RE-DESCRIPTION OF TWO SPECIES OF *PELODERA* (NEMATODA: RHABDITIDAE) FROM INDIA

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Summary. Two species of *Pelodera* Schneider, 1866, reported for the first time from India, have been redescribed and illustrated. *Pelodera teres* Schneider, 1866 is characterised by oviparous females having prominent, separate lips; heavily cuticularised, refractive labial margins with fine bristles in inter-labial grooves; three setose denticles on each metastegostomal plate; cupola-shaped tail in females and males with crystalline needle-like structures in vas deferens; distally fused spicules and an open peloderan bursa with three pre-cloacal and seven post-cloacal bursal papillae. *Pelodera icosiensis* (Maupas, 1916) Dougherty, 1955 is characterised by ovoviviparous females having wider and offset lip region, swollen pharyngeal corpus and hemispheroid tail of nearly half anal body diameter, males with distally-fused spicules having bicuspid capitula, and a short, expanded, semicircular, anteriorly-closed, peloderan bursa with lobes and ten paired bursal papillae.

Key words: Pelodera icosiensis, P. teres.

Andrássy (1984), in his system of classification for rhabditids, placed those taxa having relatively prominent metastegostomal denticles, moderately to strongly swollen pharyngeal corpus, diovarial female gonad and males with spicules often distally fused and a peloderan bursa, under subfamily Peloderinae Andrássy, 1976. The genera he included in the subfamily are *Pelodera* Schneider, 1866; *Caenorhabditis* (Osche, 1952) Dougherty 1953; *Pellioditis* (Dougherty, 1953) Timm, 1961; *Coarctadera* (Dougherty, 1953) Andrássy, 1976; *Phasmarhabditis* Andrássy, 1976; *Xylorhabditis* (Sudhaus, 1976) Blinova, 1982; *Dolichorhabditis* Andrássy, 1983 and *Rhomborhabditis* Andrássy, 1983. However, Sudhaus and Fitch (2001) and Kiontke and Fitch (2005), following the cladistic approach, considered Peloderinae as a paraphyletic taxon and designated the *Pelodera* clade, comprising two major species groups - the *Teres* group and the *Coarctata* group, with *P. kolbi* Sachs, 1950 falling out of the combination. The two species described and illustrated in the current paper, *Pelodera teres* Schneider, 1866 and *P. isociensis* (Maupas, 1916) Dougherty, 1955, belonging to the *Teres* group and the *Coarctata* group respectively (Sudhaus and Fitch, 2001), were collected from saprobic habitats during a nematode survey programme. Though both species were collected from similar types of decomposing environment, viz. cow dung or farmyard manure, the climatic conditions were very different. *Pelodera teres* was collected from Kishtwar, Jammu and Kashmir at an altitude of over 5,500 feet and with a subtropical to temperate climate, while *P. icosiensis* was collected from Bharatpur, Rajasthan, the desert region in India with a very dry climate and extreme temperatures.

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MATERIALS AND METHODS

Pelodera teres and *P. isociensis* were extracted from the soil samples using sieving and decantation and modified Baerman's funnel techniques. For light microscopy (LM), nematodes were fixed in 4% formaldehyde, processed to anhydrous glycerine and mounted on slides. They were later measured with an ocular micrometer. *En face* views and head sections were prepared by cutting serial sections of the dehydrated nematode with a sharp-edged blade. Drawings were made using a drawing tube mounted on an Olympus Trinocular DIC Microscope BX-51 and photographs were taken using an Olympus digital camera DP-11.

DESCRIPTIONS

PELODERA TERES
Schneider, 1866
Syn. *Anguillula mucronata* Grube, 1849 (*Nomen oblitum*)
Leptodera teres (Schneider, 1866) Schneider, 1866
Rhabditis teres (Schneider, 1866) Butschli, 1873
Rhabditis donbass Skrjabin, Shults *et* Serbinov, 1926
(Figs 1, 2)

Females (n = 9). L = 1.10 ± 0.03 (0.81-1.41) mm; a = 17.1 ± 1.12 (15-19); b = 5.0 ± 0.80 (4.3-6.4); c = 23.1 ± 3.35 (17.9-28.3); c' = 1.4 ± 0.24 (1.1-1.8); V = 58.0 ± 2.05 (54.4-60.4); G1 = 45.8 ± 4.35 (40-52); G2 = 48.1 ± 7.16 (39-59); stoma length = 26.1 ± 1.12 (25-28) µm;

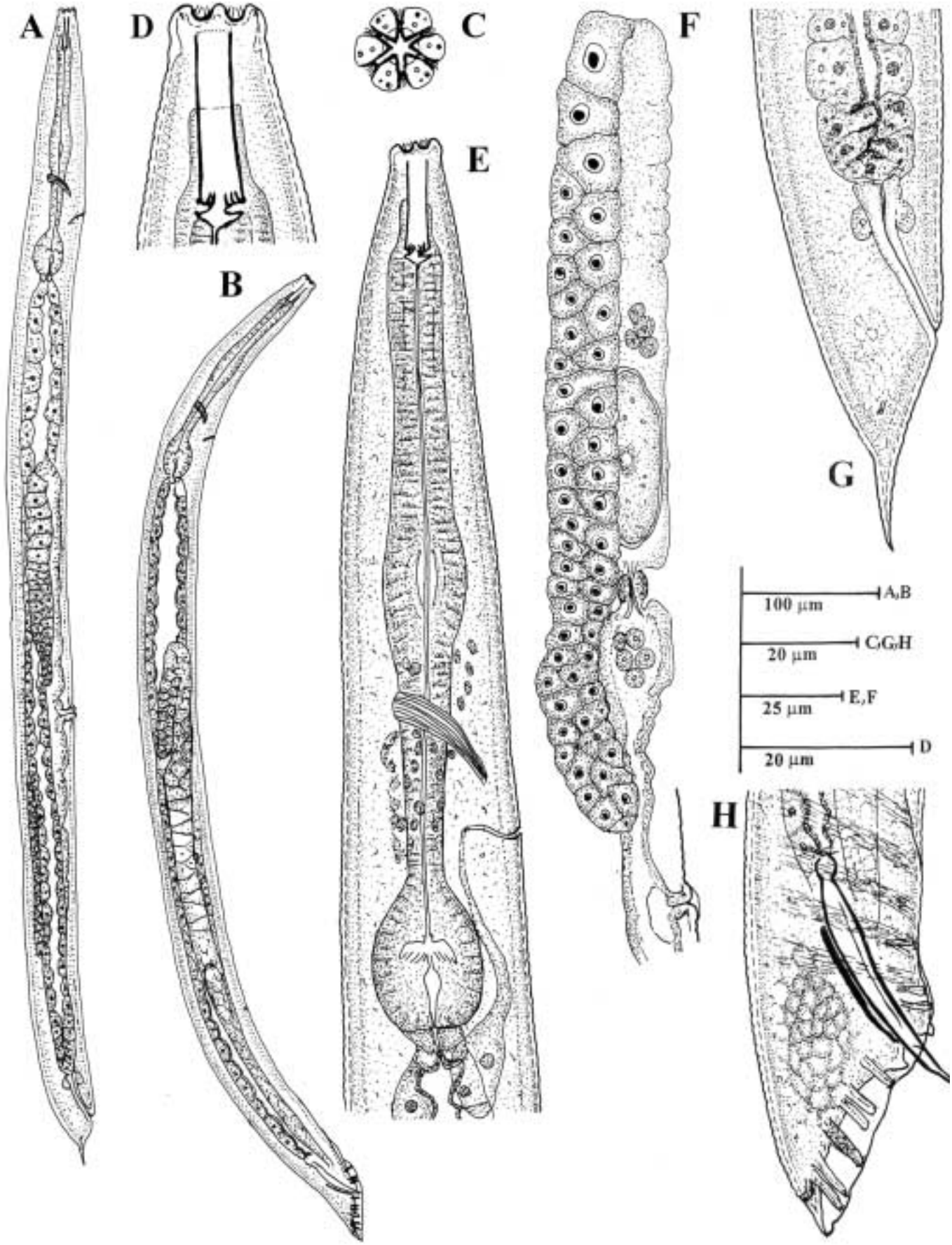

Fig. 1. *Pelodera teres* (Schneider, 1866). A: Entire female; B: Entire male; C: *En face* view; D: Anterior end; E: Pharyngeal region; F: Female reproductive system; G: Female tail; H: Male tail.

pharyngeal length = 197.2 ± 12.19 (185-220) µm; tail length = 43.1 ± 5.43 (35-51) µm; anal body diameter = 32. 4 ± 8.75 (26-38) µm.

Males (n = 7). L = 0.79 ± 0.06 (0.73-0.91) mm; a = 18.9 ± 1.23 (17-21); b = 4.7 ± 0.42 (4.3-5.2); c = 21.3 ± 1.85 (19.1-24.5); c' = 1.3 ± 0.16 (1.1-1.5); T = 71.2 ± 6.13 (64-81); stoma length = 23.7 ± 1.50 (22-25) µm; pharyngeal length = 169.8 ± 6.49 (162-177) µm; tail length = 37.2 ± 1.72 (34-39) µm; spicule length = 44.5 ± 1.37 (43-46) µm; gubernaculum length = 27.5 ± 1.82 (24-29) µm; anal body diameter = 29.7 ± 4.71 (23-35) µm.

Female. Body medium- to large-sized, slightly curved ventrally upon fixation, tapering gradually towards both extremities. Cuticle with faint transverse striae and relatively prominent longitudinal lines with fine punctations. Lateral field not distinguishable; observed with three lines in an aberrant specimen. Lip region showing sexual dimorphism: lips more prominent and projected in females compared to males. Lip region 12-17 µm wide and 4-6 µm high, offset from adjoining body. Lips separate, globular, with conspicuous labial grooves; labial margins, particularly inner ones, heavily cuticularised. Interlabial grooves between adjacent lips bearing 4-6 fine bristles projecting outwards. Inner labial sensilla papilliform, outer labials and cephalic sensilla located at outer lip margins. Amphids very small, pore-like, on lateral lips. Stoma rhabditoid type, 2-3 labial diameters long; cheilostom not cuticularised, indistinct; gymnostom cuticularised, 1/3rd of stomal length. Stegostom 50-55% of stomal length surrounded by pharyngeal tissue. Metastegostom with three well-developed, setose denticles on each plate. Telostegostom spacious. Pharynx 104-118 _m long with moderately swollen corpus, 46-62 _m long, narrow isthmus and an ovoid, valvate basal bulb of 31-43 x 23-32 _m. Nerve ring located at 67-71% of pharyngeal length. Excretory pore posterior to nerve ring, at 70-74% of pharyngeal length with duct leading to two prominent glandular cells, located closely posterior to basal bulb. Hemizonid not visible. Pharyngeal corpus 1-1.4 times longer than isthmus and basal bulb together. Body width at proximal end of pharynx 1.6-1.9 labial diameters and at distal end of pharynx 2.9-3.7 labial diameters. Cardia conoid, 7-10 _m long with wide, cuticularised lumen. Intestine narrow at level of cardia with sudden expansion posteriorly, having large polygonal cells with prominent nuclei; intestinal lumen thick with refractive lining. Intestinal cells with thick boundaries, compactly arranged at anterior and posterior extremities compressing the refractive lumen. Rectum 26-32 _m long, thick-walled, 1-1.2 anal body diameters, provided with rectal glands. Anus a crescent-shaped slit with associated muscle band.

Reproductive system didelphic, amphidelphic. Ovaries dorsally reflexed; anterior branch on right and posterior on left side of intestine with former usually smaller than latter. Oocytes arranged in two rows. Oviduct long and narrow leading into a pouch-like spermatheca through thick-walled, conspicuous sphincter. Uterus long, accommodating up to 21 eggs in different embryonic stages. Hatched juveniles were observed in body cavity of females. Vagina thick-walled, muscular, at right angles to longitudinal body axis, nearly 1/3rd of corresponding body diameter. Vulva a transverse slit, post-equatorial, located at 448-795 _m from anterior body end with cuticular flaps flanking vulval opening. Vulva-anus distance 6-11 times tail length. Tail short, cupola-shaped with terminal spike. Phasmidial ducts opening close to base of tail spike.

Male. Similar to female in general morphology of cuticle, stoma and pharynx, but comparatively smaller in size with narrower, continuous lip region and greater ventral curvature, posteriorly. Testis monorchic, reflexed dorsally, on right side of intestine. Two pseudocoelomocytes usually found close to flexure of testis. Conspicuous, paired ejaculatory glands present. Vas deferens with bunches of parallel arranged needle-like structures close to its junction with ejaculatory duct. Each needle measuring 5-10 _m. Spicules massive, 1.5-1.8 anal body diameters long, with rounded capitula, fused distally at 20-22% of their lengths; gubernaculum simple, slender, plate-like, about 1 anal body diameter long, more than half of spicular length. Bursa peloderan, anteriorly open. Genital papillae nine pairs with three pre-cloacal and six post-cloacal pairs in 1+2/1+2+ph+3 configuration. Pre-cloacals differ from post-cloacals in having broad rounded apices and narrow tapering bases. GP1 submedian, about 2/3rd spicular length anterior to cloaca; GP2, GP3 subventral, closely placed slightly anterior to cloacal opening; GP4 ventrolateral, slightly spaced from ventrolateral group of GP5 and GP6 papillae, reaching bursal margin and opening dorsally; GP7, GP8 subventral, close to dorsally oriented GP9. Tail elongate conoid with fine terminus. Phasmids located between GP6 and GP7 papillae arising laterally and opening close to bursal margin dorsally. Six paired copulatory muscle bands present with the most posterior originating closely anterior to GP2.

Habitat and locality. Samples containing *Pelodera teres* Schneider, 1866 were collected from farmyard manure storage at Kishtwar, Jammu and Kashmir, India.

Voucher Specimens. Eight females and six males on slide '*Pelodera teres* No.5 JKW/2-6' deposited in the 'Nematode Collection' of the Department of Zoology, Aligarh Muslim University, Aligarh, India. One female and one male on slide '*Pelodera teres* No.5 JKW/1' deposited at the Laboratory of Nematology, Wageningen University and Research Center (WUR), 6700 ES Wageningen, The Netherlands.

Remarks. The Indian population of *P. teres* was made up of a 1:1 ratio of ovoviviparous females and males. The individuals possessed six fine bristles in each interlabial groove. In view of their fine nature they might

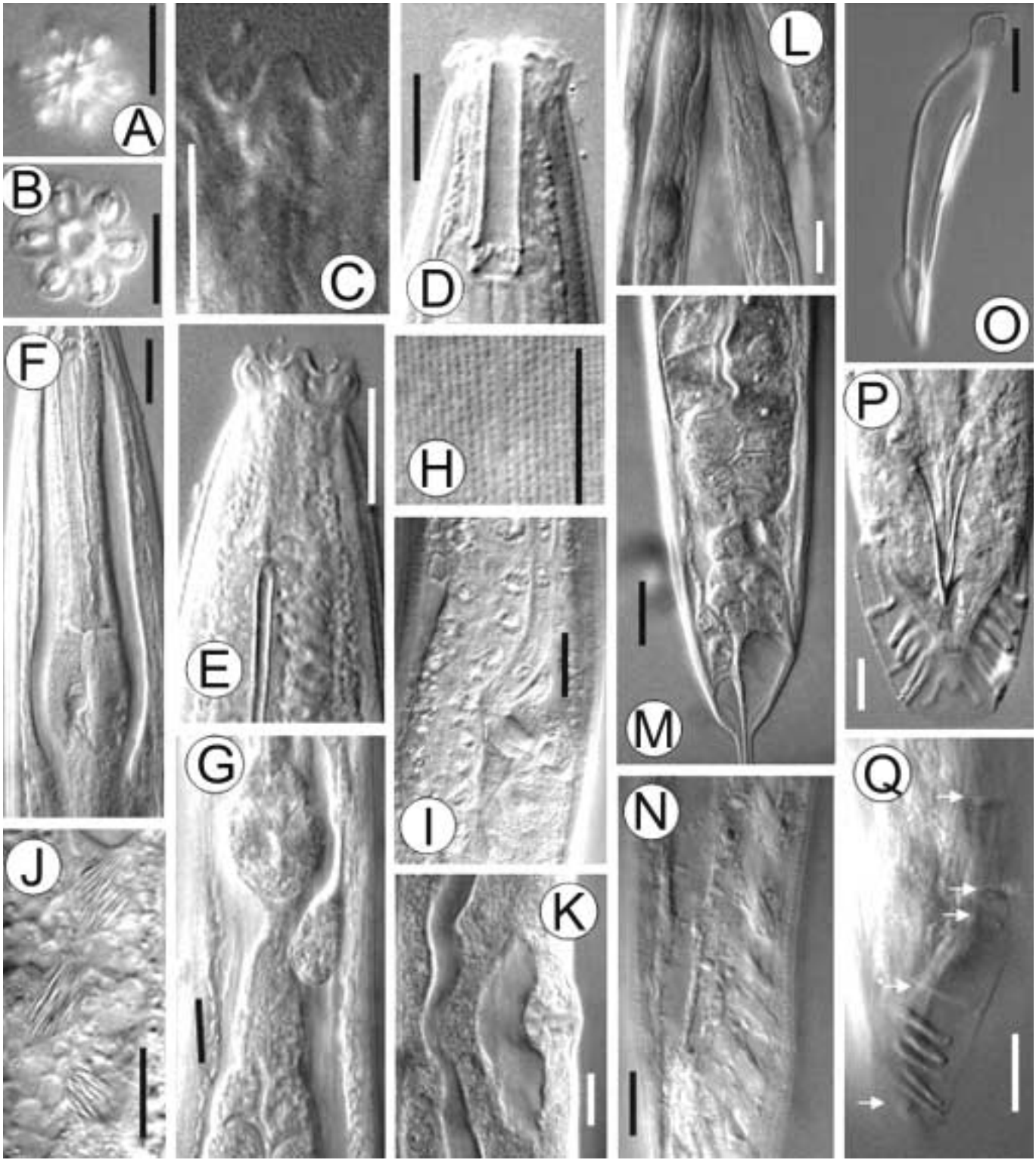

Fig. 2. *Pelodera teres* (Schneider, 1866). A, B: *En face* view; C, D: Anterior end (female); E: Anterior end (male); F: Pharyngeal corpus; G: Posterior pharyngeal region; H: Cuticular markings; I: Part of female genital tract; J: Vas deferens with needle-like structures; K: Vulval region (lateral); L: Intra-uterine juveniles; M: Female posterior region showing compactly arranged intestinal cells; N: Male posterior region showing copulatory muscle bands; O: Extracted spicule; P: Male tail (ventral); Q: Male tail (lateral), arrows indicate the less focused papillae. (Scale bar = 10 _m).

have been overlooked by previous workers. The specimens described by Schulte (1989) as *P. teres* and *P. pseudoteres* possessed these structures though they were not mentioned in the description. The other features that have been observed in the present specimens, but not reported in the original or subsequent descriptions, are prominently cuticularised and refractive lip margins and sexually dimorphic lip region, with females having prominently expanded lips; intestinal cells compactly arranged at anterior and posterior extremities, com-

pressing the refractive lumen. Also, the reproductive system in females has a well developed sphincter between oviduct and spermatheca. Although the male accessory sexual structures were similar to those of the original description, the closely placed genital papillae GP8 and GP9 of the Indian specimens were larger (reaching the bursal margins) than in *P. teres apud* Schulte (1989).

PELODERA ICOSIENSIS **(Maupas, 1916)**

Syn. *Rhabditis icosiensis* Maupas, 1916
Pelodera (Cylindridera) icosiensis (Maupas, 1916) Dougherty, 1955
Rhabditis mutatoris Fuchs, 1931
(Figs 3, 4)

Females (n = 23). L = 0.89 ± 0.15 (0.63-1.28) mm; a = 11.5 ± 2.11 (9-14); b = 5.4 ± 0.76 (4.3-6.9); c = 57.7 ± 8.58 (38.6-70.9); c' = 0.5 ± 0.05 (0.4-0.6); V = 61.6 ± 1.55 (58-65); G1 = 60.9 ± 11.80 (35-78); G2 = 49.9 ± 8.69 (31-64); stoma length = 24.6 ± 2.10 (21-30) _m; pharyngeal length = 166. 5 ± 13.25 (141-187) _m; tail length = 15.3 ± 3.49 (11-25) _m; anal body diameter = 32.0 ± 6.75 (23-50) µm.

Males (n = 13). L = 0.68 ± 0.12 (0.45-1.05) mm; a = 12.6 ± 1.63 (9-16); b = 4.8 ± 0.78 (3.2-5.7); c = 17.3 ± 2.69 (12.5-21.4); c' = 1.5 ± 0.17 (1.2-1.7); T = 71.7 ± 8.81 (64-84); stoma length = 22.2 ± 1.33 (20-24) _m; pharyngeal length = 140.9 ± 10.41 (129-162) _m; tail length = 39.4 ± 4.29 (32-45) _m; spicule length = 44.3 ± 4.26 (38-50) µm; gubernaculum length = 17.4 ± 2.73 (12-20) µm; anal body diameter = 26.9 ± 2.87 (23-31) µm.

Female. Body medium to large-sized, fairly robust, almost straight or slightly ventrally curved upon fixation; slightly tapering at extremities, more towards anterior end. Cuticle transversely striated with fine longitudinal lines and small dot-like punctations. Lip region showing pronounced sexual dimorphism: females with expanded, 16-21 µm wide, offset lip region while lip region in males is less expanded, 12-16 µm wide, continuous with adjoining body. Lips separate, globular, surrounding a round oral aperture; laterals slightly narrower than submedians. Outer labial and cephalic sensilla slightly raised, on outer lip borders. Inner labial sensilla obscure. Amphids very small, on lateral lips. Stoma tubular, about 1.5 lip diameters long or 4 times longer than wide. Cheilostom not cuticularised, gymnostom cuticularised, about 50% of stomal length; stegostom expanded posteriorly, about 2.5-3.0 times longer than wide or 35-40% of stomal length, surrounded by pharyngeal collar. Metastegostom anisomorphic with subventral metastegostomal plates longer. Each metastegostomal plate bearing three robust, curved teeth with middle tooth the largest. Pharynx composed of 85-120 µm long swollen corpus, 32-42 µm long isthmus and well developed, muscular, spherical, valvate basal bulb of 28-40 _ 21-34 µm. Nerve ring surrounding isthmus at 73-76% of pharyngeal length. Excretory pore in isthmus region, slightly posterior to nerve ring, at 75-78% of pharyngeal length. Body at proximal end of pharynx about 1.0-1.5 labial diameters and at distal end about 2.4-2.6 labial diameters wide. Pharyngeal corpus 1.1-1.5 times longer than isthmus and basal bulb together. Cardia disc-shaped, 7-19 µm long attached to narrowed intestine. Intestine with large granular cells surrounding a thick lumen with refractive lining. Rectum thick-walled, about 0.4-0.5 anal body diameters long. Anus a crescent-shaped slit.

Reproductive system didelphic, amphidelphic. Ovaries dorsally reflexed. Oocytes arranged in multiple rows at distal end of ovary followed by a single row proximally. Spermathecae long and elongate containing sperms. Uterus usually with 6-20 eggs, arranged in several tiers showing intra-uterine development. Vagina at right angles to longitudinal body axis, thick-walled, wide without sclerotization, about 1/3rd of corresponding body diameter long. Vulva a transverse, post-equatorial slit, located at 391-748 µm from anterior end with thick, protruded lips. Vulva-anus distance 230-515 µm. Tail very short without a spike, bluntly conoid or hemispheroid. Phasmidial ducts open very close to tail terminus.

Male. Similar to females in general morphology except lip region structure, tail shape and greater posterior body curvature. Lip region in males narrow, 13-17 µm wide, continuous with adjoining body. Lips relatively smaller and amalgamated. Testis monorchic, dorsally reflexed, on right side of intestine. Reflexed portion about 80-135 µm long. Spicules slender, setaceous with bicuspid capitula, 1.0-1.6 anal body diameters long, fused distally up to 15-20% of length. Fused region spatula-shaped. Spicules possess a narrow manubrium, with ventral arm forming a triangular process, projected distally like a spur anterior to fused distal part. Gubernaculum flask-shaped with tapering proximity, about 40-45% of spicular length. Bursa punctated, anteriorly closed, laterally expanded, semicircular, peloderan, with wavy margins forming 4-6 shallow lateral lobes. Genital papillae nine pairs comprising of one pre-cloacal, one adcloacal and seven post-cloacal pairs. GP1 pre-cloacal close to anterior bursal margin, GP2 adcloacal; GP3 post-cloacal, slightly spaced from dorsally oriented GP4; GP5 reaching the bursal margin. Phasmids between GP5 and GP6, not reaching bursal margin. GP6, GP7 and GP8 arising from the same root. GP9 dorsally oriented, thinnest and smallest pair. Tail conoid, longer than that of females.

Habitat and locality. Cow dung samples containing *Pelodera icosiensis* Maupas, 1916 collected from sluice gate, Keoladeo National Park, Bharatpur, Rajasthan.

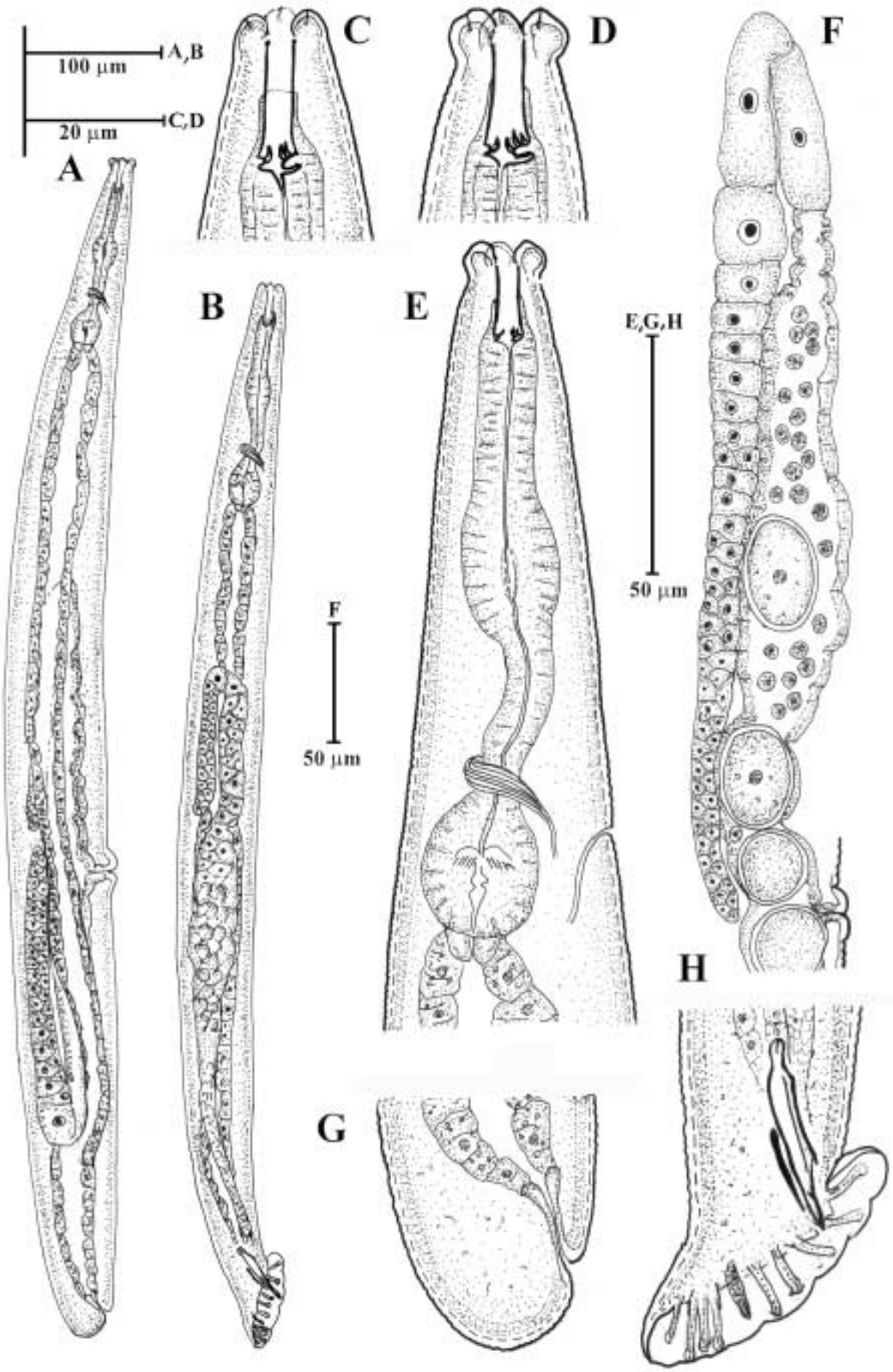

Fig. 3. *Pelodera icosiensis* (Maupas, 1916). A: Entire female; B: Entire male; C: Male anterior end; D: Female anterior end; E: Pharyngeal region; F: Female reproductive system; G: Female tail; H: Male tail.

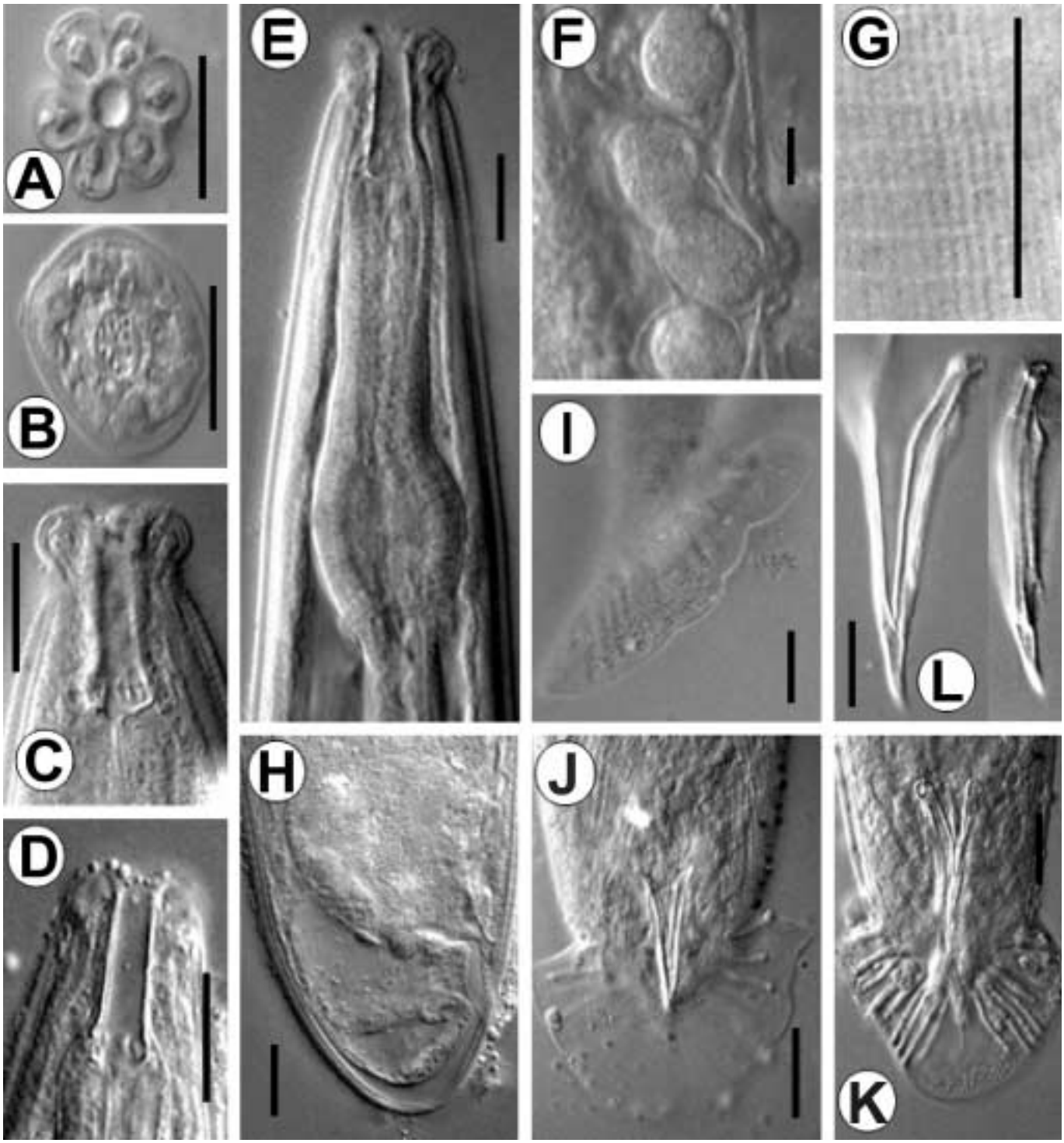

Fig. 4. *Pelodera icosiensis* (Maupas, 1916). A: *En face* view; B: T.S. at level of metastegostom; C: Anterior end (female); D: Anterior end (male); E: Anterior pharyngeal region; F: Vulval region (lateral); G: Cuticular markings; H: Female tail; I: Male tail (lateral); J, K: Male tail (ventral); L: Extracted spicules. (Scale bar = 10 _m).

Voucher specimens. Twenty two females and twelve males on slide *Pelodera icosiensis* KNP 12B/2-11 deposited in the Nematode Collection, Department of Zoology, Aligarh Muslim University, Aligarh, India. One female and one male on slide *Pelodera icosiensis* KNP 12B/1 deposited at the Laboratory of Nematology, Wageningen University and Research Center (WUR), 6700 ES Wageningen, The Netherlands.

Remarks. The present population is the first report of *P. icosiensis* from India. The specimens show overall conformity with the characters of the species. However, some differences have been noticed in the ovoviviparous females, which showed a greater ‘c’ value; narrower lateral lips; anisomorphic metastegostom, smaller pharyngeal collar and hemispheroid tail without spike. The earlier descriptions depicted a relatively smaller ‘c’

value owing to the existing tail spike. However, the *en face* view was not available with earlier descriptions to ascertain the labial structure, though the metastegostom appeared to be anisomorphic in illustrations (*apud* Sachs, 1950; Osche, 1952). The Indian population also shows a noticeably shorter, laterally expanded, semicircular, lobed, peloderan bursa, which appears different from *P. icosiensis* in having a much longer bursa with smooth margins. Nevertheless, the configuration of genital papillae is similar. The present specimens resemble *P. cylindrica* Cobb, 1898 in the shape of the female tail. However, several important differences have been noticed, *viz*. pronounced sexual dimorphism in lip region, narrower lateral lips, greater number of embryonating intra-uterine eggs, bicuspid capitula, semi-circular bursa, dissimilar configuration of genital papillae with reference to pre-cloacals, and 1, 4, 10^{th} bursal papillae not protruding outside the bursal margin.

Pelodera icosiensis and *P. cylindrica* occupy a subgroup of the *Coarctata* group, along with *P. tretzeli*, *P. par* and *P. voelki*, for their non-cyst-forming habit and a longitudinally and transversely striated closed bursa (Sudhaus and Fitch, 2001). The present specimens exhibit a combination of characters of the two species of the *Cylindrodera* subgroup (Dougherty, 1955) of *P. cylindrica* and *P. icosiensis* in having females with hemispheroid tails and males with spicules bearing bicuspid capitula and a bursa with two pre-cloacal and eight post-cloacal paired papillae. The laterally expanded, semicircular bursa in the present specimens, however, resembles that of *P. cystilarva* Völk, 1950, which belongs to the *Coarctadera* subgroup within the group *Coarctata*. This feature can be considered as the transitional stage of apomorphy leading to the formation of a bursa with undulated margin or may simply be an example of convergence.

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LITERATURE CITED

Andrássy I., 1984. *Klasse Nematoda* (Ordungen Monhysterida, Desmoscolecida, Araeolaimida, Chromadorida, Rhabditida). Gustav Fischer Verlag, Stuttgart, Germany, 509p.

Dougherty E.C., 1955. The genera and species of the subfamily Rhabditina Micoletzky, 1922 (Nematoda). A nomenclatorial analysis – including an addendum on the composition of the family Rhabditidae Örley 1800. *Journal of Helminthology, 29*: 105-152.

Kiontke K. and Fitch D.H.A., 2005. The phylogenetic relationships of *Caenorhabditis* and other rhabditids. *In*: WormBook (The *C. elegans*, Research Community, ed.). WormBook. Doi/10.1895/wormbook.1.11.1, http://www.wormbook.org.

Osche G., 1952. Systematik und Phylogenie der Guttung *Rhabditis* (Nematoda). *Zoologische Jahrbücher, Abteilung für Systemmatik Ökologie und Geographie der Tiere, 81*: 190-280.

Sachs H., 1950. Die Nematodenfauna der Rinderexkremente. Eine ökologisch-systematische Studie. *Zoologische Jahrbücher (Systematik), 78*: 323-366.

Schulte F., 1989. Description of *Rhabditis (Pelodera) pseudoteres* n. sp. (Rhabditidae: Nematoda) with a redescription of its sibling *R. (P.) teres* (Schneider, 1866). *Revue de Nématologie, 12*: 387-394.

Sudhaus W. and Fitch D.H.A., 2001. Comparative studies on the phylogeny and systematics of the Rhabditidae (Nematoda). *Journal of Nematology, 30*: 1-70.