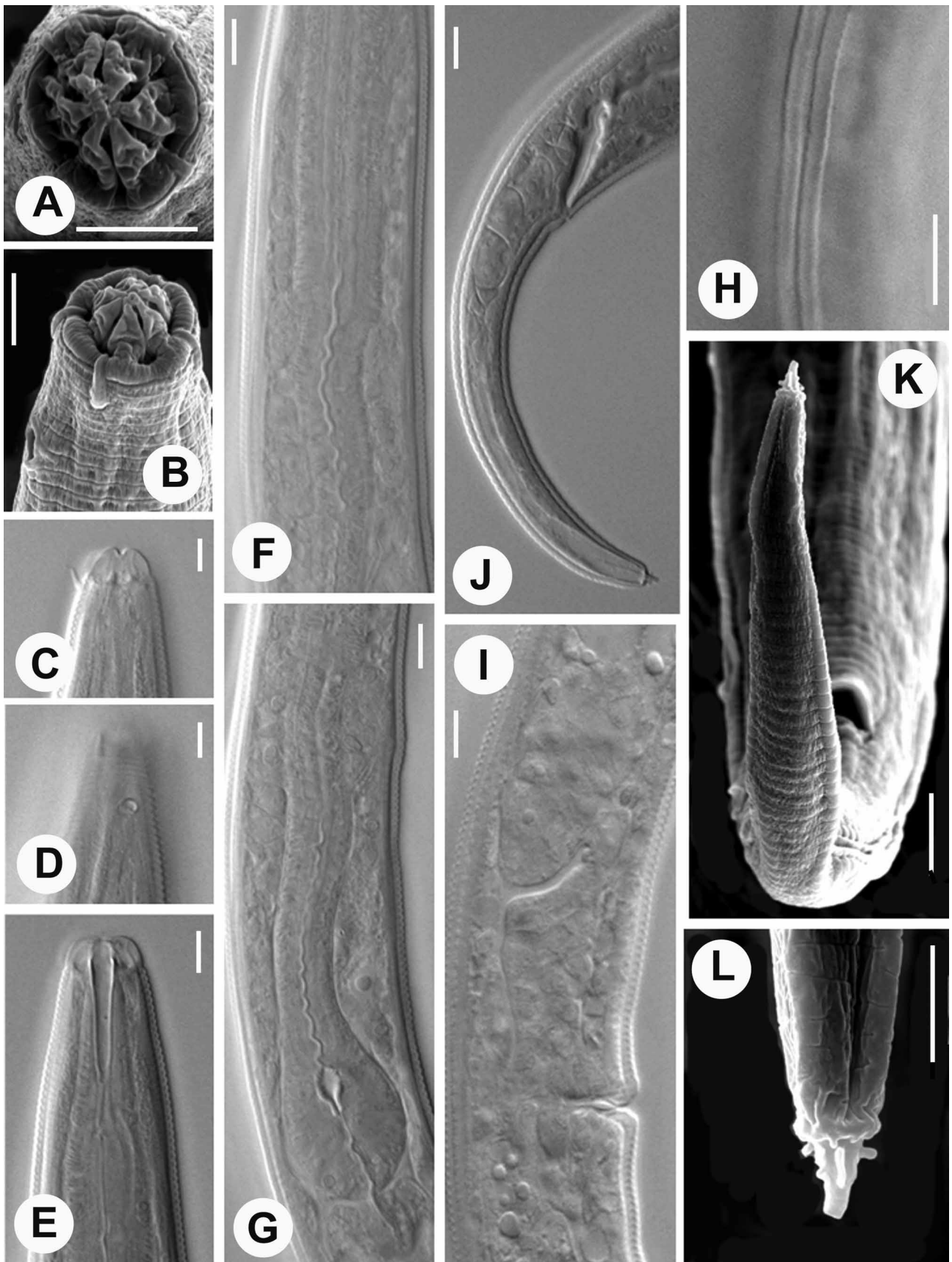


FIGURE 10. *Plectus magadani* Kuzmin, 1979. A: *En face* view. B–E: Anterior end. F: Body region showing corpus-isthmus. G: Body region showing posterior pharynx. H: Body region showing lateral alae. I: Female reproductive system. J, K: Caudal region. L: Tail terminus (Scale bar = 5 μ m).

Male: not found.

Locality and habitat. A sample containing *Plectus magadani* was collected from a drain at Nainital, Uttaranchal, India.

Voucher specimens. One female on slide *Plectus magadani* Kuzmin, 1979 NON/ 1–6 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. [One female was used for SEM study].

Salient characters. A small species with narrow but continuous lip region; lips with simple, smooth inner ends; cephalic setae anteriorly directed, parallel to main body axis; amphidial fovea circular, at middle or posterior to middle level of stoma; secretory-excretory duct conspicuous with turns, pharyngeal bulb weak with *parietinus*-like grinder, vagina with epiptygmata and two pairs of sphincter muscles; tail spinneret surrounded by small papillae.

Remarks. *P. magadani* has been reported from Africa (Egypt, Nigeria, Zaire, South Africa) and Europe (Bulgaria, Czech Republic, Finland, Hungary, Poland, Romania, Russia, Spain). In the present paper, the two specimens, the first report of the species from India, show conformity to *P. magadani* in all morphological and morphometric characteristics (*apud* Zell, 1993) except the setose papillae surrounding spinneret observed by Scanning Electron Microscope which are obviously not discernible in LM.

***Plectus communis* Bütschli, 1873**

(Figs. 11, 12)

Measurements: Table 1.

Description. Adult: Body slender, small to medium-sized, slightly arcuate upon fixation, tapering towards extremities, more towards the posterior end. Cuticle 0.8–1.2 μm thick; outer and inner cuticles finely striated. Somatic setae sparse, cervical setae 4 pairs, projecting perpendicular to body surface. Lip region slightly elevated to truncate, continuous with adjoining body. Lips amalgamated; inner labial sensilla inconspicuous, outer labials papilliform not discernible in LM. Cephalic sensilla setose, 3 μm long, directed anteriorly, parallel to main body axis. Amphidial fovea circular, 3 μm in diameter, located at 10 μm from anterior end. Stoma plectoid type, tubular. Cheilostom weakly cuticularised, with posteriorly converging walls; gymnostom parallel-walled, cuticularised. Stegostom slightly tapering with abrupt narrowing at base. Pharynx comprising of a cylindrical corpus continuous with isthmus. Basal bulb elongate to ovoid, moderately muscular, 20x15 μm in dimension having a valvular apparatus with six pairs of denticulate ridges; post-bulbar extension 10 μm long. Cardia inconspicuously separated from post-bulbar extension. Body at pharyngeal end *ca* 2.5 times lip diameters wide. Nerve ring encircling pharynx at 53% of pharyngeal length. Secretory-excretory pore slightly posterior to nerve ring, at 59% of pharyngeal length with the duct forming two loops before joining the renette cell. Intestine with wide lumen. The rectum is 20 μm long. . A pair of oval shaped pseudocoelomocytes *ca* 0.7 times corresponding body diameter long, located posterior to cardia. Rectum thin-walled, 0.8–0.9 times anal body diameter long. Anus a crescent-shaped slit.

Female: Reproductive system didelphic, amphidelphic; ovaries reflexed antidromously on the dorsal side. Anterior ovary on the left and posterior on the right side of intestine. Spermatheca absent; crustaformeria prominent. Vagina anteriorly directed, *ca* 30% of corresponding body diameter in length with folded inner walls forming a weak epiptygmata; provided with two pairs of sphincter muscles. Vulva nearly equatorial transverse slit, vulval lips not protruded. Vulva-anus distance 200 μm . Tail long, largely straight to slightly curved, *ca* 31% of vulva-anus distance long. Caudal setae five including one subventral pair and one lateral pair, pointing downward. Terminal seta 15 μm anterior to tail terminus. Three linearly arranged caudal glands opening to exterior through 2 μm long spinneret without any surrounding papilla.

Male: Not found.

Locality and habitat. A sample containing *Plectus communis* was collected from a small ditch at Nainital, Uttaranchal, India.

Voucher specimens. One female on slide *Plectus communis* Bütschli, 1873 NON1/ 1 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, Uttar Pradesh, India. [One female was used for SEM study].

Salient characters. A small, species with conspicuous cuticular striations; continuous, slightly elevated lip region; lips with simple, smooth inner ends; cephalic setae anteriorly directed, parallel to main body axis; amphidial fovea circular, at middle level of stoma; secretory-excretory duct conspicuous with turns, pharyngeal bulb weak with parietinus-like grinder, vagina with epiptygmata and two pairs of sphincter muscles, tail spinneret simple.

Remarks. The present population of *P. communis*, reported for the first time from India, conforms to previously described populations of *P. communis* in most morphological and morphometric characteristics. However, some minor differences were observed *viz.*, absence of males [vs males reported in *P. communis* apud Zell, (1993)].

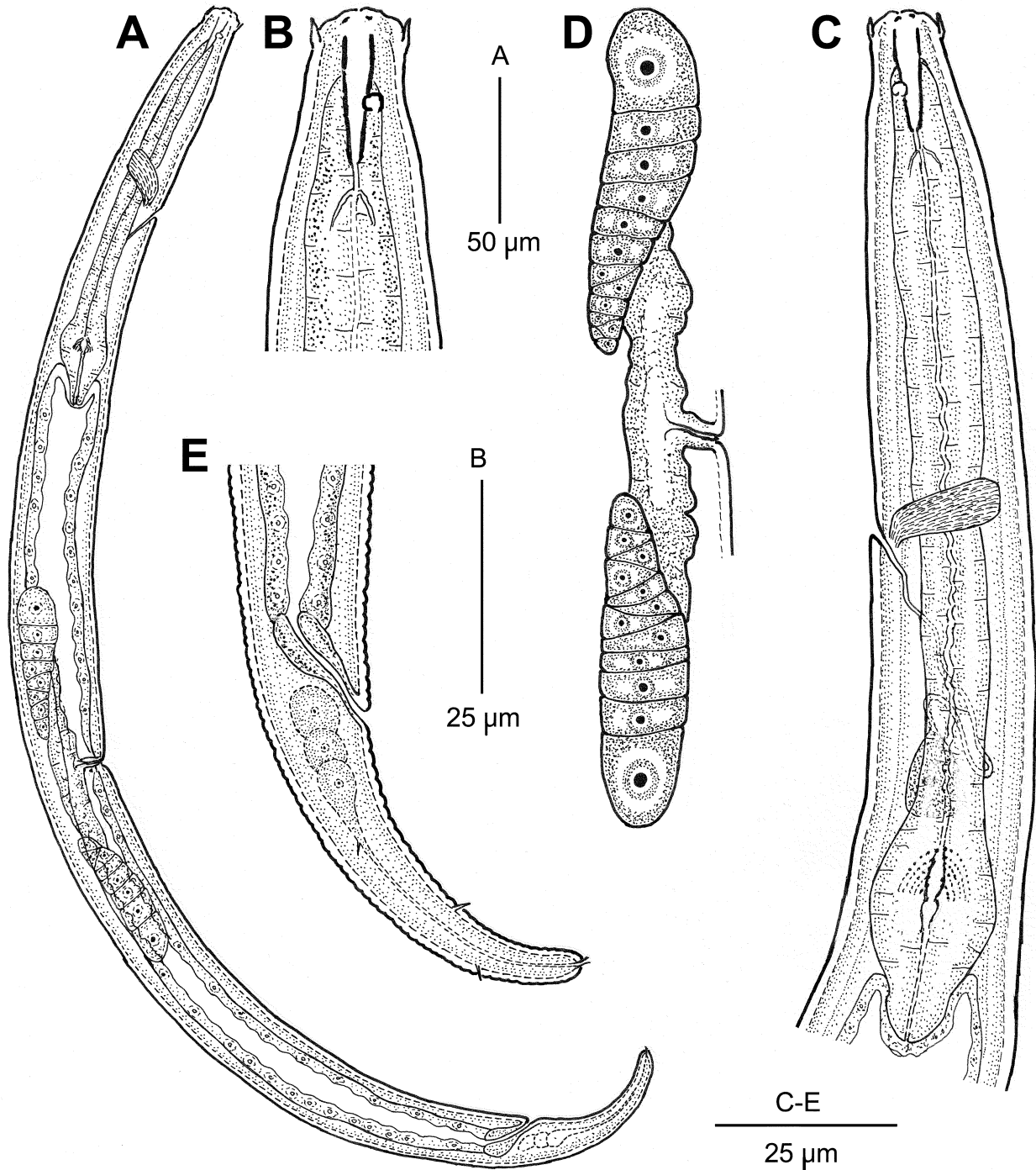


FIGURE 11. *Plectus communis* Butschli, 1873. A: Female, entire. B: Anterior end. C: Pharyngeal region. D: Female reproductive system. E: Caudal region.



FIGURE 12. *Plectus communis* Butschli, 1873. A–D: Anterior end. E, F: Body region showing posterior pharynx. G, H: Body region showing lateral alae. I: Female reproductive system. J, K: Caudal region. L: Tail terminus (Scale bar = 5 μ m).

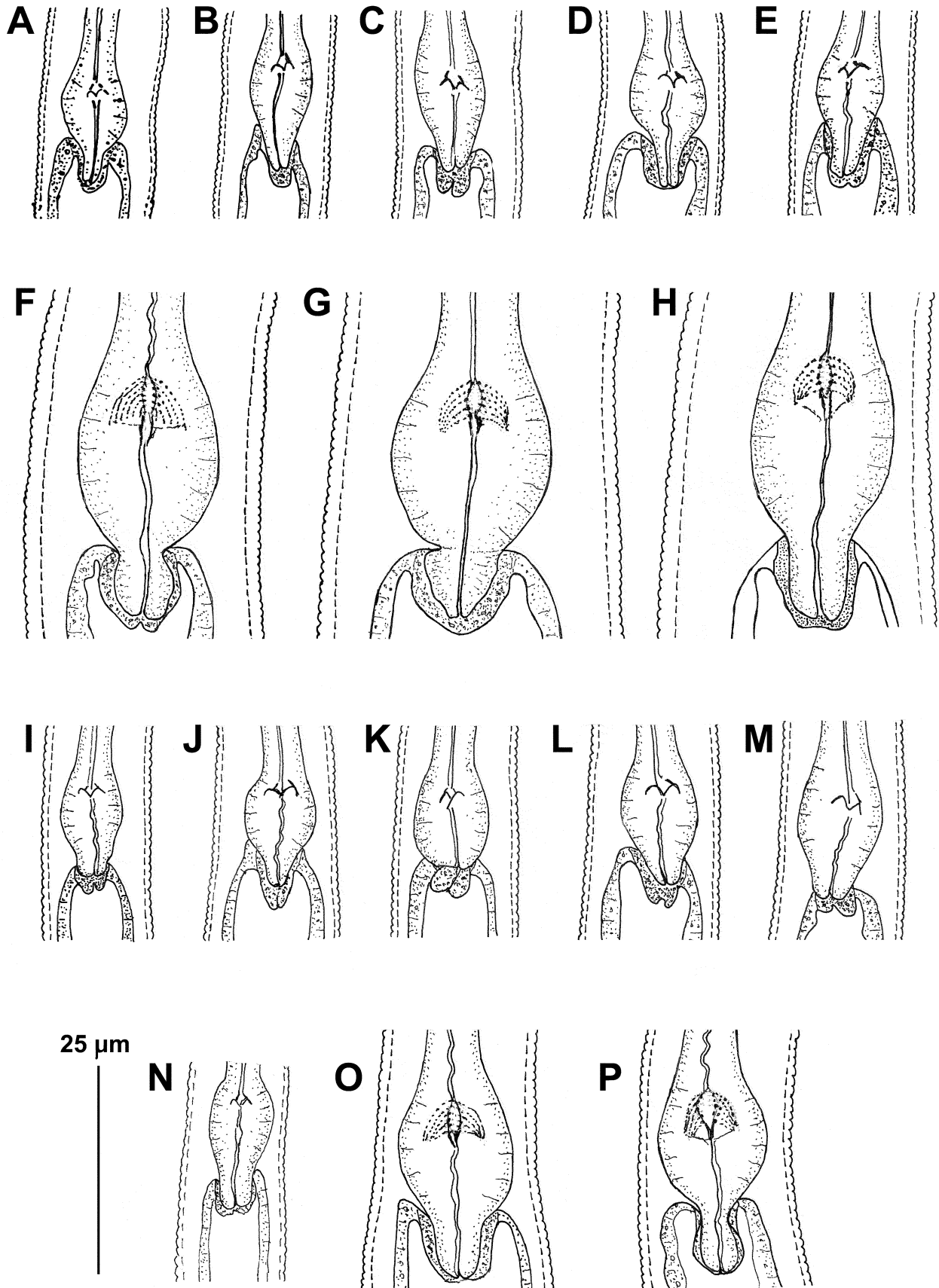


FIGURE 13. Variation in basal pharyngeal bulb and associated structures in *Plectus* spp. A–E: *P. geophilus* de Man, 1880. F–H: *P. aquatilis* Andrassy, 1985. I–M: *P. parvus* Bastian, 1865. N: *P. minimus* Cobb, 1893. O: *P. magadani* Kuzmin, 1979. P: *P. communis* Butschli, 1873.

On the taxonomy of the genus *Plectus*

The taxonomic placement of Plectidae has been a matter of discussion for years. In the past, the taxon has been placed in the Class Adenophorea. However, few taxonomists (Maggenti, 1963; Paramonov, 1964) noted the similarities between plectids and rhabditids (placed under Class Secernentea) in a number of characters *viz.*, presence of a deirid, cylindrical stoma with jointed rhabdions, pharynx with corpus, isthmus and basal bulb holding a valvular apparatus, long and cuticularised excretory duct, rectal glands and meromyarian somatic musculature. Fürst von Lieven (2003) suggested a common origin of the “grinder” (= valvular apparatus) in the basal bulb of Plectidae, Rhabdidae and Cephalobidae. The saprobiotic affiliations and a bacteriovorous habit of both taxa further indicate some convergence. However, plectids show differences from rhabditids in having double genital primordia. In the old scheme of classification Plectidae was placed under the Class Adenophorea along with dorylaimid, mononchid, chromadorid and enoplid taxa. In molecular-based phylogenetic analyses (De Ley & Blaxter, 2002; 2004), the taxon enjoys a sister-group relationship with rhabditids (placed under Secernentea in earlier schemes) and is placed in the Class Chromadorea that also holds other taxa earlier placed under Secernentea. It has been lately demonstrated that Plectidae share a number of embryonic similarities with these representatives, including *Caenorhabditis elegans* (Maupas, 1900) Dougherty, 1955, but not with the groups earlier lodged in Adenophorea and now largely considered under Class Enoplea, thus supporting conclusions concerning their phylogenetic position drawn from molecular data. However, some developmental differences *viz.*, generation of a prominent early bilateral symmetry and a very early start of gastrulation with immigration of a single gut precursor cell, suggest an early separation of Plectidae from its sister groups.

Plectus Bastian, 1865 is one of the most widely-distributed, polytypic nematode taxa in continental habitats (Zell, 1993) including freshwater, soil, litter, moss, and rotting wood. It has even been reported from regions not usually included within the limits of the biosphere (Borgonie *et al.*, 2011). Most of the species of the genus are cultured with relative ease, and as a result are widely used in research on metabolism (Klekowski *et al.*, 1980), environmental toxicology (Kammenga *et al.*, 2001, Stürzenbaum *et al.*, 2005), and developmental biology and phylogenetics (Saverimuttu *et al.*, 2000, Smythe & Nadler, 2006). A good number of studies have been carried out on developmental biology of species of *Plectus* by different workers. The embryonic development of *P. palustris* de Man, 1880 lasts from 68 to 680 h depending on temperature (Schiemer *et al.*, 1980) while *P. zelli* Tahseen, Ahmad & Jairajpuri, 1992 shows a relatively shorter embryogenesis time of 18–20 h and a generation time of 7–9 days at 26–30°C (Tahseen *et al.*, 1992). The cleavage patterns in *Plectus* were described for *P. acuminatus* Bastian, 1865, *P. aquatilis* and *P. minimus* (Lahl *et al.*, 2003) whereas post-embryonic development has been studied in *P. zelli* (Tahseen *et al.*, 1992), *P. parietinus* Bastian, 1865, *P. communis* and *P. decens* Andrásy, 1985 (Holovachov, 2004). Despite the extensive work and numerous comprehensive keys given by taxonomists (Andrásy, 1984, 1985; Ebsary, 1985; Zell, 1993; Andrásy, 2005; Holovachov & De Ley, 2006), the identification of the species of *Plectus* remains a difficult task. This is due to the fact that new species are described relatively frequently and that identification is often complicated due to the lack of detailed species descriptions and the characterization of species based on relatively inconsistent and variable characters by the early workers. Most of the species differentiations are based on the allometric ratios and unreliable characters or minor qualitative discrepancies. For species of more or less equal body lengths, the allometric values *viz.*, ‘a’, ‘b’, ‘V’, stoma length, etc. usually overlap and are difficult to differentiate. However, certain morphological characters, which appear to be relatively consistent or reliable, are the nature of lateral alae; shape and arrangement of lips; shape and position of amphidial fovea; presence or absence of hypodermal glands; nature of secretory-excretory duct; type of valvular apparatus (Fig. 13); presence or absence of epiptygmata; the number of sphincter muscles of the vagina; position of terminal caudal seta; spinneret structure and associated papillae. The use of setotaxy, though considered important in identification of *Plectus* (De Ley & Coomans, 1994), may not be judiciously used in most cases as setae may appear inconspicuous against the granular background and are likely to be overlooked. Thus a good number of species of the genus require reexamination to validate their status using a combination of more consistent and reliable characters. In this regard, detailed SEM information can prove very useful, as also suggested by De Ley & Coomans (1994). Molecular studies can be an additional advantage in the identification of species; however, the connection of this information to the description of every morphologically identified species is not possible and relatively a difficult task for many taxonomists. On the contrary, the DNA sequences of an incorrectly identified species may lead to extreme confusion and chaos. Thus, the characters considered as being important, consistent and diagnostic for the species, can be summed up in the following amended diagnosis of the genus:

Diagnosis (emended). Plectidae, Plectinae. Small- to large-sized nematodes ranging, from 0.3–2.0 mm in length. Somatic setae distributed over the entire body. Hypodermal glands and body pores occasionally present. Lip region usually continuous, rarely set off from adjoining body. Lips six, smooth or radially incised with inner ends, simple obtuse, bifid or attenuated. Inner and outer labial sensilla papilliform, usually embedded in pits or radial incisures. Cephalic sensilla setose, oriented parallel or perpendicular to main body axis. Amphidial fovea circular to unispiral. Stoma plectoid, tubular. Pharynx with cylindroid corpus usually indistinguishable from isthmus, a basal bulb with valvular apparatus having paired denticulate ridges and a post-bulbar extension. Secretory-excretory duct prominently cuticularised, making several turns before joining the renette cell. Female genital system didelphic-amphidelphic. Genital tract simple and relatively undifferentiated, usually devoid of spermatheca. Eggs with smooth or spinose shell. Vagina usually perpendicular to main body axis, rarely anteriorly directed; provided with one or two pairs of sphincter muscles; with or without epiptygmata. Rectum short to long, with cuticularized and occasionally dilated lumen. Males with or without tubular supplements. Male and female tail usually with sub-ventral and sub-dorsal rows of setae. Tail terminus with a simple or crooked spinneret, occasionally surrounded by papillae.

References

- Adhikari, B.N., Tomasel, C.M., Li, G., Wall, D.H. & Adams, B.J. (2010) The Antarctic nematode *Plectus murrayi*: an emerging model to study multiple stress survival. *Cold Spring Harbor Protocols*, November 1, 2010. Doi: 10.1101/pdb.emo142.
- Andrássy, I. (1953) Die Wirkung der verschiedenen Pflanzenarten auf die Zusammensetzung der in der Rhizosphäre lebenden Nematodengemeinschaften. *Annales Historico-naturales Musei Nationalis Hungarici*, 3, 93–99.
- Andrássy, I. (1954) Über einige von Daday beschriebene Nematoden-Arten. *Zoologischer Anzeiger*, 152, 138–144.
- Andrássy, I. (1955) Az erdei talajban élő fonálféreg (Nematoda) mennyiségi és produktóbiológiai vizsgálata. *Kandidátusi értekezés*, 1–260.
- Andrássy, I. (1958) Erd- und Süßwassernematoden aus Bulgarien. *Acta Zoologica Hungarica*, 4, 1–88.
- Andrássy, I. (1959) Neubenennungen einiger homonymen Nematoden-Gattungen. *Nematologica*, 4, 223–226.
- Andrássy, I. (1967) Ergebnisse der zoologischen Forschungen von Dr. Z. Kaszab in der Mongolei. 92. Weitere Bodennematoden aus den Jahren 1964 und 1965. *Opuscula Zoologica Budapest*, 6, 203–233.
- Andrássy, I. (1972) A Magyarországról eddig kimutatott szabadon élő fonálféreg (Nematoda) jegyzéke. *Állattani Közlemények*, 59, 161–171.
- Andrássy, I. (1976) *Evolution as a basis for the systematization of nematodes*. Budapest, *Akadémiai Kiado*, 288 pp.
- Andrássy, I. (1978) *Nematoda*. A checklist of the animals inhabiting European inland waters with account of their distribution and ecology. In: Illies, J. (Ed.) *Limnofauna Europaea*, 98–117.
- Andrássy, I. (1984) Klasse Nematoda (Ordnungen Monhysterida, Desmoscolecida, Araeolaimida, Chromadorida, Rhabditida). Stuttgart, Gustav Fischer Verlag, 509 pp.
- Andrássy, I. (1985) The genus *Plectus* Bastian, 1865 and its nearest relatives (Nematoda: Plectidae). *Acta Zoologica Hungarica*, 31, 1–52.
- Andrássy, I. (1990) Szabadon élő fonálféreg (Nematoda) a magyar faunában. *Állattani Közlemények*, 76, 17–38.
- Andrássy, I. (1991) The free-living nematode fauna of the Bátorliget Nature Reserve. In: The Bátorliget Nature Reserve - after forty years. Budapest, 129–197.
- Andrássy, I. (1992) A short census of free-living nematodes. *Fundamental and Applied Nematology*, 15, 187–188.
- Andrássy, I. (1996) Free-living nematodes in the Bükk Mountains, Hungary. - In: The fauna of the Bükk National Park. Budapest, 33–63.
- Andrássy, I. (1997) Nematológiai kutatások a Balatonon. *Állattani Közlemények*, 81, 169–175.
- Andrássy, I. (2002) Free-living nematodes from the Fertő-Hanság National Park, Hungary. In: Mahunka, S.(Ed.), *The Fauna of the Fertő-Hanság National Park*. Budapest, pp21–97.
- Andrássy, I. (2005) The free-living nematode fauna of Hungary (Nematoda- Errantia), I. In: Csuzdi, Cs. & Mahunka, S. (Eds.) *Pedozoologia Hungarica*, 3. Budapest, 518 p.
- Bastian, H.C. (1865) Monograph on the Auguillulidae, or free nematodes, marine, land, and freshwater; with descriptions of 100 new species. *Transactions of the Linnaean Society of London-Zoology*, 25, 73–184.
- Bongers, T. & Bongers, M. (1998) Functional diversity of nematodes. *Applied Soil Ecology*, 10, 239–251.
- Borgonie, G., García-Moyano, A., Litthauer, D., Bert, W., Bester, A., van Heerden, E., Möller, C., Erasmus, M. & Onstott, T. C. (2011) "Nematoda from the terrestrial deep subsurface of South Africa". *Nature*, 474 (7349), 79–82. Doi:10.1038/nature09974.
- Bütschli, O. (1873) Beiträge zur Kenntnis der freilebende Nematoden. *Nova Acta der Kaiserlichen Leopoldinisch- Carolinischen Deutschen Akademie der Naturforscher*, 36, 1–124.
- Chitwood, B.G. (1951) North American marine nematodes. *Texas Journal of Science*, 3, 617–672.

- Cobb, N.A. (1893) Nematode worms found attacking sugar cane. *Agricultural Gazette of New South Wales*, 4, 808–833.
- Cobb, N.A. (1918) Estimating the nema population of the soil. U.S. Department of Agriculture. *Agricultural Technical Circular of US Department of Agriculture*, 1, 48p.
- Cobb, N.A. (1920) One hundred new nemas (type species of 100 new genera). *Contribution to a Science of Nematology*, 9, 217–343.
- von Daday, E. (1894) New contributions towards the knowledge of the microfauna of lake Balaton (Nematoda, Rotatoria, Entomostraca). *Mathematikai e's Termeszettudományi Értesítő*, 12, 122–145 (in Hungarian).
- von Daday, E. (1897) Die freilebenden Süßwasser-Nematoden Ungarns. *Zoologische Jahrbücher*, 10, 91–134.
- De Ley, P. & Blaxter, M. (2002) Systematic position and phylogeny. In: Lee, D.L. (Ed.) *The biology of nematodes*. London and New York, Taylor & Francis, 1–30.
- De Ley, P. & Blaxter, M. (2004) A new system for Nematoda: combining morphological characters with molecular trees, and translating clades into ranks and taxa. *Nematology Monographs & Perspectives*, 2, 633–653.
- De Ley, P. & Coomans, A. (1994) Terrestrial nematodes from the Galápagos Archipelago IV: The genus *Plectus* Bastian, 1865, with description of three new species (Leptolaimina: Plectidae). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie*, 64, 43–70.
- de Man, J.G. (1880) Die einheimischen, frei in der reinen Erde und im Süßen Wasser lebende Nematoden. Vorläufiger Bericht und descriptivsystematischer Theil. *Tijdschrift der Nederlansche Dierkundige Vereeniging*, 5, 1–104.
- de Man, J.G. (1904) Ein neuer freilebender Rundwurm aus Patagonien *Plectus (Plectoides) patagonicus* n. Sp. *Bericht der Senckenbergischen Naturforschenden Gesellschaft*, 2, 41–45.
- Dózsa-Farkas, K. (1965) Untersuchungen über die Fauna des Budapester Leitungswassers, mit besonderer Berücksichtigung der Nematoden. *Opuscula Zoologica (Budapest)*, 5, 173–181.
- Ebsary, B.A. (1985) Two new species of *Plectus* with a redescription of *Plectus cancellatus* Zullini, 1978 (Nematoda: Plectidae) from Canada. *Canadian Journal of Zoology*, 63, 2395–2400.
- Fürst von Lieven, A. (2003) Functional morphology and evolutionary origin of the three-part pharynx in nematodes. *Zoology*, 106, 183–201. doi:10.1078/0944-2006-00115
- Geraert, E. (1962) De nematodenfauna in en om de wortels van *Musa paradisiaca normalis*. In: Bijdragen tot de kennis der plantenparasitaire en der vrijlevende Nematoden van Kongo, *Instituut voor Dierkunde, Laboratorium voor Systematiek, Rijksuniversiteit, Gent*, 5–73.
- Hendriksen, N.H. (1983) Anhydrobiosis in nematodes: studies on *Plectus* sp. In: Lebrun, P., Andre, H. M. & de Medts, A. (Eds.) *New Trends in Soil Biology*. Universite Catholique de Louvain, Louvain-la-Neuve, Belgium, pp387–394.
- Holovachov, O. (2004) Morphology, phylogeny and evolution of the superfamily Plectoidea Örley, 1880 (Nematoda: Plectida). *Annales Zoologici*, 54, 631–672.
- Holovachov, O. & De Ley, P. (2006) Order Plectida. In: Eyualem A., Andrásy, I. & Traunspurger, W. (Eds.) *Freshwater Nematodes: Ecology and Taxonomy*. CAB International, pp609–644.
- Kammenga, J.E., van Gestel, C.A.M. & Hornung, E. (2001) Switching life-history sensitivities to stress in soil invertebrates" *Ecological Applications*, 11, 226–238.
- Khan, Z. & Araki, M. (2001) Descriptions of four new and five known species of the genus *Plectus* Bastian (Nematoda: Plectidae) from Japan. *International Journal of Nematology*, 11, 177–191.
- Klekowski, R.Z., Schiemer, F. & Duncan, A. (1980) A bioenergetic study of a benthic nematode, *Plectus palustris* de Man, 1880, throughout its life cycle. I The respiratory metabolism at different densities of bacterial food. *Oecologia*, 44, 119–124.
- Kuzmin, L.L. (1979) Opisanie samtha i novogo podvida *Plectus acuminatus* Bastian, 1865 (Nematoda, Plectidae). *Zoologicheskii Zhurnal*, 68, 433–435. Moskau.
- Lahl, V., Halama, C. & Schierenberg, E. (2003) Comparative and experimental embryogenesis of Plectidae (Nematoda). *Developmental Genes and Evolution*, 213, 18–27.
- Maggenti, A.R. (1961) Revision of the genus *Plectus* (Nematoda: Plectidae). *Proceedings of the Helminthological Society of Washington*, 28, 139–166.
- Maggenti, A.R. (1963) Comparative morphology in nemic phylogeny. In: Dougherty, E.C. (Ed.) *The lower Metazoa, comparative biology and phylogeny*. Berkeley, USA. University of California Press, 273–282.
- Micoletzky, H. (1916) Ergebnisse einer botanischen Forschungsreise nach Deutsch-Ostafrika und Südafrika (Kapland, Natal und Rhodesien). Süßwasser-Nematoden aus Südafrika. *Denkschriften der Kaiserlichen Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Klasse*, 92, 49–171.
- Novikova, S.I. & Gagarin, V.G. (1971) New species of the genus *Plectus* (Nematoda, Plectidae). *Zoologicheskii Zhurnal*, 50, 1097–1098 (in Russian).
- Örley, L. (1880) Az Anguillulidák magánrajza. (Monographie der Anguilluliden). *Természetráji Füzetek*, Budapest, 4, 16–150.
- Paramonov, A.A. (1964) Osnovy fitogelmintologii II. [Fundamentals of phytonematology.] (In Russian). *Trudy Gelmintologicheskoi Laboratorii, Akademia Nauk SSSR (Moskva)*, 446 p.
- Saverimuttu, J.K.C., Karunanayake, E.H. Chandrasekharan, N.V. & Jayasena, S.M.T. (2000) Molecular characterisation of the actin gene of the filarial parasite *Wuchereria bancrofti*. *International Journal for Parasitology*, 30, 119–124
- Schiemer, F., Duncan, A. & Klekowski, R.Z. (1980) A bioenergetic study of a benthic nematode, *Plectus palustris* de Man, 1880, throughout its life cycle. II. Growth, fecundity and energy budgets at different densities of bacterial food and general

TERMS OF USE

This pdf is provided by Magnolia Press for private/research use.
Commercial sale or deposition in a public library or website is prohibited.

- ecological considerations. *Oecologia*, 44, 205–212.
- Schneider, W. (1937) Freilebende Nematoden der Deutschen Limnologischen Sundaexpedition nach Sumatra, Java und Bali. *Archiv für Hydrobiologie, Supplement*, 15, 30–108.
- Seinhorst, W. (1959) A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. *Nematologica*, 4, 67–69.
- Smythe, A. B. & Nadler, S. A. (2006) Nematode small subunit phylogeny correlates with alignment parameters. *Systematic Biology*, 55, 972–992.
- Soos, A. (1937) *Pseudorhabdolaimus limnophilus* n.g., n.sp., eine neue, freilebende, Nematode. *Zoologischer Anzeiger*, 118, 323–325.
- Stürzenbaum, S.R., Arts, M.S.J. & Kammenga, J.E. (2005) Molecular cloning and characterization of Cpn60 in the free-living nematode *Plectus acuminatus*. *Cell Stress Chaperones*, 10, 79–85.
- Tahseen, Q., Ahmad, I. & Jairajpuri, M.S. (1992) Description and developmental biology of *Plectus zelli* n. sp. (Nematoda: Araeolaimida). *Fundamental and Applied Nematology*, 15, 503–510.
- Timm, R.W. (1971) Antarctic soil and freshwater nematodes from the mcmurdo Sound Region. *Proceedings of the Helminthological Society of Washington*, 38, 42–52.
- Truskova, G.M. (1976). Shest novykh vidov roda *Plectus* (Nematoda, Plectidae) temnokvojnykh jesov Dalnego Vostoka. *Zoologicheskii Zhurnal*, 55, 1718–1726; Moskau..
- Zell, H. (1993) Die Gattung *Plectus* Bastian, 1865 sensu lato (Nematoda: Plectidae) - Ein Beitrag zur Ökologie, Biogeographie, Phylogenie und Taxonomie der Plectidae. *Andrias*, 11, 3–171.
- Zullini, A., Loof, P.A.A. & Bongers, T. (2002). Free-living nematodes from nature reserves in Costa Rica. 3. Araeolaimida. *Nematology*, 4, 709–724.