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Description of *Filenchus maqbooli* n. sp., and redescriptions of five new records of plant parasitic nematodes of maize crops from Punjab, Pakistan

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Abstract

In a recent study of plant parasitic nematodes, the following species of nematodes were encountered from maize and its adjoining crops from Punjab, Pakistan. New species *Filenchus maqbooli* n. sp., characterized by small body with short stylet and tail long, filiform has been described. Five new record species of plant parasitic nematodes viz., *Helicotylenchus certus* Eroshenko & Nguen Vu Tkhan, 1981, *Helicotylenchus gulabi* Jain, Siddiqui & Aruna Parihar, 2000, *Helicotylenchus jasminii* Jain Saddiqui & Aruna Parihar, 2000, *Pratylenchus goodeyi* Sher & Allen, 1953 and *Telotylenchus indicus* Siddiqi, 1960 and two new host records of maize viz., *Tylenchorhynchus tritici* Golden, Maqbool & Hando, 1987 and *Malenchus labiatus* Maqbool & Shahina, 1985 are briefly redescribed herein.

Keywords: New species, *Filenchus,* new host records, Pakistan

Maize (*Zea mays* L.) is the third most important cereal crops after wheat and rice that grown throughout the world (Suleiman & Omafe, 2014; Tsedaley, 2016). This is a good source of food that consumed throughout the world as well as an important feed component for livestock. The world production of maize was 885, 289, 935 metric tons which was more than rice (722, 559, 584 metric tons) and wheat (701, 395, 334 metric tons) (FAO, 2011). It was planted over 118 million hectares with an annual production of about 6.0 million metric tons.

In Pakistan also maize is the third important cereal crop after wheat and rice (Abuzar *et al*., 2011). It is cultivated on an estimated area of 1.0 million hectares and annual production is approximately 3.5 million tons. Khyber Pakhtunkhwa (KP) province contributes 63%, Punjab 30%, Sindh and Balochistan 2-3% of total maize production in Pakistan (Ghulam, 2013). There are seven broad agro-ecological maize production zones in Pakistan. Production of maize in Pakistan has increased 1185 tonnes during 1990-91 to 4271 tonnes in 2011-2012 (GOP, 2012). In Pakistan after potato, the maize stands most profitable stable and dependable crop (Tariq & Iqbal, 2010). Several nematodes are known to be associated with maize but major ones belong to genera *Meloidogyne, Heterodera*, *Pratylenchus*, *Helicotylenchus, Ditylenchus* and *Tylenchorhynchus.* In Pakistan, 54 nematode species belonging to 23 nematode genera were reported from maize (Maqbool & Shahina, 2001). Nematodes have been recognized as one of limiting factor in agriculture production and there is need to identify the nematode problem for the improvement of crop production.

Materials and Methods

Sampling: The present survey was conducted at 16 localities of Punjab, province of Pakistan. A total of 210 samples of soil and roots of maize and other crops grown in adjoining areas were collected at the depth of 10-15 cm.

Isolation and Processing of nematodes: Roots were carefully separated from soil for examination. The remaining soil was thoroughly mixed. Cobb, (1918) sieving and decantation method was followed for isolation and processing of nematodes. Nematodes were separated from soil by the help of Baermann funnel method (Baermann, 1917), after killing nematodes were fixed in TAF, processed by dehydration method (Seinhorst, 1959); slides were made by mounting them in glycerin (Siddiqi, 2000). Measurements of all nematodes were taken by a compound microscope according to De Man (1884). Illustrations were prepared with the help of camera Lucida attached to Nikon Eclipse E400 microscope.

Results and Discussion

In this study 25 species of nematodes were encountered. These include a new species viz., *Filenchus maqbooli* n. sp. and five new records viz., *Helicotylenchus certus* Eroshenko & Nguen Vu Tkhan, 1981, *Helicotylenchus gulabi* Jain *et al*., 2000, *Helicotylenchus jasminii* Jain *et al*., 2000, *Pratylenchus goodeyi* Sher & Allen , 1953 and *Telotylenchus indicus* Siddiqi, 1960. Also the following two species are first time reported on maize: *Tylenchorhynchus tritici* Golden *et al*., 1987 and *Malenchus labiatus* Maqbool & Shahina, 1985.

Filenchus maqbooli n. sp. (Fig. 1 A-G; Table 1)

Female: Body straight to arcuate when it relaxed. Cuticle coarsely annulated. Lateral field with four incisures. Lip region slightly offset, cephalic frame work lightly sclerotized. Stylet moderately developed 8-9 µm long. Conus about 1/3 of the total stylet length. Dorsal oesophageal gland opens just beneath the stylet knobs. Median oesophageal bulb oval in shape. Excretory pore situated 62-74 µm from anterior end whereas hemizonid present just or 1-2 annules above from it. Cardia distinct located between basal bulb and intestine. Nerve ring encircling oesophagus and situated anterior to middle of isthmus. Transverse slit of vulva present, 62.2-66.2% of total body length. Ovary outstretched, spermatheca filled, rounded to oval. A single row of oocytes present. Tail filiform, straight, lightly arcuate on ventral side, about 74-90 µm long.

Male: General body shape similar to the female but stylet slightly larger 8-10 µm long. Testis outstretched, single. Spicules well developed 16-19 µm long, pointed tip with posterior half angular. Gubernaculum slightly cup shaped or rod like about 6-8 µm long. Bursa adanal.

Type habitat and locality: Specimens collected from soil around the roots of maize from Bhalwal, Punjab. Specimens were encountered from other hosts viz., potato, wheat, sorghum, tobacco and chilli from various localities viz., Dera General Umro Khan, Islampur, Koat Maan Singh, Mazaharabad, 123EB Canal system, Sheikhupura and Chak Hazara.

Etymology: The new species described here is named after Dr. M. A. Maqbool, Founder & Former Director, National Nematological Research Centre (NNRC), University of Karachi, Karachi, in recognition of his outstanding contributions to Nematology and in the establishment of NNRC.

Type Specimens: Holotype specimens on Slide No. NNRC- 112/110 and paratype on Slide No. NNRC-112/111-117 (11 females and 4 males) deposited in the National Nematode Collection of NNRC, University of Karachi, Karachi, Pakistan. Slide No. NNRC-112/118 (one paratype female and one paratype male) have been deposited in British Nematode Collection at the Food and Environment Research Agency (FERA), Sand Hutton, York, England, U.K.

Differential Diagnosis: *Filenchus maqbooli* n. sp., differs from other species of *Filenchus* by the combination of these features: small body (412-475 µm) with short stylet (8-10 µm), tail (74-90 µm) long, filiform not form

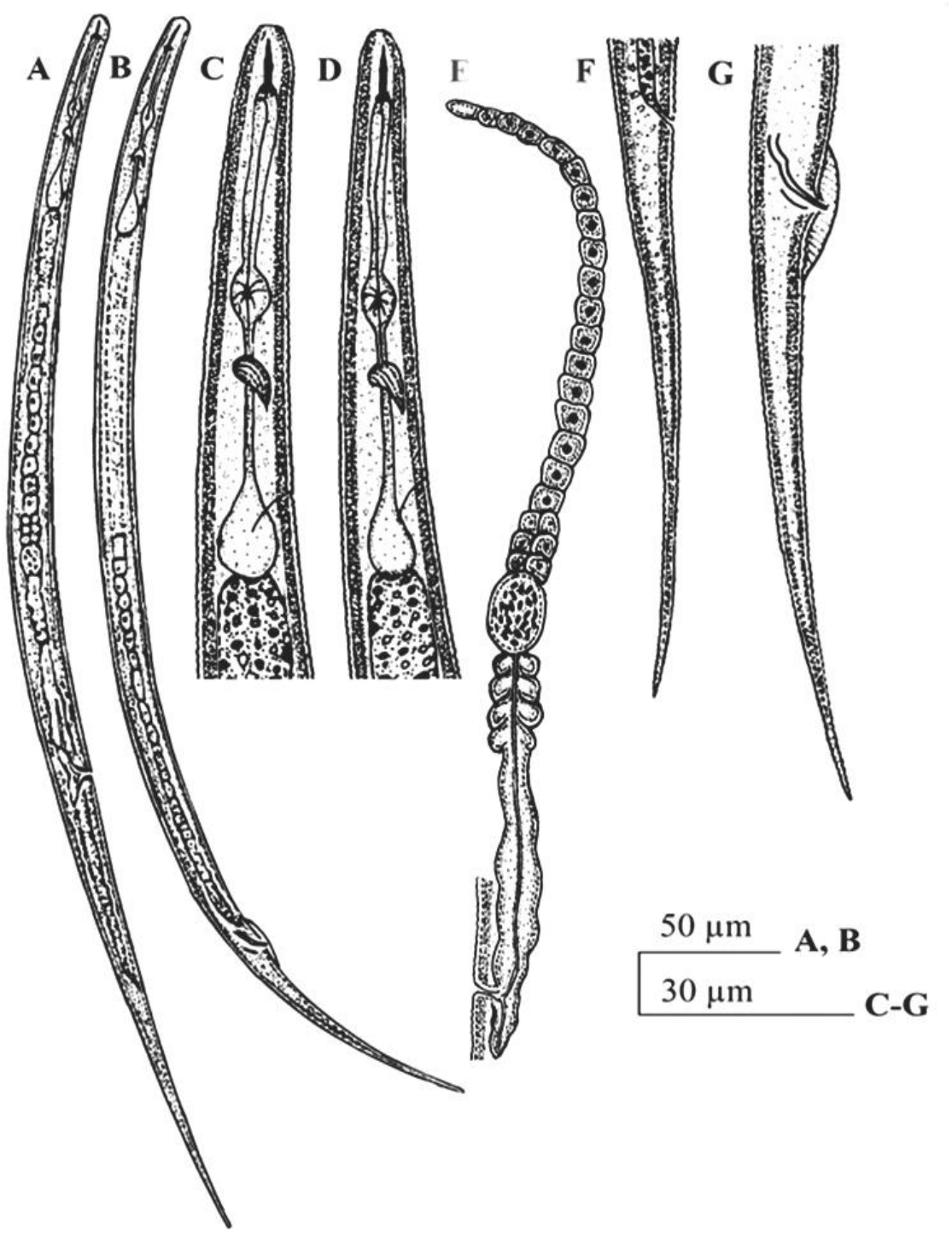

Fig. 1 (A-G). *Filenchus maqbooli* n. sp. A. Entire body of female; B. Entire body of male; C. Oesophageal region of female; D. Oesophageal region of male; E. Reproductive system of female; F. Female tail; G. Male tail.

Table 1. Measurements of *Filenchus maqbooli* n. sp. All measurements are in µm.

Characters	Holotype females	Paratype females (n=11)	Paratype males (n=4)
		Range (Mean±SD)	Range (Mean±SD)
L	454	412-475 (448.2±17.67)	419-462 (437.7±21.6)
a	30.2	28.1-32.9 (30.2±1.89)	29.9-32.3 (30.6±1.129)
b	6.4	5.05-6.13 (5.7±0.44)	5.12-5.7 (5.4±0.25)
c	5.5	5.05-5.8 (5.4±0.283)	4.7-5.13 (4.8±0.198)
c´	10.2	6-10.2 (9.07±0.885)	8.09-9.7 (8.8±0.659)
V%	62.9	62.2-66.2 (64.5±1.208)	-
Stylet	8	8-9 (8.72±0.46)	8-10 (9±0.81)
Greatest body width	15	14-16 (14.8±0.75)	13-15 (14.2±0.95)
Oesophageal length	70	70-94 (78.3±6.50)	76-82 (79.5±3)
Excretory pore	62	62-78 (67.9±5.43)	58-68 (62.7±4.39)
Tail length	82	74-94 (82.8±6.49)	88-98 (90.7±4.85)
Anal body width	8	8-11 (9.27±1.103)	9-11 (10.2±0.957)
Spicules	-	-	16-19 (17±1.41)
Gubernaculum	-	-	6-8 (6.75±0.957)

hook like structure, spicules 16-19 µm and gubernaculum 5-8 µm long. *Filenchus maqbooli* n. sp., is closely related to *Filenchus afghanicus* (Khan & Khan, 1978) Siddiqi, 1986; *Filenchus annulatus* (Siddiqui & Khan, 1983) Siddiqi, 1986 and *Filenchus sheri* (Khan & Khan, 1978) Siddiqi, 1986. *Filenchus maqbooli* n. sp., differs from *Filenchus afghanicus* in having large 'c' and 'V%' values (c= 5-5.8 vs 4-5; V%= 62.2-66.2 vs 56-63) with smaller body (L= 0.41-0.47 vs 0.46-0.6 mm) while large gubernaculum (5-8 vs 4-6) µm in male.

Filenchus maqbooli n. sp., also differs from *Filenchus annulatus* in having large 'c' and 'V%' values (c= 5-5.8 vs 3.08-4.2; V%= 62.2-66.2 vs 61.9-63.7) whereas less 'a' ratio (a= 28.1-32.9 vs 30.7-36.6). The new species can be distinguished from *Filenchus sheri* due to difference in L, a, c, and V% values (L= 0.41-0.47 vs 0.46-0.55mm; a= 28.1-32.9 vs 31-38; c= 5-5.8 vs 4-5; V%= 62.2-66.2 vs 61-63).

***Helicotylenchus certus* Eroshenko & Nguen Vu Tkhan, 1981**
(Fig. 2 A-D; Table 2)

Female: After killing, body assumed loosely spiral shape. Tapered anteriorly. Lip region continuous, hemispherical marked with 4-5 annules, lateral field about 1/4 at the mid-region of the body, bearing 4 incisures extending from head to tail terminus. Stylet 24-28 µm long with anteriorly flattened knobs, 4-5 µm across. Dorsal oesophageal gland opening at 10-11µm posterior to the stylet knobs.

Median oesophageal bulb oval in shape, 9-13 µm long and 9-10 µm wide, about 82-86 µm from anterior end to the base of median bulb. Procorpus cylindrical. Excretory pore 84-122 µm away from anterior end. Hemizonid distinct, located 1-2 annules anterior to excretory pore. Vulva situated at 381-451 µm away from head, ovary didelphic. Tail pointed, dorsally curved bearing 6-12 annules on ventral side. Phasmid, located 1-4 annules above or at the level of anus.

Male: Not found.

Remarks: This species is a new record from Pakistan, collected from around the roots of maize, potato, wheat, sorghum and chilli from Sheikhupura, Chak Hazara, Pakistan Pull and Mazaharabad, Punjab. Measurements and description are similar to original description given by Eroshenko & Nguen Vu Tkhan (1981).

***Helicotylenchus gulabi* Jain, Siddiqui & Aruna Parihar, 2000**
(Fig. 3 A-D; Table 2)

Female: Body loosely spiral in shape after killing by gentle heat, tapering anteriorly. Head continuous bearing 4-5 annules; labial frame work greatly sclerotized. Stylet 23-24 µm long with rounded basal knobs, 4-5 µm across. Dorsal oesophageal gland opening into the oesophagus lumen at 10 µm from the base of stylet. Lateral field approximately 1/6 of body width – bearing 4 incisures, outer two are prominent while inner two are lighter, start from procorpus and end into tail. Procorpus cylindrical in shape. Median bulb oval to rounded 84 µm from anterior end. Hemizonid situated 2-3 annules anterior to excretory pore. Vulva transverse slit situated 58.3-62.3% of total body length. Ovaries didelphic. Tail smooth, rounded bearing 7-8 annules. Phasmid situated at the level of anus.

Male: Not found.

Remarks: This species is a new record from Pakistan, collected from around the roots of maize, potato, chilli from Shamsabad, Dera General Umro Khan, Chak 103EB and Islampur, Punjab. The measurements are quite similar to original description given by Jain *et al*., (2000) but with very slight variation in 'b' value (4.4-4.8 vs 3.6-4.2) and more anteriorly located vulva V% (58.3-62.3 vs 61.0-66.3).

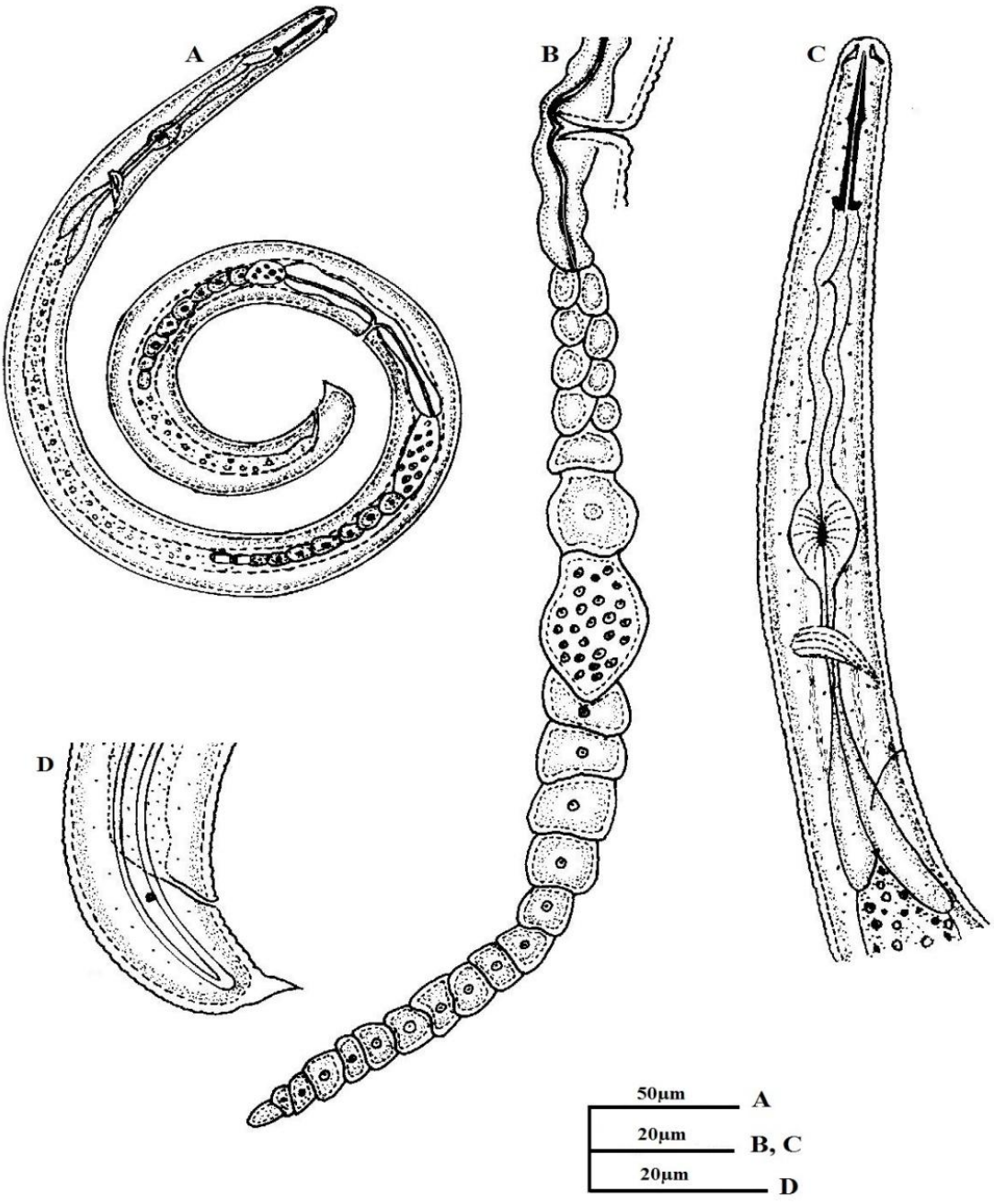

Fig. 2 (A-D). *Helicotylenchus certus* Eroshenko & Tkhan (1981). Female: A. Entire body of female; B. Posterior reproductive branch of female; C. Oesophageal region of female; D. Female tail.

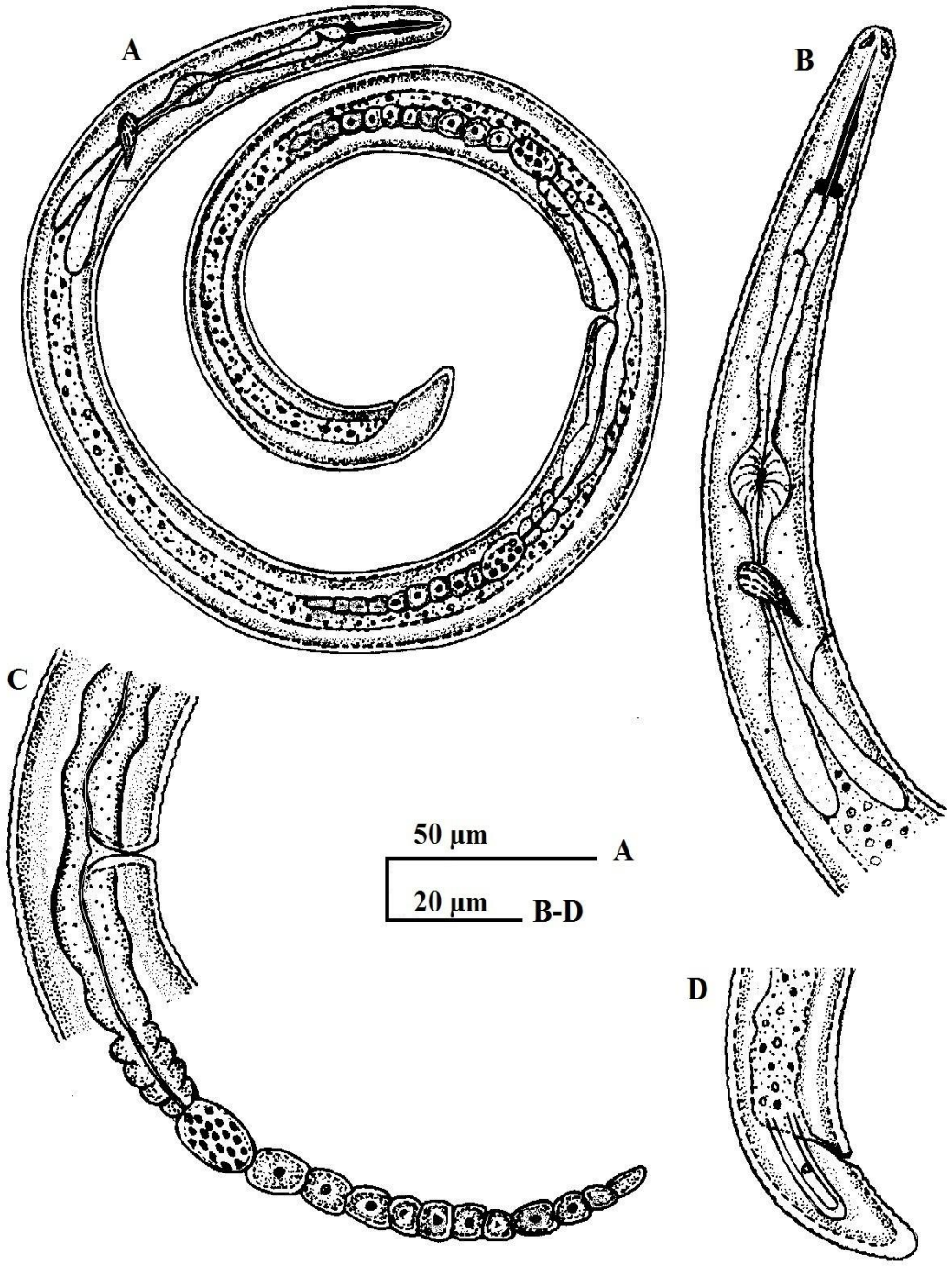

Fig. 3 (A-D). *Helicotylenchus gulabi* Jain, Siddiqui & Parihar, 2000. Female: A. Entire body of female; B. Oesophageal region of female; C. Posterior reproductive branch of female; D. Female tail.

***Helicotylenchus jasminii* Jain, Siddiqui & Aruna Parihar, 2000)**
(Fig. 4 A-D; Table 2)

Female: Body loosely spiral in shape, body tapering anteriorly, head continuous, cuticle striated. Labial frame work moderately sclerotized. Lateral field with four incisures; at mid of body the lateral field about ¼ of body. Stylet 22-24 µm long with rounded knobs. Dorsal oesophageal gland orifice 9-11 µm posterior to stylet knobs. Procorpus cylindrical in shape. Median oesophageal bulb oval in shape, 8 µm wide and 13 µm long. Nerve ring situated 76-82 µm from anterior end. Excretory pore located at 74-103 µm from anterior end, whereas the hemizonid present 1-2 annules anterior to it. Vulva transveres slit, present at 59.8-63.5% of total body length. Ovaries outstretched, amphidelphic, spermatheca filled. Tail smooth with 9-10 annules, small conical projection present at tail terminus. Phasmid situated 1-2 annules below to anus.

Male: Not found.

Remarks: This species is a new record from Pakistan, present around the roots of sorghum and maize from Burj Jieway Khan, Chak 35-2R/A, Mazaharabad, Noorpur and Islampur, Punjab, Pakistan. Measurements and description are similar to original description given by Jain *et al*., (2000).

***Pratylenchus goodeyi* Sher & Allen, 1953**
(Fig. 5 A-E; Table 3)

Female: Body slightly ventrally curved after killing by gentle heat. Cephalic frame work strongly sclerotized divided into four annules. Head continuous. Stylet moderately sclerotized about 18-20 µm long with rounded knobs. Dorsal oesophageal gland open into oesophagus at 3 µm posterior to stylet knobs. Lobes of oesophageal gland overlapping with intestine ventrally. Median oesophageal bulb oval or rounded in shape. Excretory pore situated at 83-90 µm from anterior end. Hemizonid located 1-2 annules or just above from excretory pore. Vulva transverse slit located near posterior end, at 71.2-78.8% of total body length. Ovary outstretched, anteriorly directed. Post uterine sac present, spermatheca oblong, filled with sperms. A single row of oocytes also present. Tail slightly arcuate on ventral side, bearing 27-30 annules. Tail terminus smooth, narrowly rounded.

Male: Not found.

Remarks: This species is a new record from Pakistan, collected around the roots of maize, potato, tobacco and sorghum from Burj Jieway Khan, Chak Hazara, Islampur, Koat Maan Singh, Mazaharabad, Pakistan Pull, Shamsabad and Sheikhupura, Punjab, Pakistan. Measurements and description are quite similar with original description given by Sher & Allen, 1953 but with slightly longer stylet (18-20 vs 16-17 µm) and shorter DGO (3 vs 2 µm).

***Telotylenchus indicus* Siddiqi, 1960**
(Fig. 6 A-F; Table 3)

Female: After killing, body slightly ventrally arcuate. Lateral field with four incisures, outer incisures crenated about 5.6 µm wide at mid of the body. Cuticle annulated. Head rounded offset, marked by 7-8 lip annules. Labial frame work not sclerotized. Stylet 15.2-16.8 µm long with forwardly directed stylet knobs. Dorsal oesophageal gland orifice situated 3 µm posterior to stylet knobs. Procorpus cylindrical. Median bulb ovate, 15.2 µm long with 9.6 µm wide. Isthmus elongate, nerve ring situated 80-100 µm away from anterior extremity. Oesophagus 148-164 µm long. Oesophageal glands extending on intestine on lateral side. Vulva transverse slit located at 49.6-55% of total body length. Vagina at right angle. Ovaries out stretched, spermatheca round, filled with sperms. Tail elongate, conoid, tail terminus smooth, about 52-60 µm long with 14.4-15.2 µm anal body width.

Male: Body is similar to the female. Testis outstretched and single. Spicules ventrally arcuate 22-28 µm long. Gubernaculum rod like 11-12.8 µm long. Tail ventrally arcuate, pointed terminus. Bursa large, crenated and enveloping whole tail.

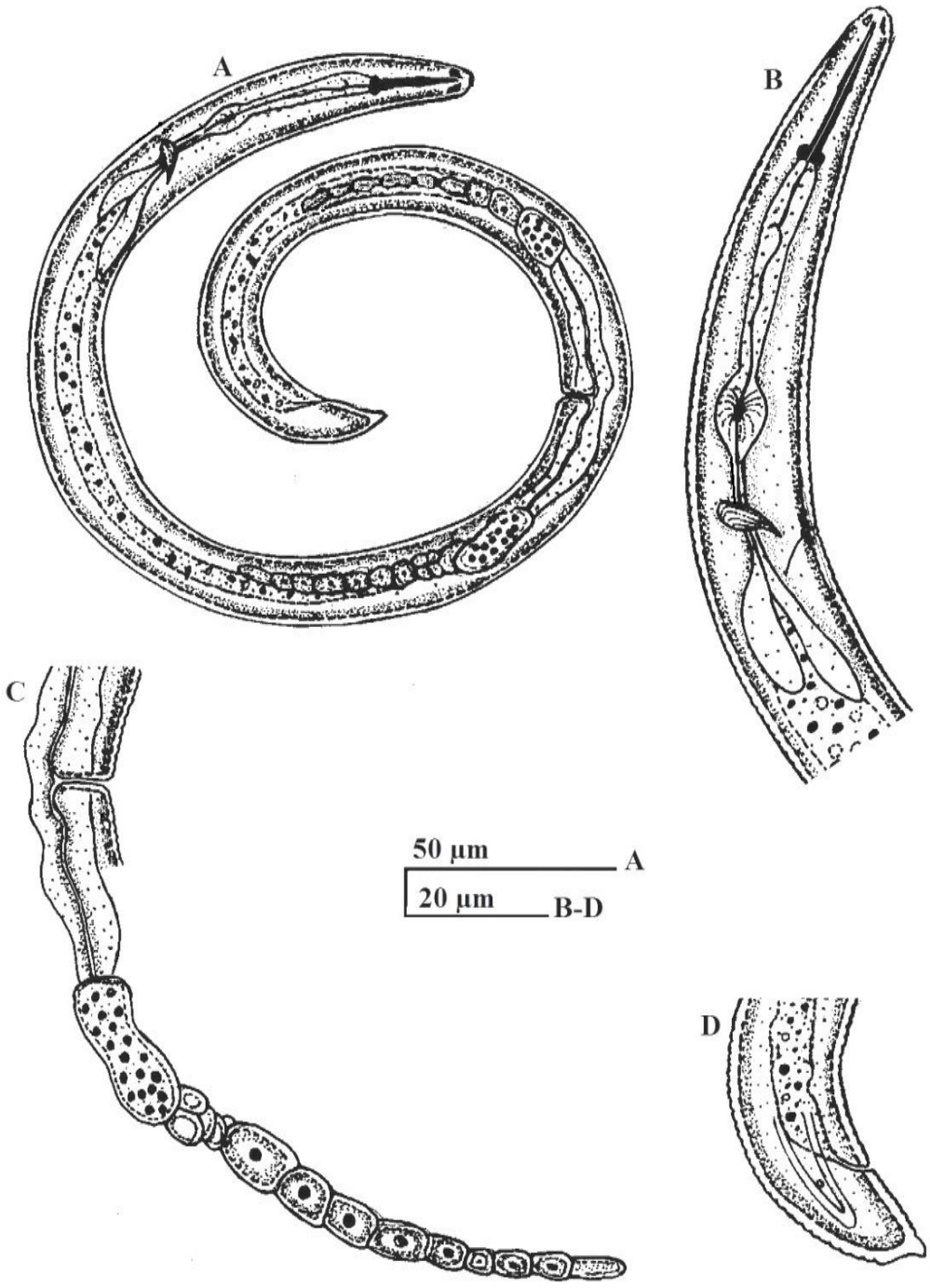

Fig. 4 (A-D). *Helicotylenchus jasminii* Jain, Siddiqui & Parihar, 2000. Female: A. Entire body of female; B. Oesophageal region of female; C. Posterior reproductive branch of female; D. Female tail.

Table 2. Measurements of *Helicotylenchus certus* Eroshenko & Nguen Vu Tkhan, 1981, *H. gulabi* Jain, Siddiqui & Aruna Parihar, 2000 and *H. jasminii* Jain, Siddiqui & Aruna Parihar, 2000. All measurements are in µm.

Measurements	*H. certus*	*H. gulabi*	*H. jasminii*
	Range(Mean±SD) (Females=14)	**Range (Mean±SD) (Females=6)**	**Range (Mean±SD) (Females=5)**
L	571-717 (668.5±45.5)	521-570 (542.5±17.52)	466-571 (548.8±46.31)
a	22.8-31.3 (25.9±1.95)	22.8-27.3 (25.20±1.493)	22.1-27.1 (25.5±2.051)
b	5-6.2 (5.4±0.54)	5.4-5.8 (5.6±0.189)	4.68-5.4 (5.06±0.293)
b´	4.02-5.7 (4.71±0.45)	4.4-4.8 (4.63±0.163)	3.75-4.3 (4.11±0.234)
c	29.3-43.2 (38.14±5.88)	30-32.9 (32.4±1.34)	29.1-35.5 (33.4±2.613)
c´	1-1.5 (1.24±0.18)	1.26-1.5 (1.37±0.09)	1.2-1.30 (1.22±0.042)
V%	60.5-67.2 (62.7±2.04)	58.3-63.4 (61.86±1.89)	59.8-63.5 (61.6±1.413)
Stylet	24-28 (26.07±1.20)	21-24 (23.16±1.169)	22-24 (23±1)
Lip annules	4-5 (4.14±2.12)	4 (4±0)	4 (4±0)
Greatest width	21-28 (25.7±2.08)	20-25 (21.3±1.861)	18-22 (20.8±1.643)
Excretory pore	84-122 (103.28±9.65)	84-91 (85.5±2.81)	16-17 (16.4±0.547)
Tail length	13-22 (17.92±3.14)	16-19 (16.8±1.169)	13-14 (13.2±0.547)
Anal body width	13-15 (14.21±0.89)	11-15 (12.16±1.47)	8-9 (8.4±0.547)
Tail annules	6-12 (7.71±2.12)	7-8 (7.66±0.516)	74-103 (90.2±11.84)

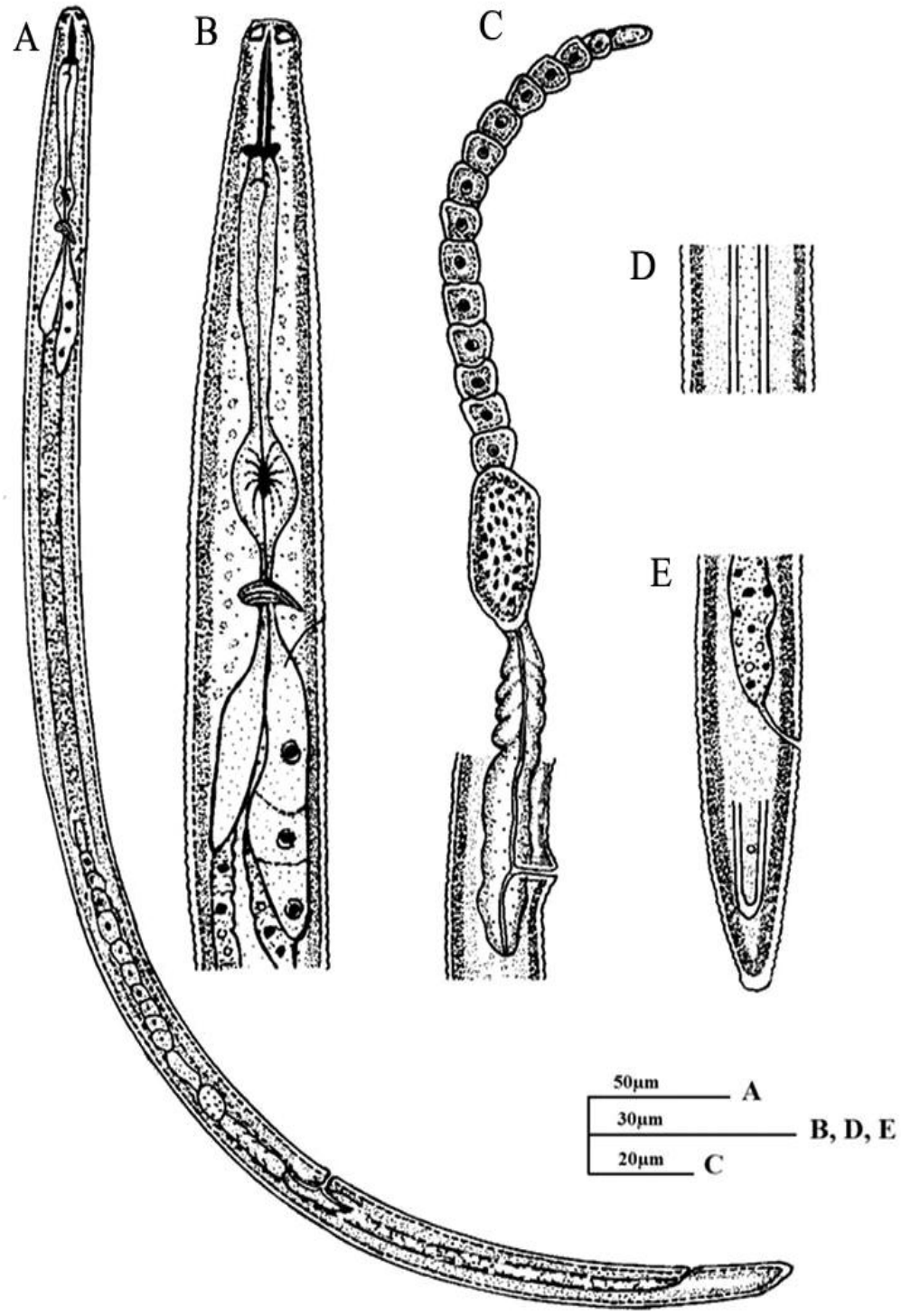

Fig. 5 (A-E). *Pratylenchus goodeyi* Sher & Allen, 1953. Female: A. Entire body of female; B. Oesophageal region of female; C. Reproductive system of female; D. Lateral field; E. Female tail.

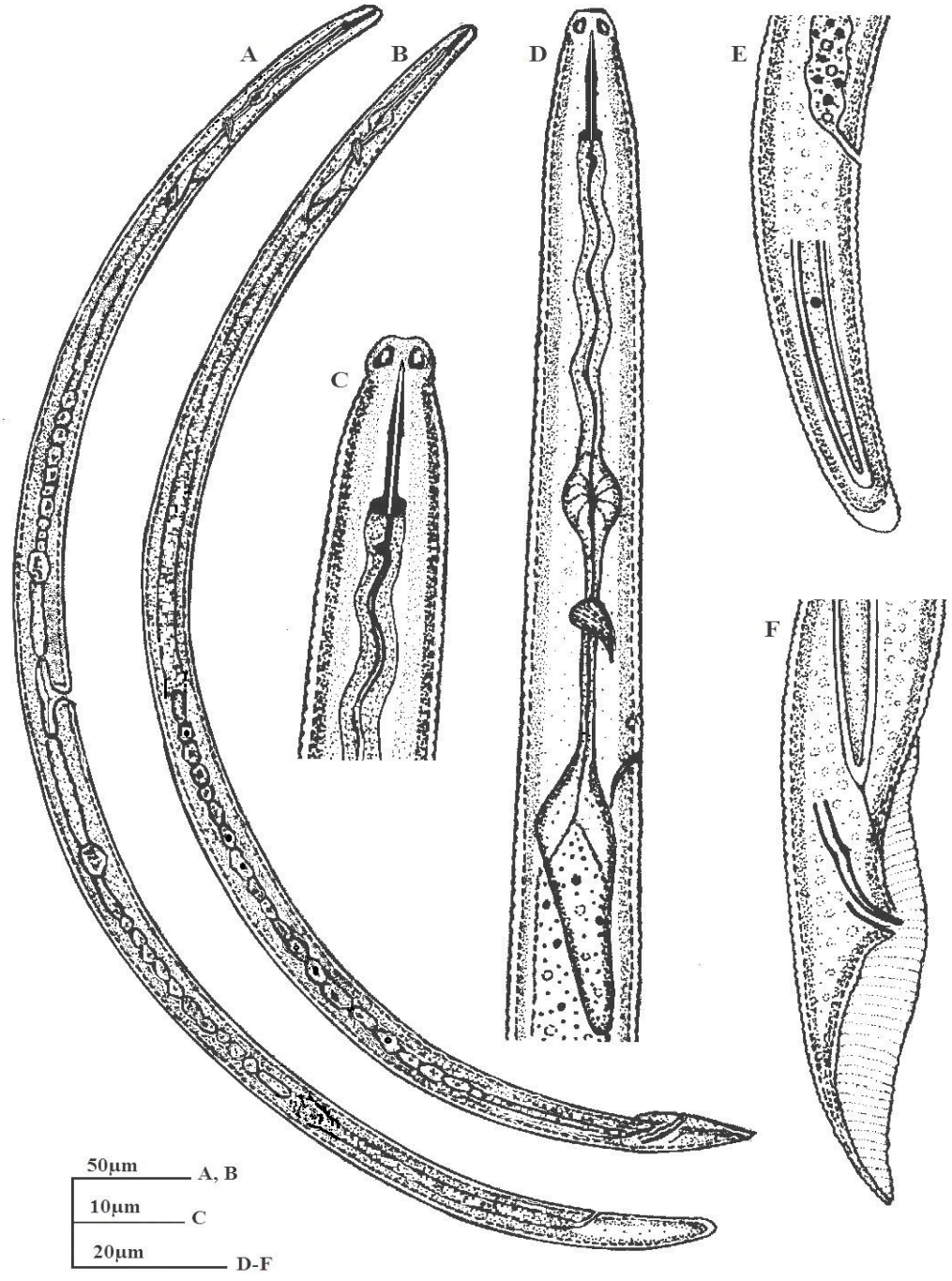

Fig. 6 (A-F). *Telotylenchus indicus* Siddiqi, 1960. A. Entire body of female; B. Entire body of male; C. Anterior end of female; D. Oesophageal region of female; E. Female tail; F. Male tail.

Table 3. Measurements of *Pratylenchus goodeyi* Sher & Allen, 1953 and *Telotylenchus indicus* Siddiqi, 1960. All measurements are in µm.

Measurements	*Pratylenchus goodeyi*	*Telotylenchus indicus*	
	Range (Mean±SD) (Females: n=5)	Range (Mean±SD) Females (n=5)	Range (Mean±SD) Males (n=3)
L	550-618 (575.8±26.6)	657-821 (734.5±63.2)	692-823 (758.5±65.2)
a	30.5-34.75 (32.19±1.68)	30.8-39.09 (33.9±3.3)	28.2-39.1 (33.9±5.15)
b	5.34-6.18 (5.76±0.32)	4.20-5.54 (4.84±0.49)	4.21-5.47 (4.93±0.65)
b´	4.21-4.50 (4.43±0.13)	-	-
c	16.05-17.37 (16.53±0.52)	11.8-14.9 (13.3±1.29)	13.2-14.6 (13.8±0.70)
c´	2.28-3.27 (2.88±0.51)	3.12-3.81 (3.54±0.28)	3.12-4.13 (3.6±0.50)
V%	71.2-78.8 (73.78±2.92)	49.8-55 (52.72±1.99)	-
Stylet	18-20 (18.6±0.89)	15.2-18 (16.4±1.05)	15-18 (16.33±1.52)
Lip annules	4 (4±0)	7-8 (7.6±0.54)	7-8 (7.33±0.57)
Greatest width	16-20 (17.8±1.48)	19-24 (21.68±1.84)	21-24 (23.46±1.50)
Excretory pore	83-90 (86.8±3.11)	91-116.8 (104.6±10.1)	91-117 (102.7±13.1)
DGO	3 (3±0)	3 (3±0)	3 (3±0)
Oesophageal length	-	134-164 (152.0±12.5)	150-164 (154.1±8.6)
Tail length	32-37 (34.6±1.94)	50-60 (55.2±4.32)	50-62 (54.66±6.42)
Anal body width	10-14 (12.2±1.78)	14.4-16.2 (15.5±0.7)	14-16 (15±1)
Tail annules	27-30 (28.4±1.14)	38-47 (41.6±3.91)	38-47 (42.33±4.50)
Spicules	-	-	22-28 (24.66±3.05)
Gubernaculum	-	-	11-12.8 (11.9±0.9)

Remarks: This species is a new record for Pakistan. Recently this species collected around the roots of maize and potato from Chak 103EB, Koat Maan Singh, Chak 35-2R/A and Pakistan Pull. The measurements are similar with original description given by Siddiqi (1960).

***Malenchus labiatus* Maqbool & Shahina, 1985 (Fig. 7 A-I; Table 4)**

Female: Body elongate, after killing slightly curved ventrally. Cuticle coarsely annulated. Lateral field with two incisures. Lip region continuous, lightly sclerotized. Stylet thin, 8-9 µm long. Dorsal oesophageal gland opens into oesophagus at 1-2 µm posterior to the stylet knobs. Procorpus equal or shorter than the isthmus. Median bulb muscular with valvular plates. Basal bulb pyriform. The distance from anterior end to basal bulb is about 83-90 µm. Excretory pore located at 60-63.4% of total body length. Ovaries outstretched, spermatheca elongate, bilobed, offset and filled with sperms. Vagina straight. Post uterine sac present. Tail filiform 94-110 µm long.

Male: General body shape is similar to the female. Testis single, outstretched. Spicules arcuate about 14-16 µm long while gubernaculum small about 3-5 µm long. Cloacal aperture form cone and depression formed around it.

Remarks: *Malenchus labiatus* was first time described by Maqbool & Shahina (1985) from the area of Qusoor around the roots of sugarcane. In the recent survey this species was collected around the roots of maize plants. It is a new host record from Chak 22GD, Noorpur and Shamsabad. The measurements are similar with the original description and there is no difference morphologically.

***Tylenchorhynchus tritici* Golden, Maqbool & Handoo, 1987**
(Fig. 8 A-H; Table 4)

Female: Body slightly to ventrally arcuate in position upon fixation. Cuticle coarsely annulated. Lateral field areolated with four incisures, outer two incisures crenated. Lip region slightly offset with 2-3 annules. Cephalic frame work very lightly sclerotized. Stylet short and delicate, with slightly posteriorly directed knobs. Dorsal oesophageal gland open at 2-3 µm behind the stylet knobs. Median oesophageal bulb oval to rounded with prominent valvular apparatus. Nerve ring encircling the oesophagus slightly above from middle of isthmus. Excretory pore located 74-90 µm from anterior end while hemizonid situated two annules above from it. Small conoid cardia located at the base of oesophageal bulb. Vulva transverse slit situated at 50.38-59.60% of total body length. Ovaries outstretched, spermatheca filled, oval and large. Tail bluntly rounded bearing 17-23 annules, smooth terminus. Phasmids located at anterior half of tail.

Male: Similar to female in general body shape. Testis single, outstretched. Spicules ventrally arcuate 17-21 µm long. Gubernaculum well developed, 9-12 µm long. Bursa tylenchoid, transverse cuticular striae present, enveloped full tail. Phasmids located approximately middle of tail.

Remarks: This species reported by Golden *et al*., (1987) from wheat. Recently this species was collected around the roots of maize a new host record from Bhalwal, Sheikhupura, Chak 35-2R/A and Chak 22GD, Punjab. The measurements and description are quite similar to the original description but with slightly variations in female (stylet = 15-16 vs 12.4-14.6 µm) and male (tail length = 38-57 vs 30.7-32.1 µm; stylet = 14-16 vs 12.9-13.3 µm).

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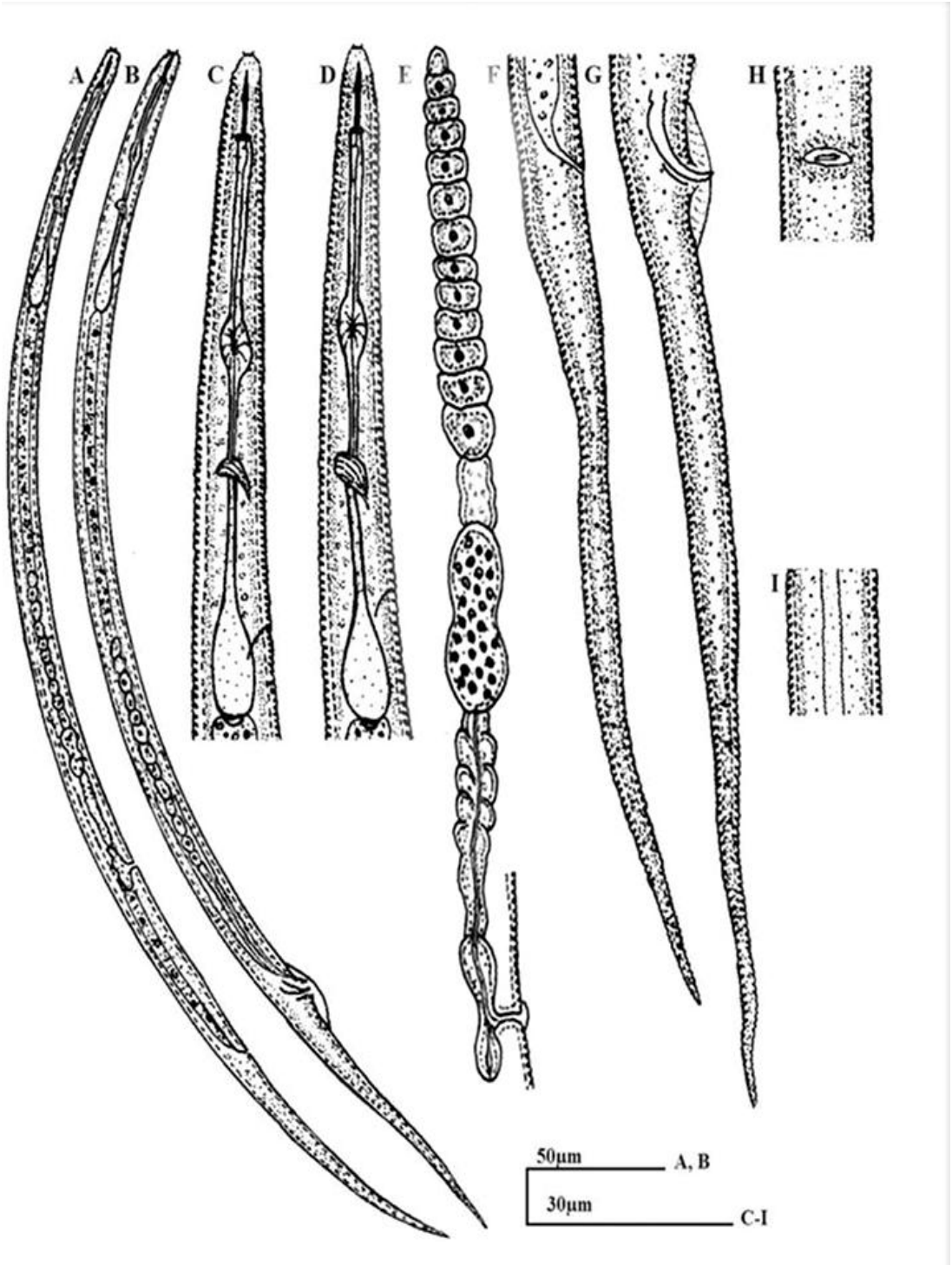

Fig. 7 (A-I). *Malenchus labiatus* Maqbool & Shahina, 1985. A. Entire body of female; B. Entire body of male; C. Oesophageal region of female; D. Oesophageal region of male; E. Reproductive system of female; F. Female tail; G. Male tail; H. Ventral view of vulva; I. Lateral field.

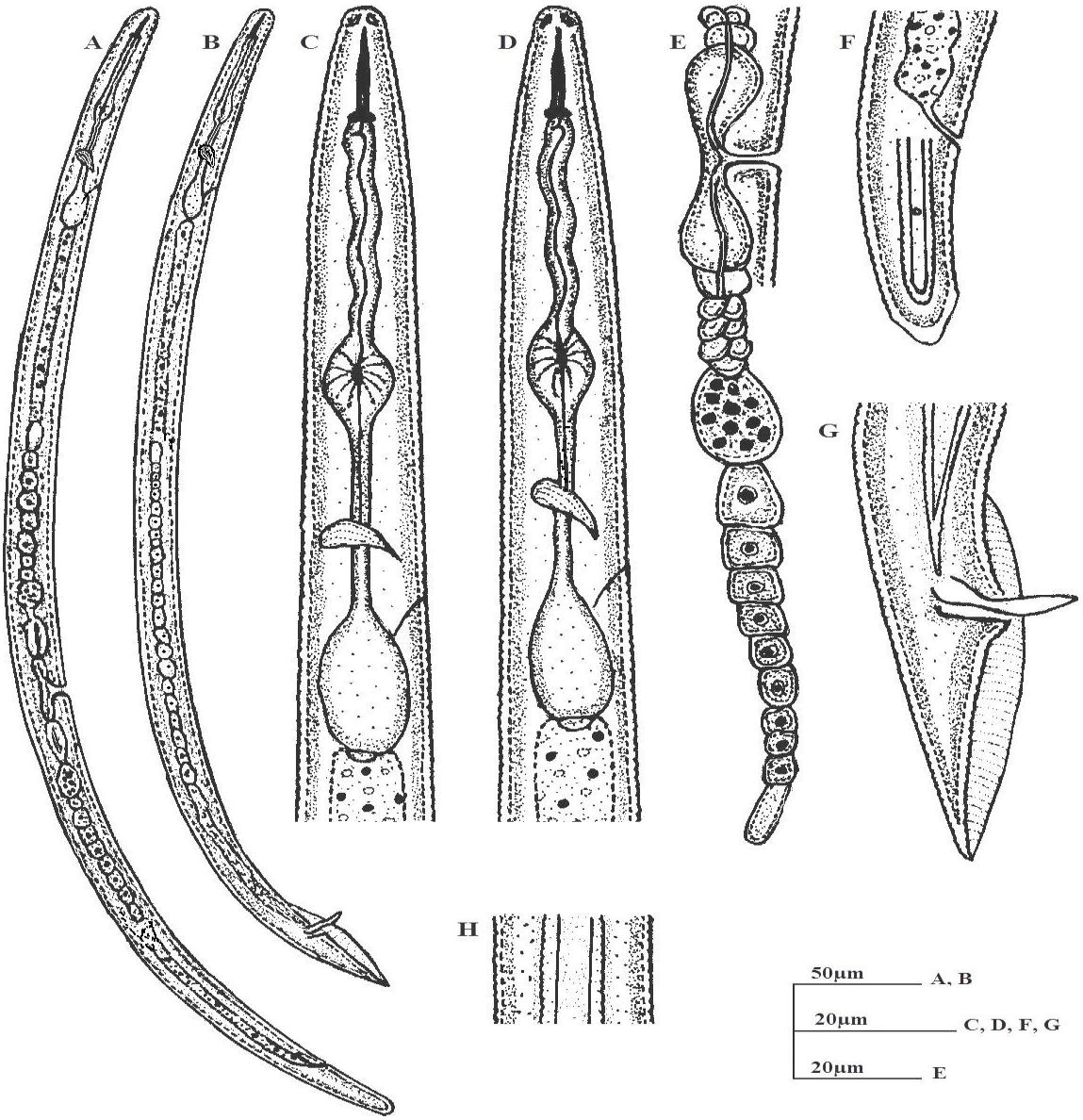

Fig. 8 (A-H). *Tylenchorhynchus tritici* Golden, Maqbool & Handoo, 1987. A. Entire body of female; B. Entire body of male; C. Oesophageal region of female; D. Oesophageal region of male; E. Posterior reproductive system of female; F. Female tail; G. Male tail; H. Lateral field.

Table 4. Measurements of *Malenchus labiatus* Maqbool & Shahina, 1985 and *Tylenchorhynchus tritici* Golden, Maqbool & Handoo, 1987. All measurements are in µm.

Measurements	*Malenchus labiatus*		*Tylenchorhynchus tritici*	
	Females (n=5) Range (Mean±SD)	**Males (n=3) Range (Mean±SD)**	**Females (n=19) Range (Mean±SD)**	**Males (n=20) Range (Mean±SD)**
L	405-446 (429.6±21.5)	412-445 (430±16.70)	503-684 (617.5±42.2)	543-668 (595.2±41.5)
a	25.9-30.3 (27.5±1.67)	29.4-33.3 (30.7±2.19)	26.9-30.71 (29.31±1.61)	24.8-33.6 (29.4±2.34)
b	4.7-5.5 (5.06±0.37)	4.8-5.05 (4.91±0.12)	3.92-6.32 (5.31±0.51)	4.03-5.84 (5.22±0.49)
c	3.7-4.86 (4.32±0.42)	3.5-4.12 (3.84±0.31)	12.62-18 (14.90±1.97)	8.3-15.04 (13.0±1.96)
c´	9.3-12.3 (10.2±1.44)	10-13.4 (10.6±2.46)	2.1-3.66 (3.02±0.41)	2.85-4.8 (3.37±0.43)
V%	59.4-63.2 (61.4±1.56)	…	50.3-59.6 (56.15±2.35)	…
Stylet	8-9 (8.6±0.54)	8-9 (8.3±0.57)	15-16 (15.84±0.37)	14-16 (15.65±0.58)
Greatest body width	14-17 (15.6±1.14)	13-15 (14±1)	20-22 (21.05±1.07)	18-22 (20.45±1.57)
Oesophageal length	80-90 (84.6±3.71)	83-90 (87±3.60)	100-134 (116.7±9.06)	97-133 (113.75±9.55)
Tail length	80-90 (84.6±3.71)	83-90 (87±3.60)	32-50 (41.94±4.92)	38-57 (46.9±7.68)
Anal body width	9-11 (9.8±0.83)	9-13 (10.3±2.08)	11-18 (13.73±1.52)	12-16 (14±0.97)
Lip annules	--	--	2-3 (2.157±0.45)	2-3 (2.16±0.45)
Tail annules	--	--	17-23 (17.86±2.62)	…
Lateral lines	2 (2±0)	2 (2±0)	4 (4±0)	4 (4±0)
Spicules	…	14-16 (15±1)	…	17-21 (19.5±1.19)
Gubernaculum	…	3-5 (4±1)	…	9-12 (10.65±1.18)

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