



Research Article

Taxonomic Data of New Recorded Plant Parasitic and Soil Nematodes from Different Vegetation of Thar Desert, Sindh Pakistan

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Abstract | Plant parasitic and soil nematodes were found associated with different vegetation of the Thar Desert, Sindh, Pakistan. Taxonomic studies of *Tylenchorhynchus neoclavicaudatus* Mathur, Sanwal and Lal, 1978, *Tylenchorhynchus mashhoodi* Siddiqi and Basir, 1958, *Pratylenchus curvicauda* Siddiqi, Dabur and Bajaj, 1991, *Pratylenchus elamini* Zeidan and Geraert, 1991, *Hemicyclophora punensis* Darekar and Khan, 1981, *Tylencholaimus shamimi* Islam and Ahmed, 2021, *Makatinus punctatus* Heyns, 1965 and *Labronema mangaloreense* Ahmad and Ahmad, 2002 are being presented in this paper. The morphology and morphometric traits of native populations of these nematodes were found correspond to the type specimens. According to the latest information, these identified nematodes species are new records from Pakistan.

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Keywords | Plant parasitic, Soil nematodes, Thar desert, Pakistan, New records



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Introduction

The Thar Desert is located between 24° and 28°N latitude and 68° to 71°E longitude, covering an area of approximately 35126 km². The desert spreads over the eastern regions of Sindh Province and with few edges of Punjab Province. The desert vegetation is mostly herbaceous or stunted scrub; drought-resistant trees occasionally dot the landscape, especially in the east. On the hills, gum arabic *Acacia* and *Euphorbia* have been found. The khajri (or *khejri*) tree (*Prosopis cineraria*) grows throughout the plains. The grasses form the main natural resources of the desert. Depending on the availability of water,

farmers grow crops such as wheat and cotton (<https://www.britannica.com/place/Thar-Desert>). Permanent features of the vegetation of the Thar Desert include trees and shrubs are *Prosopis cineraria* (Khajri), *Tamarix aphylla* (Khagal), *Lycium barbarum* (Goji berry), *Salvadora oleoides* (Peelu), *Zizyphus nummularia* (Wild Jujube), *Capparis deciduas* (Karira), *Acacia nilotica* (Gum Arabic Tree), *Calligonum polygonoides* (Phog) and *Leptadenia phytotechnica* (Khimph) from where soil samples were collected during this research work to study the association of nematodes.

The incidence and ecology of fauna of plant and soil nematodes was reported from Desert of Rajasthan,

India, adjoined to the Thar Desert, in a few research articles (Khera and Bhatnaga, 1977; Swarup and Sethi, 1977; Baqri, 1996). The review supported the evidence that about 55 species of phytophagous nematodes from the Thar Desert area of India had been reported (Bohra and Baqri, 2004).

Shahina and Maqbool (1992) reported 51 nematode species belonging to the order Tylenchida have been collected and identified and were listed from nearby areas of the Thar Desert. In that survey, *Ditylenchus anbilisposomus*, *D. geraerti*, *D. myceliophagus*, *Paurodontus similis*, *Psilenchus aestuarius* and *P. iranicus*, were found for the first time from Pakistan.

Khan et al. (2000) did the study of nematode communities associated with chillies in lower Sindh, Pakistan. In all, eight species were recorded viz., *Meloidogyne* sp. larvae; *Helicotylenchus indicus*, *Pratylenchus penetrans*, *Tylenchus* sp. larvae, *Pratylenchus thornei*, *Tylenchorhynchus annulatus*, *Psilenchus hilarulus*, *Hoplolaimus indicus* and *Aphelenchus avenae*.

Pathan et al. (2004) studied on plant parasitic nematodes associated with banana in Sindh, Pakistan. The samples of soil and banana plants showing retarded growth were collected from three fields of Nasimabad (Khisano Mori), Tando Allah Yar and Mirpurkhas. The nematodes isolated from the roots and soil samples showed the presence of seven genera of plant parasitic nematodes, namely, *Hoplolaimus columbus*, *Belonolaimus longicaudatus*, *Helicotylenchus dihystra*, *Meloidogyne incognita*, *Xiphinema brevicol*, *Longidorus africanus* and *Trichodorus christiei*. Zahid and Firoza (2014) reported nematodes associated with date palm orchards of Khairpur District Sindh, Pakistan. One new species of soil nematode viz., *Acrobelloides gossypii* n. sp., along with three new record species viz., *Tylenchorhynchus ewingi* Hopper (1959); *T. crassicaudatus* Williams (1960) and *Pratylenchus pseudofallax* Café-Filho and Huang were described and re-described from the areas of Umerkot, Tando Allahyar, and Mirpurkhas respectively of Sindh, Pakistan (Ashfaq et al., 2019). Time by time, several plant parasitic nematodes have also been reported from the adjacent areas of Thar, Pakistan such as Khairpur, Umerkot, Mirpurkhas and Daharki (Maqbool and Shahina, 2001; Shahina et al., 2019).

However, proper survey for phytonematodes of desert areas has not been under done todate. Therefore,

systematic surveys and proper identification of nematode fauna associated with vegetation of desert areas are the main objectives of the present research.

Materials and Methods

Samples were collected from several vegetation grown in different localities of the Thar Desert, Pakistan. The nematodes samples were extracted from soil by Cobb's wet sieving technique (Cobb, 1918) followed by a modified Baermann funnel method (Baermann, 1917). Extracted nematodes were killed by gradual heat, fixed in TAF and mounted in dehydrated glycerine (Siddiqi, 1986). Illustrations were made by using a drawing tube attached to the compound microscope Nikon Eclipse E400 and photographed with a Nikon DS-Fil camera, attached to the same microscope. Identification of nematodes was made by following Siddiqi (2000) and Jairajpuri and Ahmad (1992). Identified specimens are deposited in the Nematode Collection of the National Nematological Research Centre, University of Karachi, Karachi, Pakistan.

Results and Discussion

Tylenchorhynchus neoclavicaudatus (Mathur et al., 1978). Figures 1 and 2

Measurements

See Table 1.

Table 1: Morphometrics of *Tylenchorhynchus neoclavicaudatus* (Mathur et al., 1978) from Pakistan. All measurements are in μm and in the form mean \pm s.d. (range).

Characters	Morphometric data	
	Range (n= 12) ♀♀	mean \pm s.d.
L	546 - 630	610 \pm 23.86
a	23.9 - 26.3	25.5 \pm 1.74
b	2.8 - 3.95	2.9 \pm 0.87
c	8.0 - 9.7	9.2 \pm 0.94
c'	4.0 - 4.5	4.2 \pm 0.28
V%	53 - 56	54.3 \pm 2.19
Stylet	20 - 23	22.5 \pm 2.45
Median bulb	70 - 75	73.42 \pm 2.95
Excretory pore	105 - 115	109.7 \pm 4.55
Oesophagus	136 - 145	139.56 \pm 4.21
Vulva	194 - 212	207 \pm 7.32
Tail length	60 - 65	63.5 \pm 3.18
Vulva to anus	295 - 306	300 \pm 4.29
Hyaline portion	9 - 10	9.5 \pm 0.85
Body width	20 - 22.5	21.5 \pm 1.22
Anal body width	13 - 14	13.5 \pm 0.62

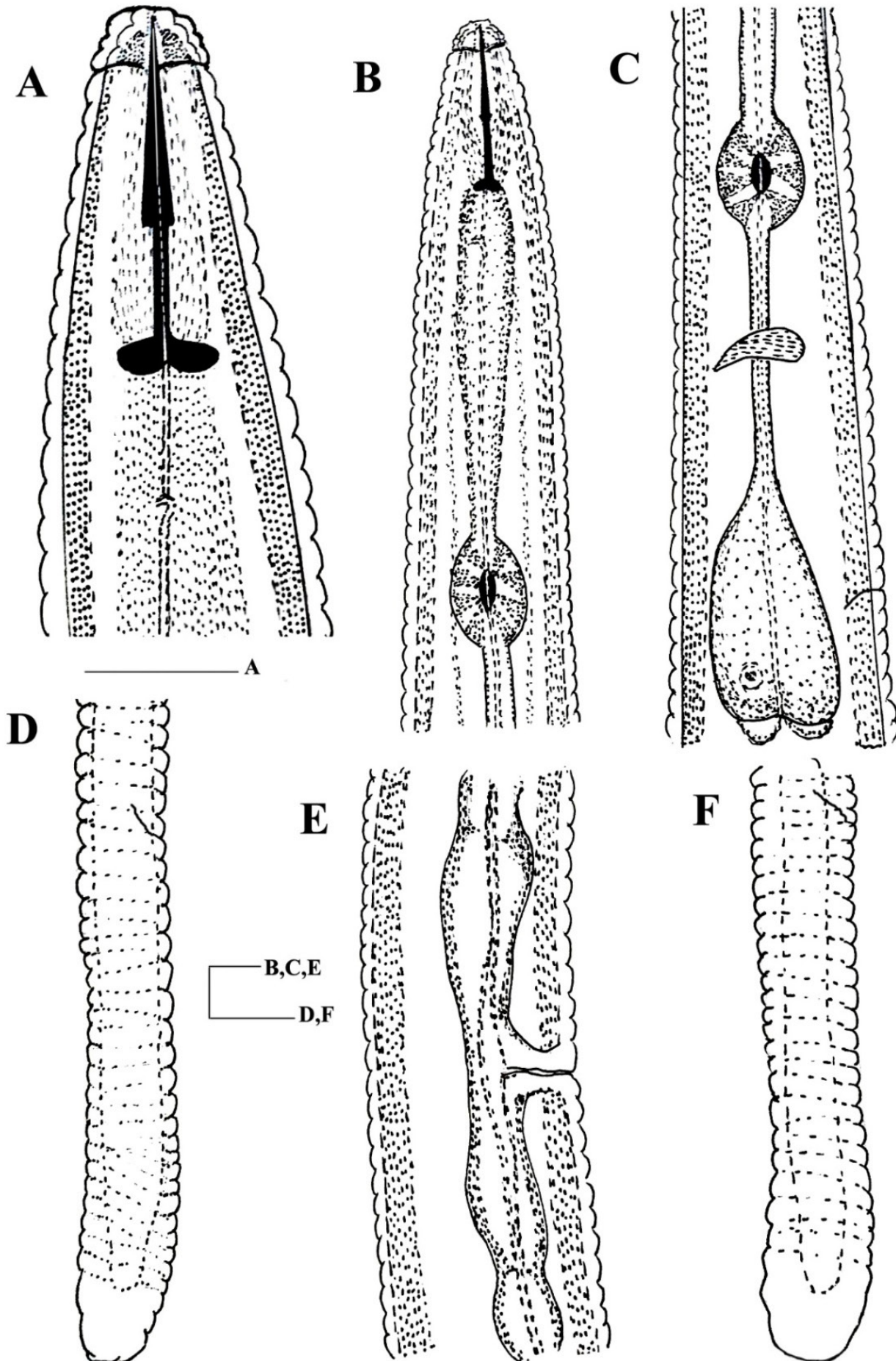


Figure 1: *Tylenchorhynchus neoclavicaudatus* (Mathur et al., 1978). A: Head (50µm); B: Anterior end (20µm); C: Oesophageal part (20µm); D, F: Female tail (20µm), E: Vulva (20µm).

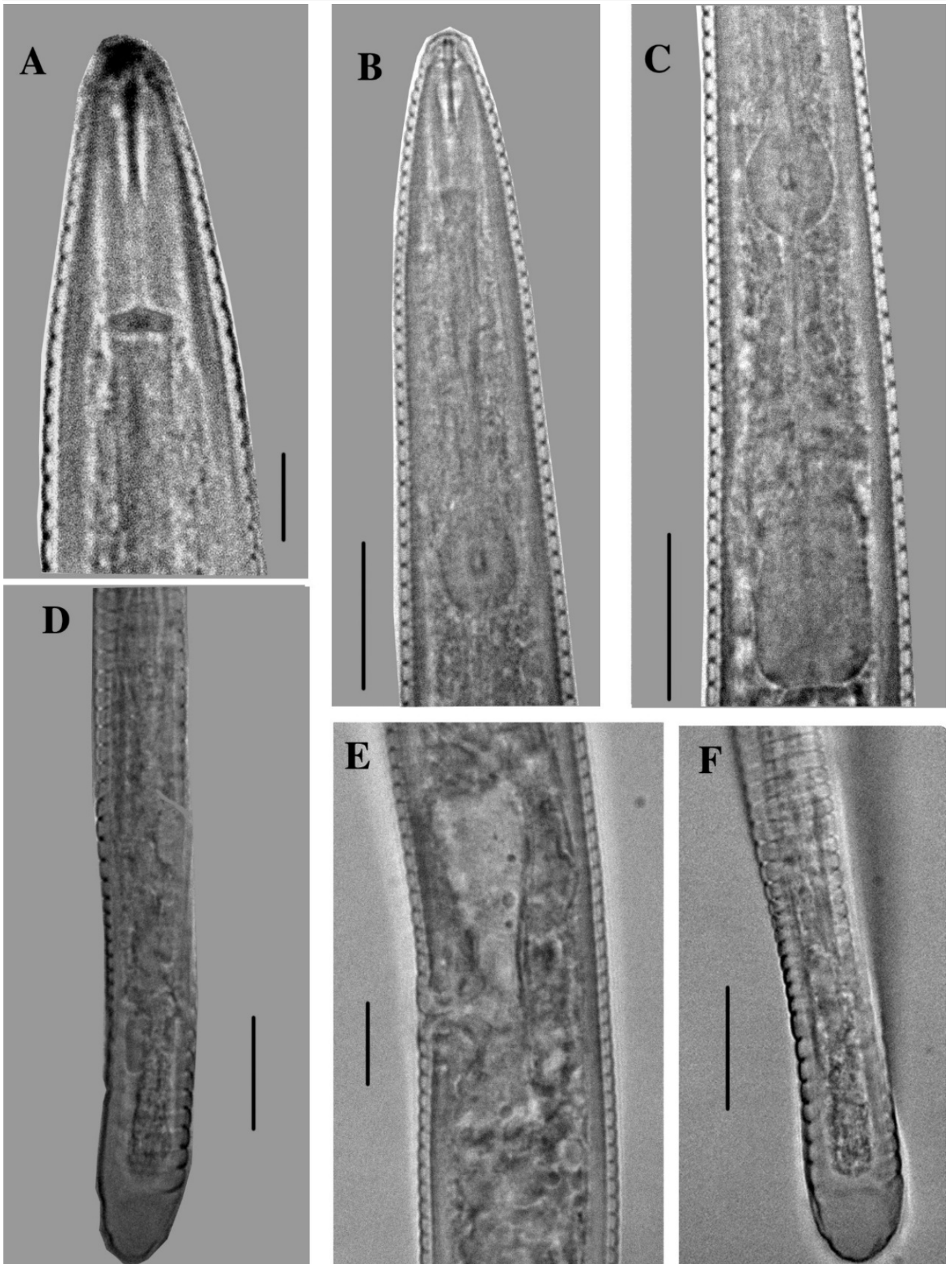


Figure 2: *Tylenchorhynchus neoclavicaudatus* (Mathur et al., 1978). A and B: Anterior end (50µm); C: Median bulb and Oesophageal bulb (20µm); D and F: Female tail (20µm); E: Vulva (20µm).

Description

Female (n =12): Body open C shaped when relaxed, conspicuously striated, striae about 2µm wide in region of oesophagus. Lateral field occupying about one third body width near the mid body and marked with 4 incisures, outer ones crenated. Lip region bearing 2-3 annules and continuous with body contour. Labial sclerotization inconspicuous. Stylet moderately developed with broad basal knobs 4-5µm across. Dorsal oesophagus gland orifice 3-4µm, posterior to spear knobs. Excretory pore anterior to basal bulb, 90-104µm from the anterior end. Hemizonid just anterior to excretory pore, about one annule wide. Intestine extending to the tail ends as post rectal blind sac. Gonads paired, out stretched, spermatheca present. Tail about 4 anal body width long narrowing from anus, then expending again to a clavate rounded tip. Tail terminus smooth and without annulation. Number of tails annules 32-50, unequal in width especially near middle of tail. Phasmids anterior to middle of tail.

Male: Not found

Remarks: Specimens were collected from soil around the roots of *Vachellia nilotica* from Kot Jubo Khairpur,

Sindh, Pakistan 26.578486°N, 69.360173°E. It resembles with type specimens, but have slight differentiation i.e., tail annules 34-40 vs 21-29, post uterine branch differentiated, much longer in Pakistani specimens.

Tylenchorhynchus mashhoodi (Siddiqi and Basir, 1958) **Figures 3 and 4**

Measurements

See **Table 2**.

Description

Female (n = 9): Habitus almost straight to open C shape. Lip region 6.0 ± 0.8 (5-6.5) µm high and 7 ± 0.5 (7-8.5) µm wide, anteriorly hemispherical and offset with body contour, with 3 annules. Labial framework moderately sclerotized. Stylet (16.50-18.20) µm long, length of conus 2-3µm more to shaft. Stylet knobs varied from rounded to anteriorly inclination with pointed edge anteriorly to slopping backward. Position of dorsal pharyngeal gland opening (DGO) (5.5-8) µm posterior to stylet knobs. Median pharyngeal bulb varied from rounded, spherical to ovate, measuring at about 1-14.5 µm long and 7-11 µm wide; median bulb valve 3 µm long and 3 µm wide.

Table 2: Morphometrics of *Tylenchorhynchus mashhoodi* (Siddiqi and Basir, 1958) from Pakistan. All measurements are in µm and in the form: mean ± s.d. (range).

Characters	Morphometric data			
	Range (n=9) ♀♀	mean ± s.d.	Range (n=5) ♂♂	mean±s.d.
L	550-600	586 ± 29.86	530-585	554 ± 24.69
a	30.26-36.30	34.5 ± 3.74	28.58-34.20	30.2 ± 2.69
b	4.14-5.87	5.11 ± 0.17	4.00-5.55	5.24 ± 0.15
c	13.40-17.69	14.95 ± 0.92	13.58-16.59	14.99 ± 0.84
c'	1.89-3.18	2.61 ± 0.98	1.42-2.84	2.61 ± 0.97
V%	51.30-57.30	54.51 ± 1.19	--	--
Stylet	16.50-18.20	17.5 ± 2.75	16.00-18.00	17.5 ± 2.25
Median bulb	48-61	52.72 ± 3.45	46-59	53.14 ± 3.78
Excretory pore	78-85	82.7 ± 4.59	78-84	81.22 ± 4.19
Oesophagus	100-120	110.56±6.51	90-110	105.29 ± 6.55
Vulva	300-330	314 ± 7.72	--	--
Body width	18-21	19.5 ± 1.22	16-20	18.5 ± 1.54
Vulva to anus	250-288	269 ± 14.29	--	--
Hyline portion	7-9	7.9 ± 0.45	5-6	5.59± 0.46
Tail length	31-40	34.5 ± 3.17	29-38	34.14 ± 3.43
Anal body width	12-14	13.7 ± 0.62	10-12	13.7 ± 0.62
Testis	--	--	48-62	55.78 ± 5.14
Spicules	--	--	22-24	23.4 ± 2.4
Gubernaculum	--	--	11-14	12.75 ± 1.25

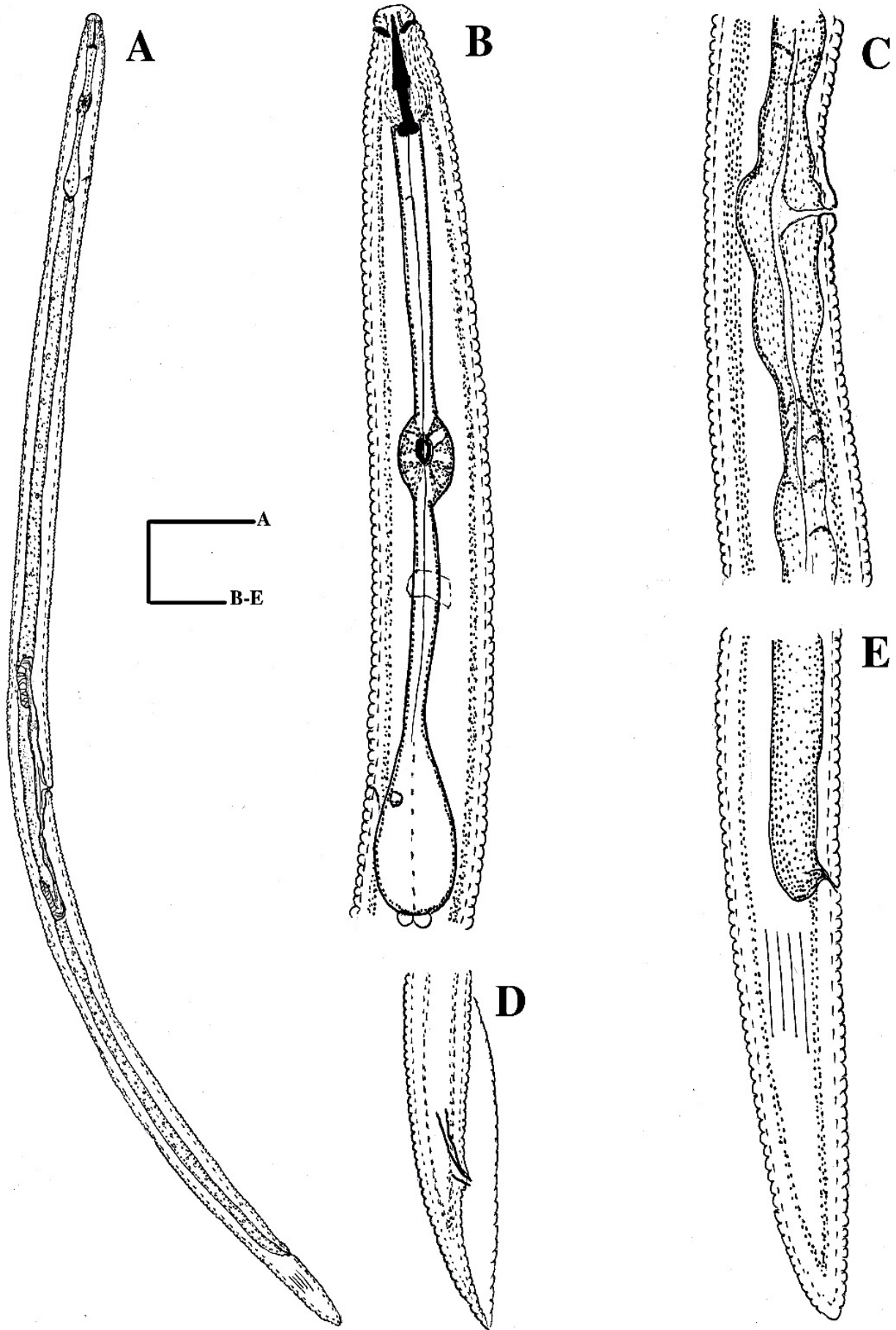


Figure 3: *Tylenchorhynchus mashhoodi* (Siddiqi and Basir, 1958). A: Whole body (100µm); B: Anterior end (20µm); C: Vulva (20µm); D: Male tail (20µm); E: Female tail (20µm).



Figure 4: *Tylenchorhynchus mashhoodi* (Siddiqi and Basir, 1958). A: Whole body (100µm); B: Anterior end (20µm); C: Vagina (20µm); D: Male tail (20µm); E: Female tail (20µm).

Oesophagus tylenchoid. Procorpus tubuler structure extending to about 40-50% of the total oesophagus length. Opening of dorsal oesophageal gland about 2-3 μm behind the spear base. Shape of median bulb varied from round, spherical to ovate measuring at about 11-14.5 μm in length and 7-11 μm in width. Basal oesophageal bulb does not overlap intestine, comprises of dorsal gland nucleus observed in anterior part while subventral at posterior region of basal bulb. Pharynx 100-120 μm long ventral overlap. Deirids not seen. Hemizonid situated one to two annules anterior to excretory pore. Nerve ring at isthmus, at 60-65% of pharyngeal length. Excretory pore located 1-3 annules posterior to hemizonid at the level of nerve ring.

Vulva a transverse slit. Two branches of the reproductive system are both functional, spermatheca varied from rounded, ovate full of sperms; oviduct almost equal to the corresponding body diameter, thin, well differentiated from the ovary. Uterus tubular, about twice the corresponding body diameter. Rectum half or less than equal to the anal body diameter. Intestine not extended over rectum. Tail varied from cylindrical to subcylindrical slightly ventrally arcuate posture, number of annules ranges from 17-32 on the ventral side and tail terminus appeared bluntly conoid and unstrained.

Male (n=5): Spicules tylenchoid, arcuate, gubernaculum trough-shaped. Bursa enveloping entire tail, Tail terminus acute.

Remarks: Specimens were collected from soil around the roots of *Tamarix aphylla* from Lal Juryo Khan Shambani Sukkur, Sindh, Pakistan 27.218163°N, 69.203098°E. It resembles with type specimens, but has slight differens in vulva position 51-57 *vs* 49-55%, tail length 31-40 μm in Pakistani specimens *vs* 35-49 μm of type specimens. This species was first reported by [Maqbool et al. \(1975\)](#), whereas complete description of the Pakistani population of *T. mashhoodi* has been given first time in this article.

Pratylenchus curvicauda (Siddiqi et al., 1991)

Figures 5 and 6

Measurements

See Table 3.

Description

Female (n = 12): Body irregularly curved, never straight in relaxed condition. Cuticle finely annulated, annules 1.0 μm wide near mid body. Lateral fields

about one third of body width in vulval region with 4 incisures forming three bands, not aerolated posterior to pharynx. Lateral field originates in the region of cephalic. Cephalic region broadly rounded to truncate, continuous with body or sometimes slightly offset, heavily sclerotized, bearing 3 annuli. Stylet strong with conus 7.5-8.5 μm long, basal knobs large, rounded, anteriorly flattened, 3.9-4.8 μm across and about 2 μm high. Opening of DGO at 2.5-3.7 μm from stylet base. Median bulb rounded to oval, large and muscular 15.2-18 μm long, 10-12 μm wide; valvular apparatus 3.4-3.8 μm long x 2.6-3.2 μm wide. Nerve ring at middle or posterior region of isthmus. Excretory pore slightly anterior to Pharyngo-intestinal junction located at 70-85 μm from the anterior extremity. Hemizonid prominent 1-2 annules anterior to excretory pore, 2-4 annuli long. Pharyngeal glands extending to 62-80 μm over intestine. Vulva located on a prominent protuberance of body. Ovary outstretched; oocytes arranged in a single row except for zone of multiplication where they are in double rows. Spermatheca small, empty. Uterine egg 60x20 μm . Post vulval uterine sac 15-25 μm long with rudimentary ovarian cells. Tail ventrally arcuate, conoid-rounded 27-38 μm usually indented, bearing 34-40 annules ventrally. Phasmids pore like located at or just anterior to middle of tail, 16-22 annuli, or 21-29 μm from terminus.

Table 3: Morphometrics of *Pratylenchus curvicauda* Siddiqi et al. (1991) from Pakistan. All measurements are in μm and in the form: mean \pm s.d. (range).

Characters	Morphometric data	
	Range (n=12) ♀♀	mean \pm s.d.
L	520-570	547 \pm 27.86
a	20.26-28.30	24.5 \pm 374
b	5.14-6.57	6.11 \pm 0.87
b'	3.2-3.6	3.41 \pm 0.28
c	13.40-18.69	14.95 \pm 0.92
c'	2.49-2.98	2.55 \pm 0.55
V%	65.30-77.30	70.51 \pm 1.19
Stylet	15.50-16.50	15.5 \pm 2.45
Median bulb	64-75	68.72 \pm 3.98
Excretory pore	70-89	81.55 \pm 5.55
Oesophagus	135-150	144.56 \pm 9.21
Body width	22-25	23.5 \pm 1.22
Vulva	180-200	197 \pm 7.32
Vulva to anus	250-288	269 \pm 14.29
Hyaline portion	10-12	11.5 \pm 0.85
Tail length	50-58	53.5 \pm 3.18
Anal body width	12-14	13.7 \pm 0.62

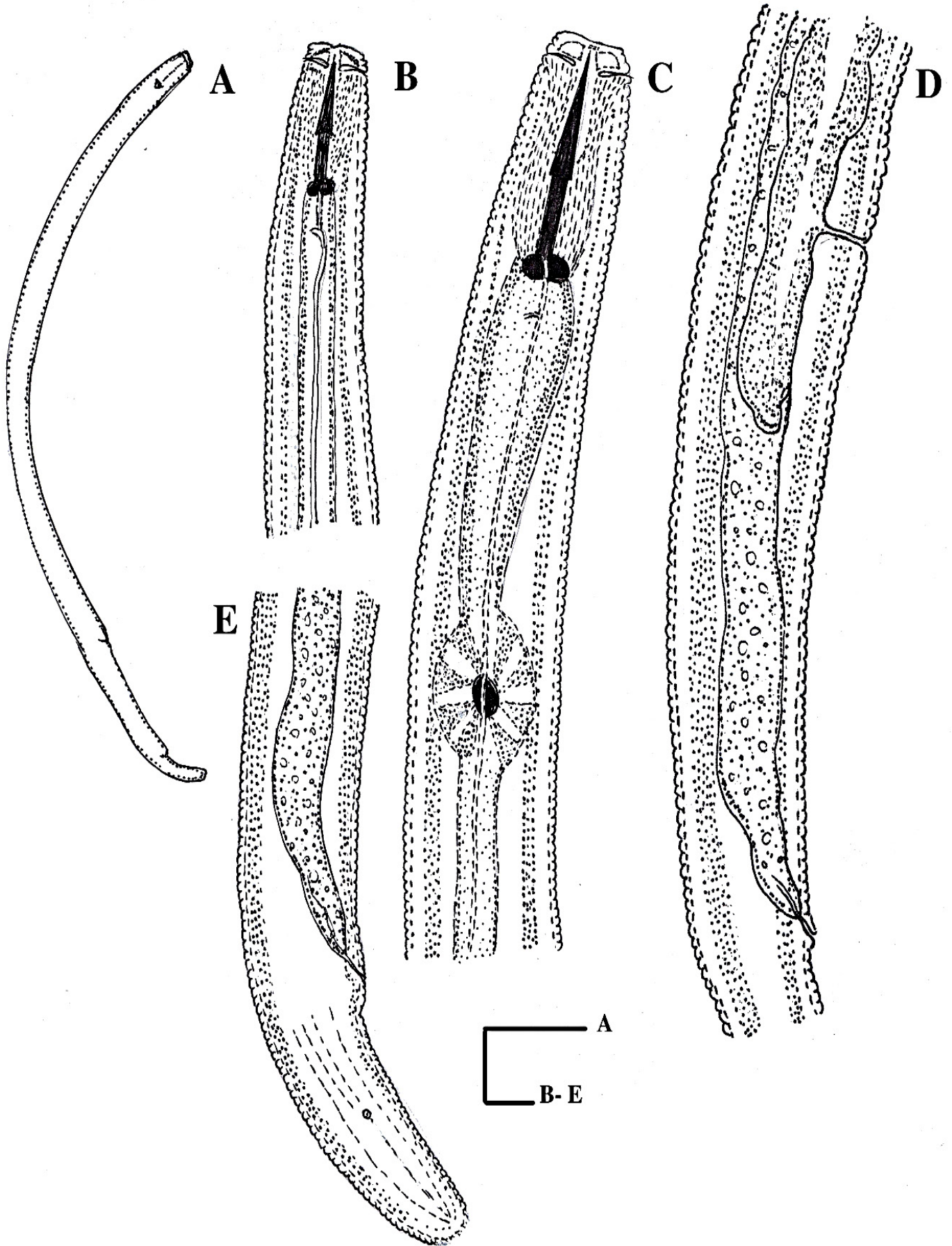


Figure 5: *Pratylenchus curvicauda* Siddiqi et al. (1991). A: Whole body (100µm); B: Anterior end (20µm); C: Head and median bulb (20µm); D: Vulva and post uterine sac (20µm); E: Female tail (20µm).

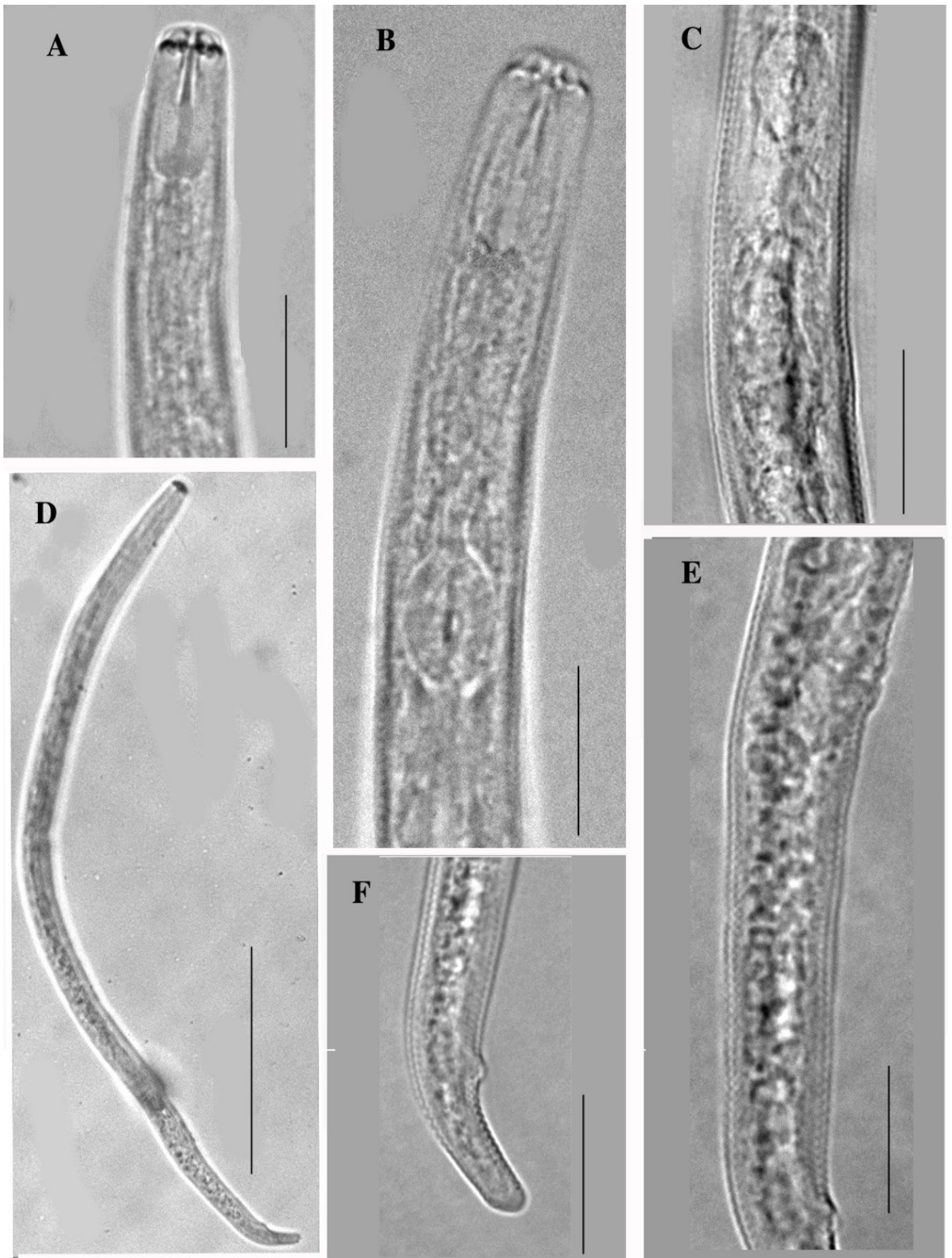


Figure 6: *Pratylenchus curvicauda* Siddiqi et al. (1991). A and B: Anterior end (20 μ m); C: Median bulb and oesophageal glands (20 μ m); D: Whole body(100 μ m); E: Post uterine sac(20 μ m); F: Female tail (20 μ m).

Male: Not found.

Remarks: Specimens were collected from soil around the roots of *Vachellia nilotica* from Bilawal Hangorjo, Sanghar, Sindh, Pakistan 25.876491°N, 69.763305°E. It resembles with type specimens, but have slight differentiation i.e., tail annules 34-40 vs 24-31, vulva percentage 65.30-77.30 vs 69-77 and post uterine branch differentiated smaller in Pakistani specimens 15-25 µm vs 19-37 µm .

Pratylenchus elamini (Zeidan and Geraert, 1991)
 Figures 7 and 8

Measurements
 See Table 4.

Table 4: Morphometrics of *Pratylenchus elamini* Zeidan and Geraert, 1991 from Pakistan. All measurements are in µm and in the form: mean ± s.d. (range).

Characters	Morphometric data	
	Range (n=6) ♀♀	mean ± s.d.
L	410-450	434 ± 19.86
a	24-32	28.5 ± 374
b	4.7-6.8	5.14 ± 0.87
b'	3.3-4.5	4.1 ± 0.48
c	16-20	18.59 ± 0.47
c'	2.0-3.7	3.02 ± 0.27
V%	72-77	75.50 ± 1.19
Stylet	14-15	14.5 ± 0.45
Median bulb	15-21	17.77 ± 3.95
Excretory pore	110-120	118.7 ± 4.47
Oesophagus	150-168	159.56 ± 421
Vulva	180-200	192 ± 5.32
Tail length	54-59	56.5 ± 3.79
Vulva to anus	255-284	269 ± 11.29
Hyaline portion	10-12	11.5 ± 0.85
Body width	24-25	23.57 ± 1.20
Anal body width	12-14	13.4 ± 0.62

Description

Female (n = 6): Short nematodes with slender body, showing variation in body posture upon relaxation. Body irregularly curved, never straight in relaxed condition. Cephalic region low distinctly offset, heavily sclerotized framework with outer margin extending posteriorly between first and second body annuli, bearing 3 annuli. Stylet strong with conus almost equal to or slightly shorter than shaft basal knobs, basal knobs large, rounded, anteriorly slightly

indented margins. Pharynx with elliptical median bulb and rather long glandular lobe overlapping intestine over poorly developed pharyngo-intestinal junction. Opening of dorsal pharyngeal gland at 2.4-3.2 µm from stylet base. Cuticle transversely striated with annuli less than 1 µm wide near mid body. Lateral fields starting about four annuli posterior to labial region with two lines. Nerve ring at middle, located at 62-72 µm from the anterior extremity. Hemizonid prominent 1-2 annules wide and anterior to excretory pore. Vulva a transverse slit, sometimes with protuberance. Female genital branch anteriorly outstretched, oocytes arranged in a single row. Spermatheca oval and devoid of sperms. Post vulval uterine sac 28-32 µm long with rudimentary ovarian cells. Tail conical in shape with a smooth terminus. Phasmids pore like located at or just anterior to middle of tail.

Male: Not found.

Remarks: Specimens were collected from soil around the roots of *Salvadora oleoides* from Kantio Tharparkar, Sindh, Pakistan 25.172849°N, 69.979427°E. It resembles with type specimens of the same species, but have slight differentiation i.e., strongly irregularly curved body posture; body length 410-450 vs 390 µm, slightly longer stylet 14-15 vs 13 µm, anterior margin of stylet knobs slightly slopping backward vs flattened anterior margin.

Hemicyclophora punensis (Darekar and Khan, 1981)
 Figures 8 and 9

Measurements
 See Table 5.

Description

Female (n = 8): Body almost straight when killed, tapering towards extremities. Cuticle sheath tightly fitting body, only attached to labial and vulval region. Body and sheath annuli smooth, similar, several longitudinal lines near mid body. Cephalic frame work moderately developed. Lip region rounded with two broad annuli. Labial area with open amphids, labial disc not raised and merged with the lip annules.

Lateral field of sheath of two crenate incisures forming a single row of rectangular blocks with intersecting transverse striae. Enface view showing two large lateral lips and small subdorsal and subventrals.

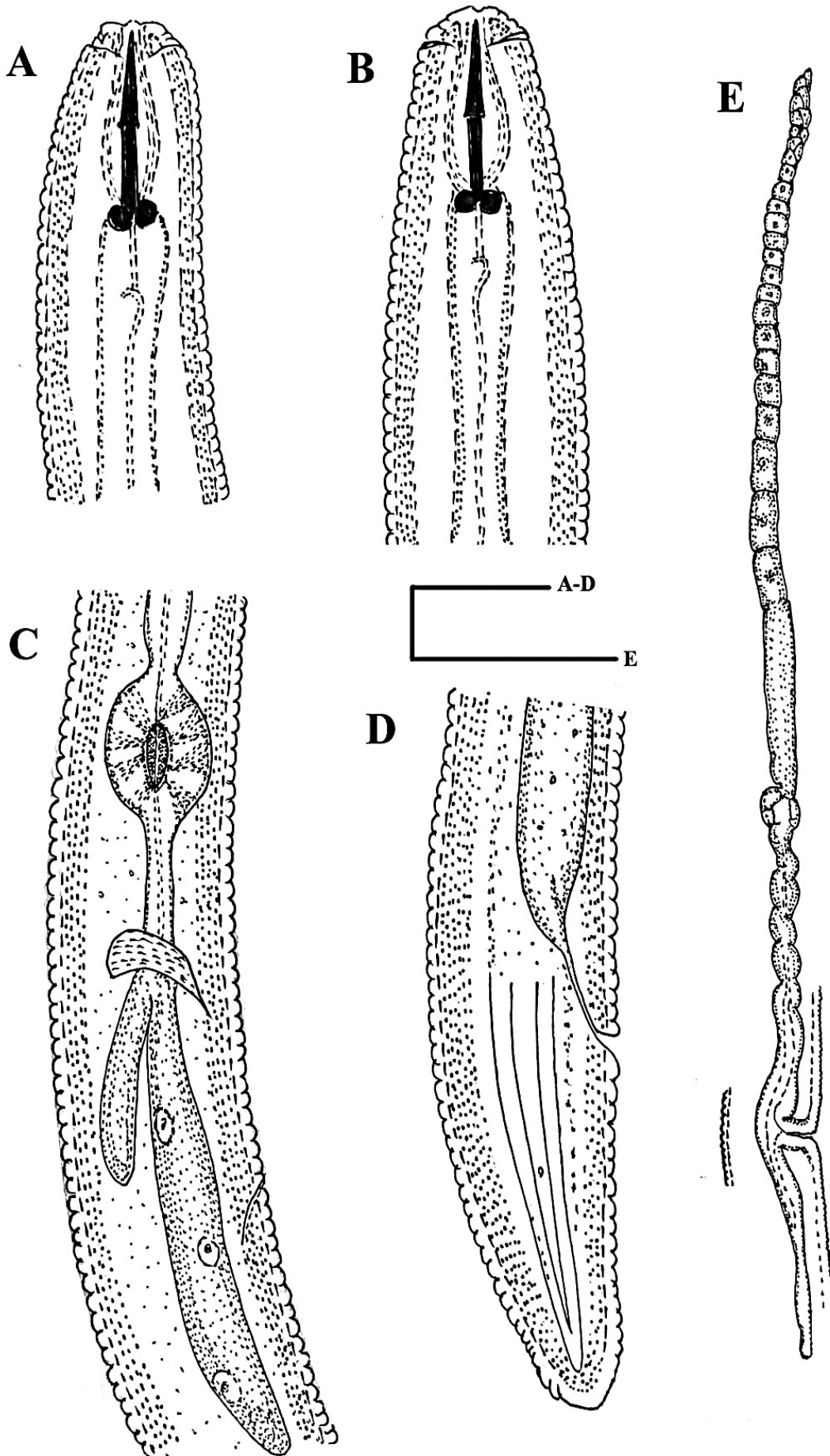


Figure 7: *Pratylenchus elamini* Zeidan and Geraert (1991). A and B: Anterior end (20µm); C: Oesophageal part (20µm); D: Female tail (20µm); E: Reproductive system(10µm).

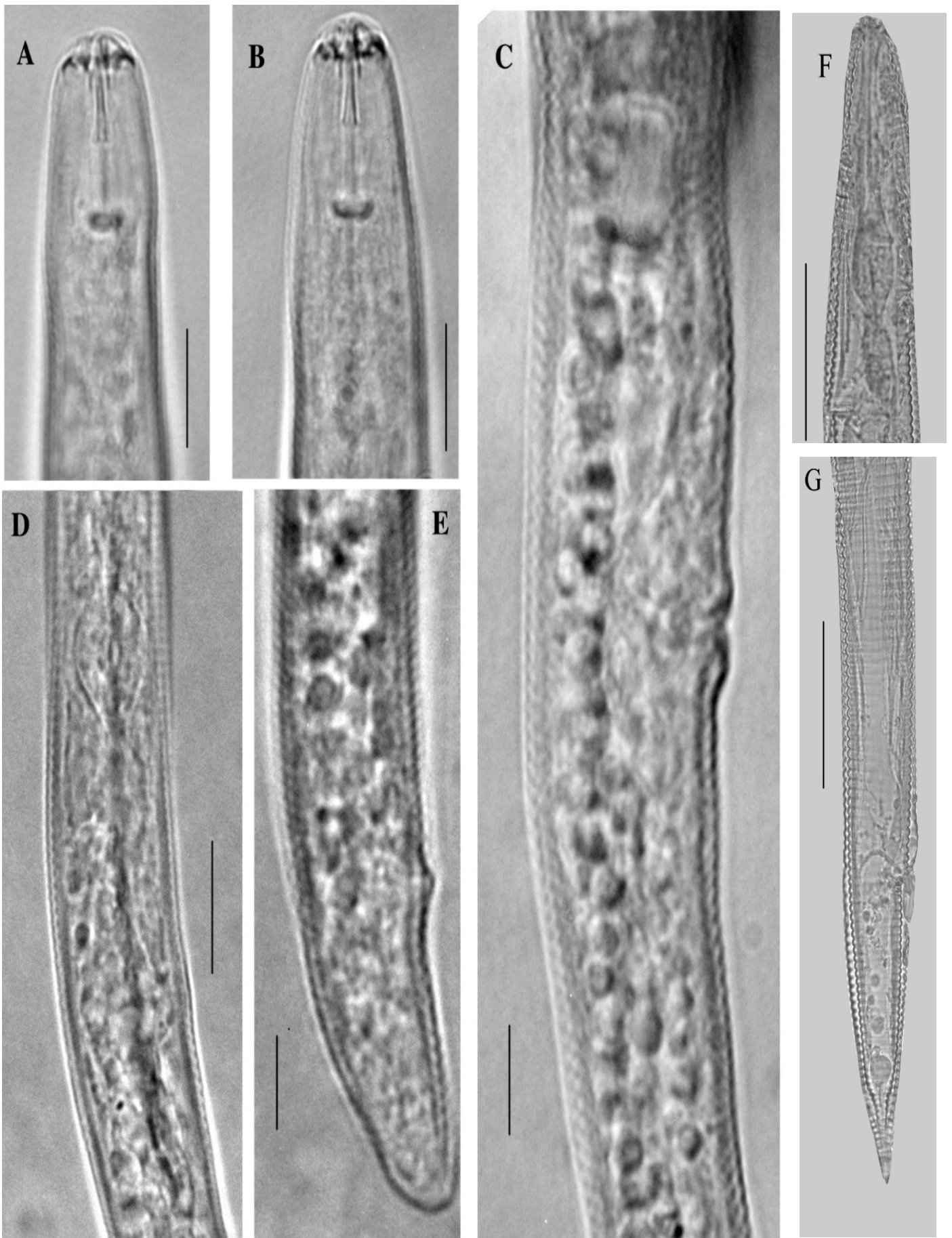


Figure 8: *Pratylenchus elamini* Zeidan and Geraert (1991). A and B: Anterior end (20 μ m); C: Vulva and post uterine sac (20 μ m); D: Oesophageal gland(20 μ m); E: Female tail (20 μ m). F and G: *Hemicyclophora punensis* Darekar and Khan (1981). F: Anterior end (50 μ m); G: Female tail (50 μ m).

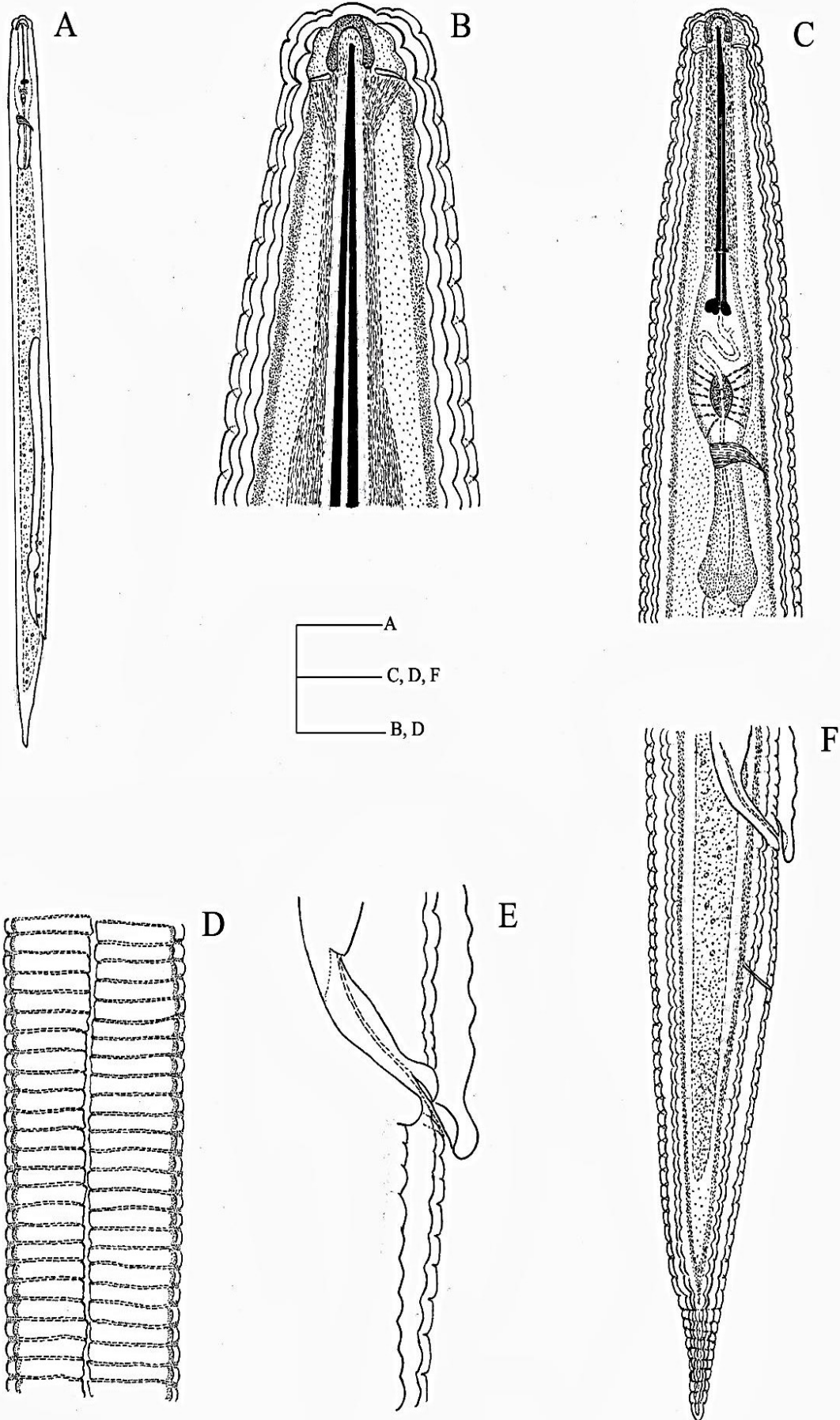


Figure 9: *Hemicyclophora punensis* Darekar and Khan (1981). A: Whole body (100µm); B (40µm) and C: Anterior end (20µm); D: Lateral field (20µm); E: Anus (40µm); F: Female tail (20µm).

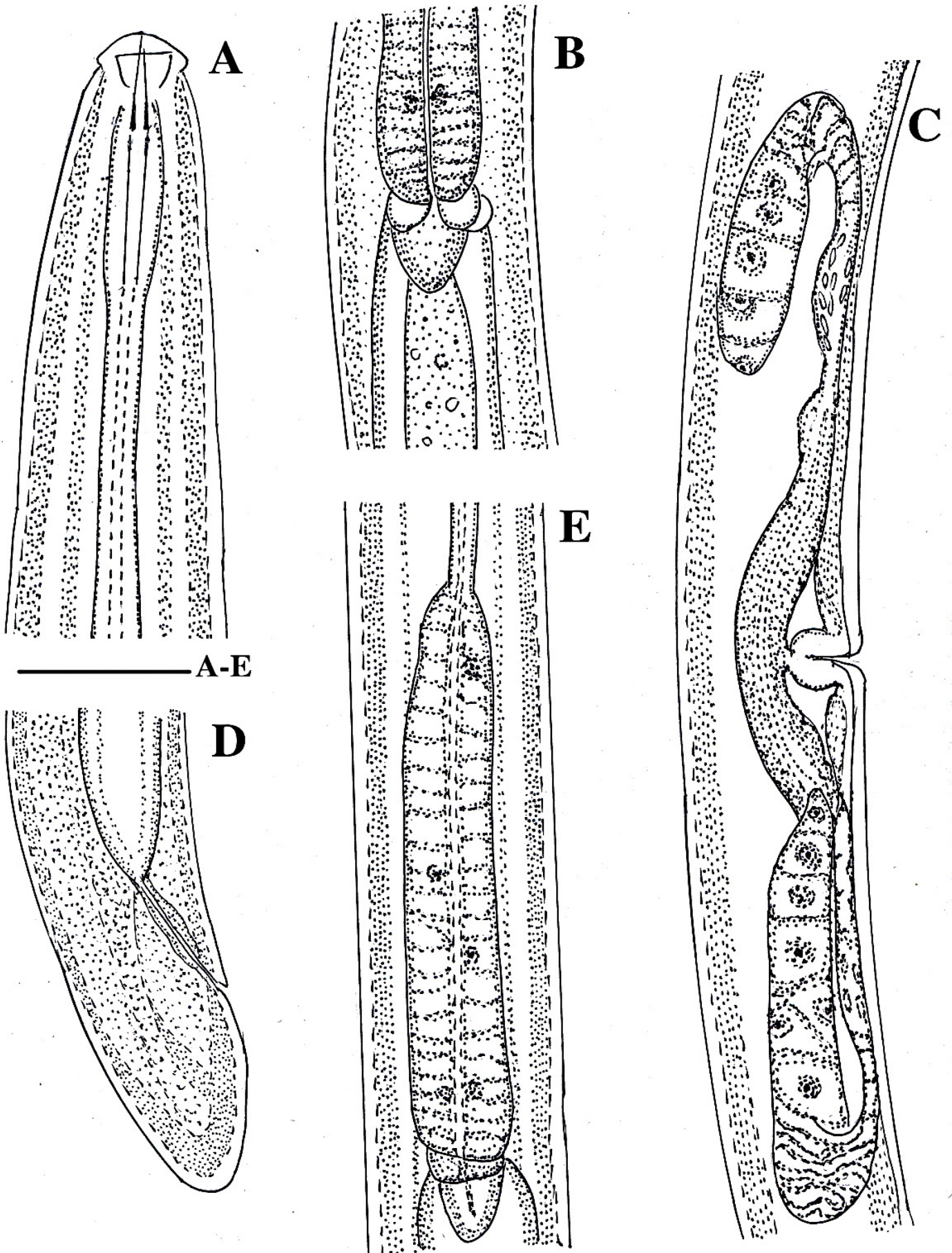


Figure 10: *Tylencholaimus shamimi* Islam and Ahmed (2021). A: Anterior end (20µm); B: Cardia (20µm); C: Reproductive system (20µm); D: Female tail (20µm); E: Oesophagus posterior expansion (20µm).

Stylet slender, slightly curved dorsally. Stylet knobs sloping posteriorly. Excretory pore 5-8 annuli anterior to basal bulb. Hemizonid distinct, located 3 annuli anteriorly to excretory pore and extending over 1 to 2 body annuli. Oesophagus typical of the genus. Median oesophageal bulb amalgamated with procorpus 14-18 μm wide with a distinct valve. Isthmus short encircled by nerve ring. Nerve ring 144-150 μm from anterior end.

Table 5: *Morphometrics of Hemicyclophora punensis Darekar and Khan (1981) from Pakistan. All measurements are in μm and in the form: mean \pm s.d. (range).*

Characters	Morphometric data	
	Range (n=6) ♀♀	mean \pm s.d.
L	810-1120	1009 \pm 100.05
a	19.8-25.0	22.01 \pm 2.94
b	5.1-6.8	5.7 \pm 1.09
c	5-7	6.35 \pm 2.12
c'	3.0-4.1	3.28 \pm 0.29
V%	80.1-90.7	83.05 \pm 2.0
O	6.0-9.3	7.5 \pm 1.09
DGO	3-7	5.3 \pm 1.10
Stylet length	56-70	67.75 \pm 9.03
Stylet knob width	5-7	6.07 \pm 0.82
Stylet knob height	3-5	4.54 \pm 0.44
Excretory pore from head end	177-196	189.90 \pm 9.93
Width at mid body	45-58	51.27 \pm 5.15
Lip region width	15-18	16.61 \pm 1.07
Lip region height	5-7	6.07 \pm 0.82
Annules width at mid body	5-6	5.18 \pm 0.49
Tail length	80-108	101.61 \pm 7.61
Oesophagus length	172-182	178.81 \pm 5.2
Vulva-anus distance	54-66	59.33 \pm 4.59
R	160-188	176.54 \pm 7.44
Rst	18-22	19.0 \pm 1.29
Roes	35-42	39.58 \pm 3.94
Rex	35-40	38.42 \pm 1.89
RV	36-49	43.4 \pm 5.44
R Van	11-15	13.1 \pm 1.58
Ran	21-29	24.3 \pm 2.3
VL/VB	3.1-4.0	3.52 \pm 0.33
St % L	8.4-11.0	9.45 \pm 0.66
Vulval width	44-56	49.2 \pm 5.18

Gonads prodelphic: Vulval lips elongated. Vulval sheath two to three annuli long, vagina thick walled.

Spermatheca round, mostly filled with small round sperm cells. Oocytes arranged in a single row. Anus indistinct. Body posterior to vulva gradually narrow to about last quarter. Tail elongate, conoid, with subacute terminus.

Male: Not found.

Remarks: The specimens were collected from soil round the roots of *Ziziphus nummularia* from Yazman Bahawalpur, Punjab, Pakistan 28.974027°N, 71.656123°E, Thar Desert.

Tylencholaimus shamimi (Islam and Ahmed, 2021) Figures 10 and 11

Measurements
See Table 6.

Table 6: *Morphometrics of Tylencholaimus shamimi Islam and Ahmed (2021) from Pakistan. All measurements are in μm and in the form: mean \pm s.d. (range).*

Characters	Morphometric data	
	Range (n=5) ♀♀	mean \pm s.d.
L	525 - 545	537 \pm 10.25
a	25 - 29	27.35 \pm 2.73
b	3.3 - 4.5	3.9 \pm 0.77
c	35.27 - 54.5	49.75 \pm 7.2
c'	0.74 - 1.1	0.92 \pm 0.95
V%	57 - 62	59.5 \pm 2.41
G1	18.2 - 20	19.4 \pm 0.59
G2	12.7 - 16.54	14.94 \pm 2.7
Body width	21 - 25	24.1 \pm 3.31
Anal body width	15 -17	15.4 \pm 2.36
Lip width	7 - 8	7.5 \pm 1.24
Lip height	3 - 4	3.4 \pm 0.7
Amphidial aperture	2.5 - 3	2.8 \pm 0.35
Odontostyle	6 - 8	7.4 \pm 1.15
Odontophore	8 - 12	10 \pm 12.33
Cardia	6 - 7	6.5 \pm 0.48
Guiding ring from anterior end	5 - 8	7.1 \pm 1.86
Tail length	15 - 20	17.8 \pm 2.86

Description

Female (n = 5): Small size nematode less than 550 μm , very slender. Body cylindrical and gradually tapering from the neck to the anterior end. Habitus straight to slightly curve ventrally when relaxed. Lip region narrow, cap like, marked off from the adjacent body by a constriction, more than 2-2.6 times as

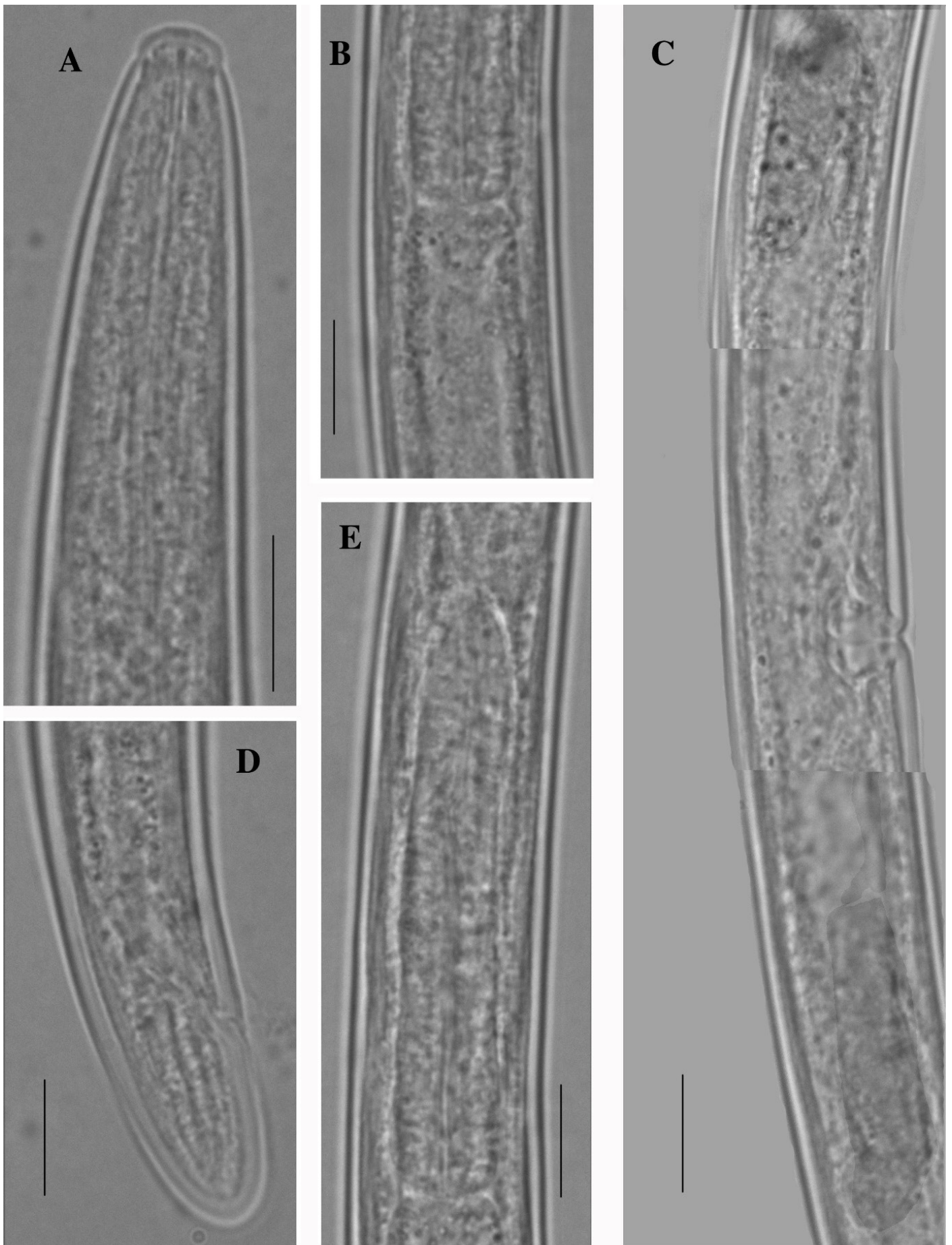


Figure 11: *Tylencholaimus shamimi* (Islam and Ahmed, 2021). A: Anterior end (20 μ m); B: Cardia(20 μ m); C: Reproductive system(20 μ m); D: Female tail(20 μ m); E: Oesophagus posterior expansion (20 μ m).

wide as high and about 1/2 of the body diameter at neck region. Lips rounded, amalgamated, inner part slightly elevated. Labial and cephalic papillae clear but not protruding. Amphid small, cup shaped opens at the level of the cephalic constriction and about 1/2 of the corresponding diameter. Outer cuticle with finely transverse striations. Inner cuticle with irregular outline loosened from the outer layer. Radial refractive elements abundant along the entire body. Lateral chord relatively wide, about 23-32% of the mid body width, with irregular margins. Dorsal, ventral and lateral pores indistinct. Odontostyle short, cylindrical, 0.8-0.9 times lip region diameter long, its aperture about 1/4-1/3 of the odontostyle length. Odontophore simple, rod like with basal knobs, 1.5 times longer than odontostyle. Cheilostome a truncate cone, its base forms a single guiding ring.

Anterior part of the pharynx slender muscular expanding gradually into the basal bulb. Basal bulb 7-8 times as long as wide and occupying 38-42 % of the total pharyngeal length. Pharyngeal gland nuclei and outlets very clear.

Genital system didelphic. Reflexed ovary long, 43-80 µm anterior and 36-52 µm in length, not reaching the oviduct-uterus junction and often reaching the vulva level. Oocytes initially in single rows except at the tip. Oviduct uterus junction narrows, with specialized sphincters. Uterus short and tubular, occupy 26-40 µm of anterior and 26-42 µm of posterior gonad. Vagina directed inwards, cylindrical or somewhat conical, surrounded by weak musculature and occupying 1/4 of the body width.

Vulva a transverse slit. Prerectum relatively short, 3-5 µm long. Rectum length 0.8-1.4 of anal body width. Tail short, convex, conoid 0.8-1.0 times anal body diameter long, with a pair of caudal pores on each side and a distinct terminal pore.

Male: Not found.

Remarks: The samples were collected from soil around the plant of *Capparis decidua* at Dad Laghari No. 12 Ghotki, Sindh, Pakistan 27.776387°N, 69.769487°E, Five paratype females were isolated from the above mentioned localities of Pakistan and are housed in the National Nematological Research Centre, University of Karachi, Karachi, Pakistan.

Makatinus punctatus (Heyns, 1965)

Figures 12 and 13

Measurements

See Table 7.

Table 7: *Makatinus punctatus* Heyns (1965) from Pakistan. All measurements are in µm and in the form: mean ± s.d. (range).

Characters	Morphometric data	
	Range (n=9) ♀♀	mean ± s.d.
L	2430 -3200	2907 ± 78.32
a	25 - 42	39 ± 9.22
b	4.2 - 4.4	4.3 ± 0.23
c	83 - 98	87 ± 2.59
c'	0.5 - 0.7	0.7 ± 0.0
V%	56 - 58	57 ± 1.34
Odontostyle	24 -30	26.5 ± 3.15
Neck	785 - 799	790 ± 5.72
Anal body width	60	60 ± 0.00
Lip region width	23 -25	24.5 ± 1.33
Prerectum	54 -63	60.75 ± 4.25
Tail	31-36	33 ± 2.11

Description

Female (n = 9): Large sized nematodes, body robust, slightly ventrally curved when relaxed. Cuticle without criss –cross lines, but with superficial punctuations arranged in a definite rows, distinct towards both the extremities, about 3-4µm thick at the anterior region and 6-8µm at tail. Lateral hypodermal chords 11-12µm wide.

Head region angular, offset by a weak constriction, lips amalgamated, and anterior part of oesophagus appearing cruciform in end face view. Amphids cup shaped, aperture occupying about half of its length. Guiding ring thin, 1/3 of lip width. Odontostyle wide, 1.4-1.5 times lip region widths long, its aperture occupies 1/3 of its length. Odontophore long, rod like, 3/2 of odontostyle, dorylaimoid type. Strong muscular, both sections expands gradually. The expansion covers 52-57% of its total length. Cardia tongue shaped, a thin cardiac disc is also present which appears like less developed ring like structure and around the junction between the oesophageal base and intestine. Oesophageal gland nuclei locate as follows: DO= 50-52%; DN=53-55%; S₁N₁= 65-70%; S₁N₂= 75-78%.

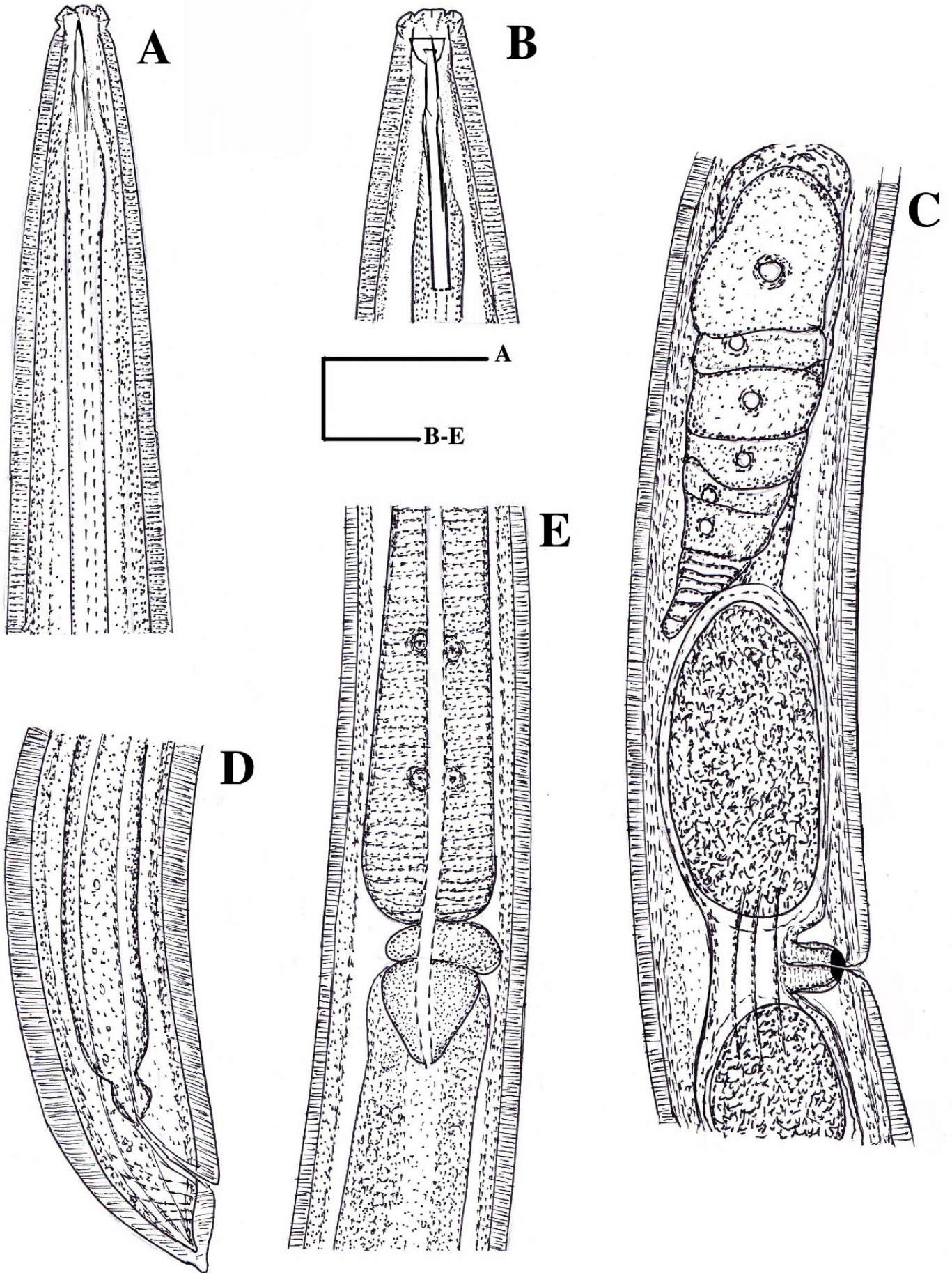


Figure 12: *Makatinus punctatus* Heyns (1965). A (30µm) and B: Anterior end (20µm); C: Vulva and anterior ovary (20µm); D: Female tail (20µm); E: Cardia (20µm).

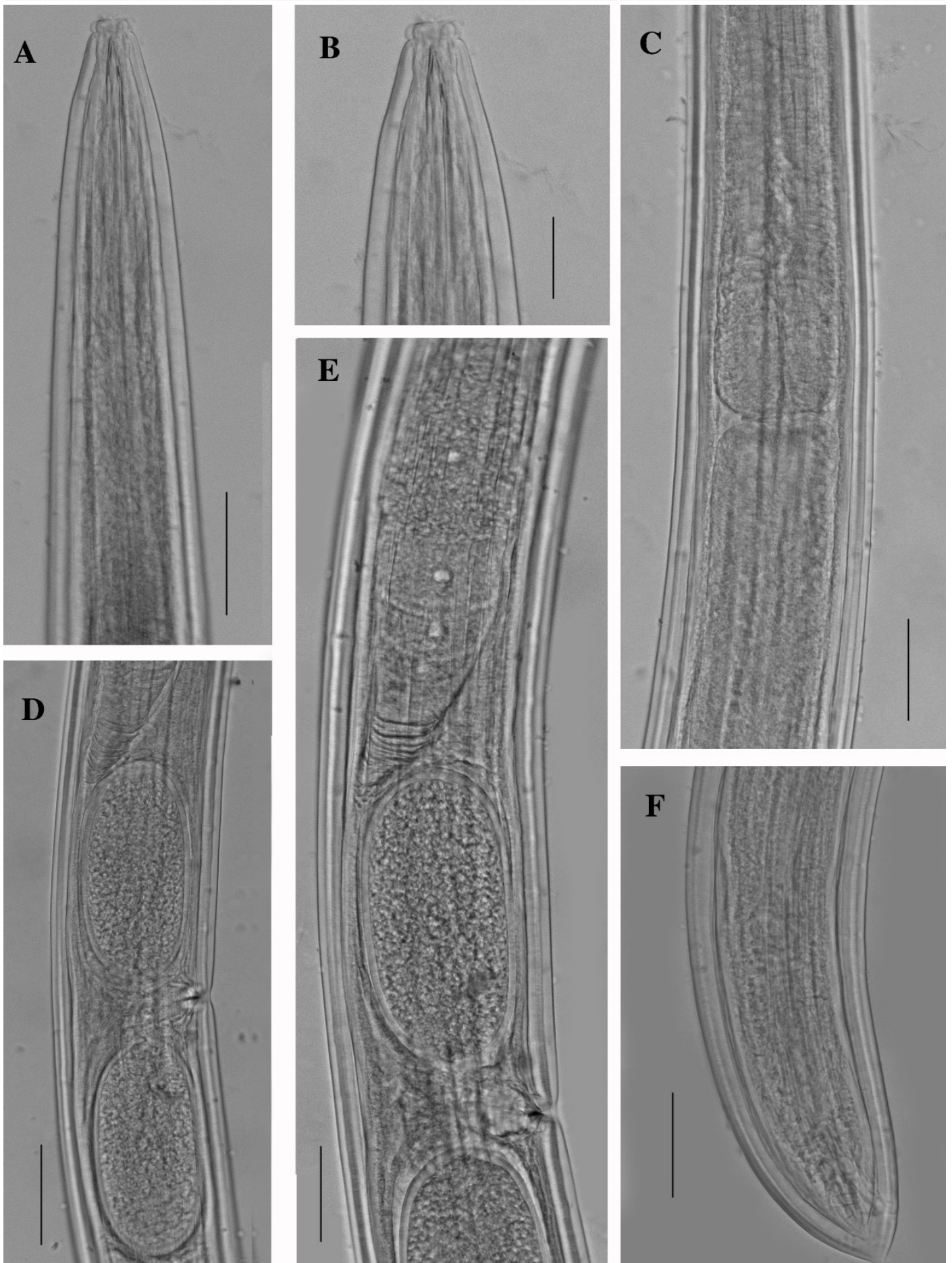


Figure 13: *Makatinus punctatus* Heyns (1965). A (30 μ m); and B: Anterior end (20 μ m); C: Oesophageal part (20 μ m); D: Vulva (20 μ m); E: Anterior ovary (20 μ m); F: Female tail (20 μ m).

Reproductive system didelphic, both gonads equally well developed. Vulva transverse, strongly sclerotized. *Pars proximalis vaginae* 5-6µm long; ovaries reflexed; oocytes arranged in a single row. Prerectum twice anal body width long. Tail nearly conical, with a short terminal digitation.

Male: Not found.

Remarks: The samples were collected from soil around the plant of *Calligonum polygonoides* at Berutta No. 11, Ghotki, Sindh, Pakistan 27.855041°N, 69.924210°E. Nine paratype females were isolated from the above mentioned localities of Pakistan are housed in the National Nematological Research Centre, University of Karachi, Karachi, Pakistan.

Labronema mangaloreense (Ahmad and Ahmad, 2002) **Figures 14 and 15**

Measurements
See [Table 8](#).

Description

Female (n= 10): Body robust, slightly ventrally curved upon fixation, gradually tapering towards extremities. Cuticle finely striated 3-5 µm thick at mid body and 7-8 µm on tail. Lateral chords about 1/4 to 1/5 of body width at mid body. Lateral, dorsal and ventral body pores indistinct. Lip region well offset by a constriction, 15-16 µm or about 1/3 of body width at base of neck region, wider than adjoining body.

Lip broad and thick; separated, angular, inner flaps arched over vestibular region. Amphids stirrup-shaped, with silt-like apertures 8-9 µm or about half of the corresponding body width wide. Odontostyle dorylaimoid, 1.3-1.4 lip region width long, with lumen aperture, one third of its length. Guiding ring sclerotized, double, 10-13 µm or 0.6-0.8 lip region width from anterior end. Odontophore simple, rod-like, 1.2-1.3 times to odontostyle length. Nerve ring 142-155 µm from anterior end of body. Anterior portion of oesophagus generally strong, muscular, enlarging gradually. Basal expanded part of oesophagus about 42-45% of oesophageal length. Cardia small but often elongate-conoid 27-35 µm long.

Reproductive system amphidelphic, vulva longitudinal,

vagina notably sclerotized distally. Prerectum 3.4-3.8 anal body widths long. Rectum 1.0-1.2 anal body widths long. Tail short, hemispheroid, 0.6-0.7 anal body width long, with a pair of caudal pores on each side.

Table 8: *Labronema mangaloreense* Ahmad and Ahmad (2002) from Pakistan. All measurements are in µm and in the form: mean ± s.d. (range).

Characters	Morphometric data	
	Range (n=10) ♀♀	mean ± s.d.
L	1130-1250	1219 ± 22.12
a	30.54-32.00	31 ± 0.22
b	4.03-4.40	4.2 ± 0.20
c	47.08-50.54	48.54 ± 2.77
c'	1.0-1.2	1.1 ± 0.1
V %	51-55	53.47 ± 1.34
G1 %	16-17	16.5 ± 1.15
G2 %	15-17	16.23 ± 1.72
Lip height	5 - 7.5	6.0 ± 0.15
Lip width	15-16	15.5 ± 0.33
Amphid aperture	8.75	8.75 ± 0.00
Guiding ring	10-13	11.94 ± 1.11
Nerve ring	142-155	149 ± 4.32
Odontostyle length	14-19	16 ± 3.12
Odontostyle aperture	4-5	4.4 ± 0.33
Odontophore	24-28	26 ± 1.49
Oesophageal length	280-300	292± 10.0
Cardia	20-22	21.5 ± 1.34
Position of DO	56-61	59 ± 3.15
Maximum width	37-39	38 ± 0.72
Anterior end to vulva	622-635	628 ± 12.00
Vaginal width	28-32	30.5 ± 1.33
Rectum	20 -35	28.75 ± 3.25
Prerectum	95-105	99 ± 7.11
Tail length	15-20	17.45 ± 3.32

Male: Not found.

Remarks: The soil samples were taken from the area around the *Calligonum polygonoides* plant at Saindino Malik No 10, Ghotki, Sindh, Pakistan 28.001578°N, 69.739483°E. Ten female specimens were separated from the aforementioned Pakistani regions and deposited in Nematode Collection of National Nematological Research Centre at the University of Karachi, Karachi, Pakistan.

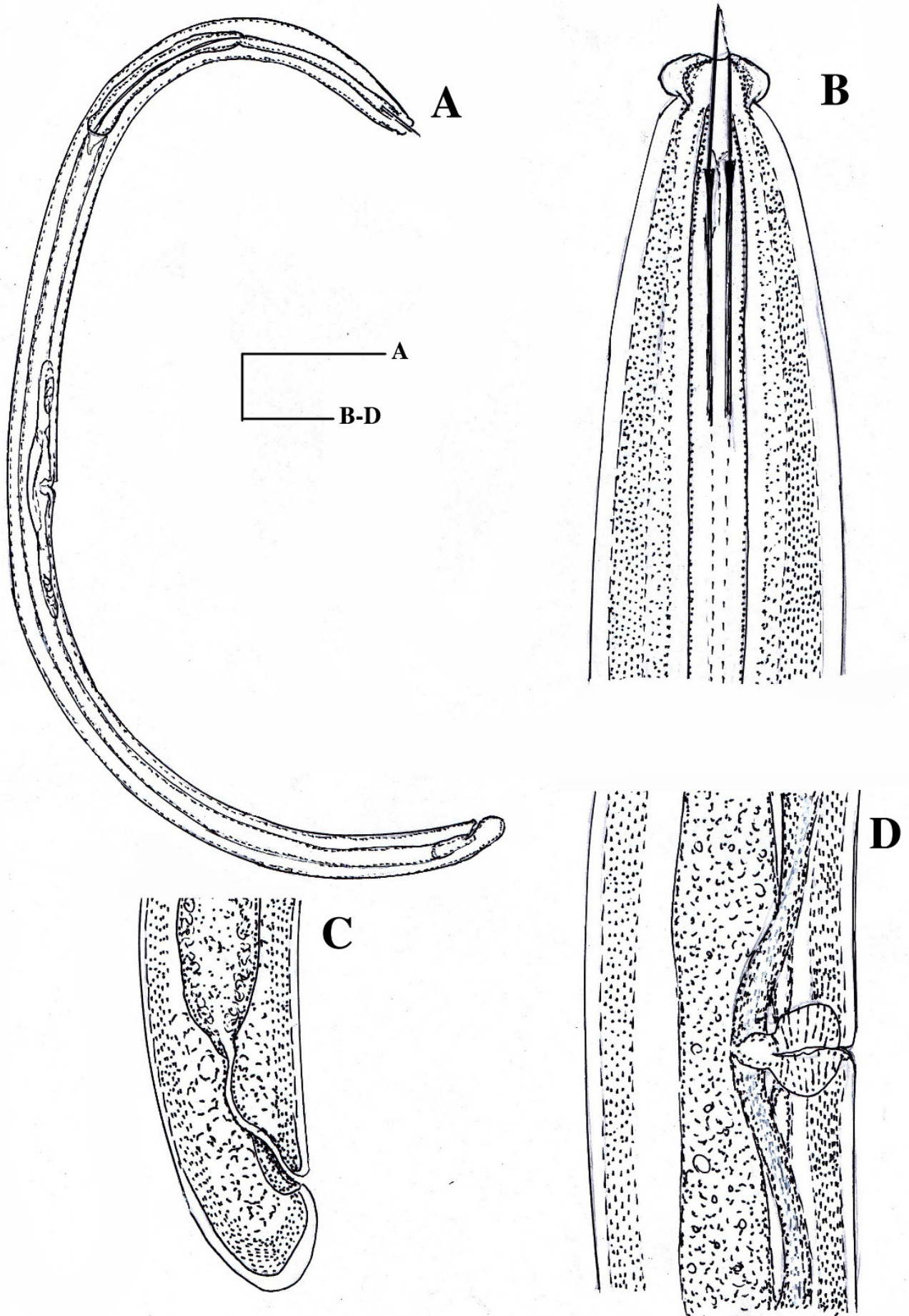


Figure 14: *Labronema mangaloreNSE* Ahmad and Ahmad (2002). A: Whole body (50µm); B: Anterior end (20µm); C: Female tail (20µm); D: Vulva (20µm).

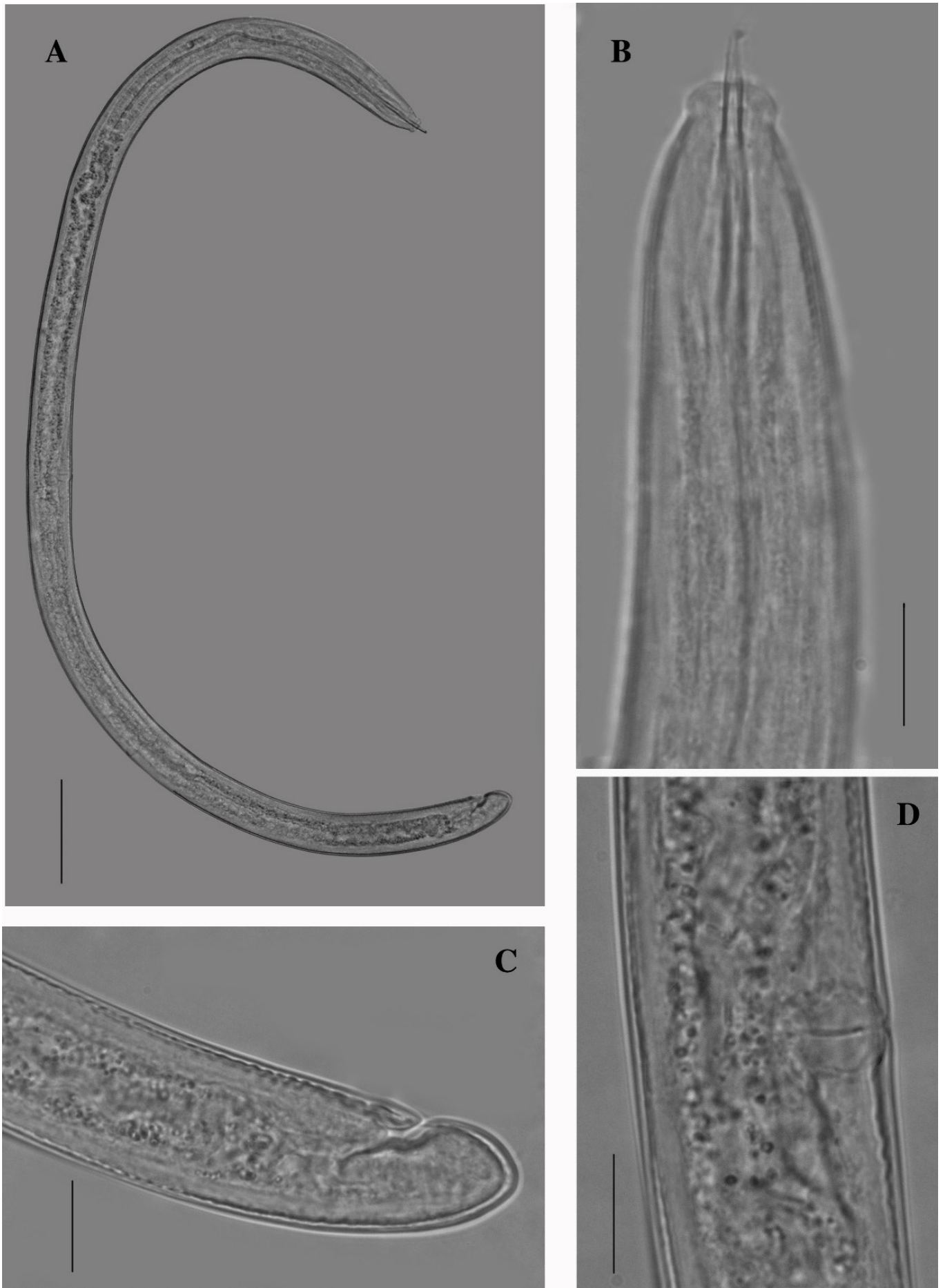


Figure 15: *Labronema mangalorensis* Ahmad and Ahmad (2002). A: Whole body (100 μ m); B: Anterior end (20 μ m); C: Female tail (20 μ m); D: Vulva (20 μ m).

Conclusions and Recommendations

The systematic surveys and proper identification of plant parasitic and soil nematode fauna associated with vegetation of desert areas have been performed which resulted in presenting new recorded species for the first time from Pakistan.

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Novelty Statement

This manuscript deals with the taxonomic data of new reported indigenous specimens of nematode fauna associated with vegetation of Thar Desert areas of Pakistan.

Author's Contribution

Ramzan Ali processed the samples, prepared slides and collect morphometric data; Erum Iqbal did identification, description and manuscript writing; Ismail Bhatti did survey, sample collection and assist in manuscript writing; Saboohi Raza supervised the research.

Conflict of interest

The authors have declared no conflict of interest.

References

- Ahmad, A. and Ahmad, W., 2002. Descriptions of three new species of Dorylaimoidea (Nematoda: Dorylaimida) from South India. *Int. J. Nematol.*, 12: 23-28.
- Ashfaq, A.N., Shahina, F. and Nasira, K., 2019. New and Known Nematodes Associated with Cotton Plantation in Sindh, Pakistan. *Pak. J. Zool.*, 51: 1309-1314. <https://doi.org/10.17582/journal.pjz/2019.51.4.1309.1314>
- Baermann, G., 1917. Eine einfache Methode zur Auffindung von *Ankylostomum* (Nematoden) Larven in Erdproben. *Geneeskunding Tijdschrift Nederland-Indië*, 57: 131-137.
- Baqri, Q.H., 1996. Faunal diversity of nematoda in the thar Desert: Assessment and futuristic approach. In: Faunal diversity in the Thar Desert: Gaps in Research. Ed. by A.K. Ghosh, Q.H. Baqri and I. Prakash. Scientitic Publisher, Jodhpur, pp. 51-70.
- Bohra, P. and Baqri, Q.H., 2004. Nematoda. In: State Fauna Series No.8 Gujrat (Prt-2) Director, Zoological Survey of India (Ed.) Kolkata, pp. 355-400.
- Cobb, N.A., 1918. Estimating the nema population of soil. *Agriculture Technical Circular*, US Department of Agriculture, 1: 48.
- Darekar, K.S. and Khan, E., 1981. *Nenocriconema dorgeski* gen. n., sp. n. (Nematoda: Criconematidae) from Maharashtra, India. *Indian J. Nematol.*, 11(2): 172-175.
- De Man, J.G., 1884. Die frei in der reinen Erde und in sussen W affer lebenden Nematoden der neiderlandischen Fauna. Leiden, pp. 1-206. <https://doi.org/10.5962/bhl.title.46884>
- Heyns, 1965. (Nematoda: Aporcelaimidae) and description of *M. aquaticus* sp. n. from Spain. *Afro-Asian J. Nematol.*, 4: 1-6.
- Islam, N. and Ahmad, W., 2021. Five new and five known species of the genus *Tylencholaimus* de Man, 1876 (Nematoda: Dorylaimida: Tylencholaimoidea) from Western Ghats of India. *Eur. J. Taxon.*, 774: 58-105. <https://doi.org/10.5852/ejt.2021.774.1531>
- Jairajpuri, M.S. and Ahmad, W., 1992. Dorylaimida: Free-living, predaceous and plant parasitic nematodes. Oxford and IBH Publishing Company Private Limited, New Delhi, India, 458 pp.
- Khan, A., Shahid, S.S. and Iftikhar, A., 2000. Nematode communities associated with chillies in lower Sindh, Pakistan. *Pak. J. Biol. Sci.*, 3: 457-458. <https://doi.org/10.3923/pjbs.2000.457.458>
- Khera, S. and Bhatnagar, G.C., 1977. Plant nematology in Rajasthan: A review. In: *The Natural Resources of Rajasthan* (Ed) M.L. Roonwal, Jodhpur University Press, Jodhpur, pp. 437-449.
- Maqbool, M.A. and Shahina, F., 2001. Systematics and distribution: Biodiversity of nematode fauna in Pakistan. National Nematological Research Centre, University of Karachi, Karachi, pp. 179.
- Maqbool, M.A., Zain, A. and Shama, N., 1975. Studies on plant parasitic nematodes associated with sugarcane in Sindh region. *Res. Butt.*, No.1.NNRC, University of Karachi.
- Mathur, V.K., Sanwal, K.C. and Lal, A., 1978.

- Tylenchorhynchus neoclavicaudatus* sp. nov. in soil washings from imported potato tubers. *Indian J. Nematol.*, 8: 148–150.
- Pathan, M.A., Muzaffar, A.T., Jiskani, M.M. and Wagan, K.H., 2004. Studies on plant parasitic nematodes associated with banana in Sindh, Pakistan. *J. Asia-Pac. Entomol.*, 7(2): 249-252. [https://doi.org/10.1016/S1226-8615\(08\)60223-X](https://doi.org/10.1016/S1226-8615(08)60223-X)
- Shahina, F. and Maqbool, M.A., 1992. Nematodes from banana fields in Sindh with morphometric data on nine species with six representing new records of occurrence in Pakistan. *Pak. J. Nematol.*, 10(1): 23-40.
- Shahina, F., Nasira, K., Firoza, K. and Erum, Y.I., 2019. Overview of nematode fauna of Pakistan. *Pak. J. Nematol.*, 37(2): 171-243. <https://doi.org/10.18681/pjn.v37.i02.p171-243>
- Siddiqi, M.R., 1986. *Tylenchida: Parasites of plant and insects*. CABI, Sent Albans, UK, pp. 645.
- Siddiqi, M.R., 2000. *Tylenchida parasites of plants and insects*. 2nd Edition. CABI Publishing, Wallingford, UK, pp. 833. <https://doi.org/10.1079/9780851992020.0000>
- Siddiqi, M.R., Dabur and Bajaj. 1991. Description of three new species of *Pratylenchus* Filipjev, 1936 (Nematoda: Pratylenchidae). *Nematol. Medit.*, 19: 1-7.
- Siddiqi, M.R. and Basir, M.A., 1958. On some plant parasitic nematodes occurring in South India with description of two new species of the genus *Tylenchorhynchus* Cobb, 1913. p. 35 in *proceedings of the 46th meeting of the Indian Science Congress, Delhi, 1959, Part IV*.
- Swarup, G. and Sethi, C.L., 1977. Plant parasitic nematodes of Rajasthan. In: *The natural resources of Rajasthan* (Ed) M.L. Roonwal, Jodhpur University Press, Jodhpur, pp. 431-435.
- Zahid, G. and Firoza, K., 2014. Nematodes associated with date palm orchards of Kairpur District Sindh, Pakistan. *Pak. J. Nematol.*, 32(1): 113-119.
- Zeidan, A.B. and Geraert, E., 1991. *Pratylenchus* from Sudan, with the description of two new species (Nematata: Tylenchida). *Rev. Nematol.*, 14: 261-275.