



Research Article

Description of Seven New Species and One New Record of Plant-Parasitic Nematodes (Nematoda: Tylenchida) Associated with Economically Important Crops of Kashmir Valley, Jammu and Kashmir (Part-1 of the series)

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Abstract | During the survey of soil and plant-parasitic nematodes of vegetable and fruit crops of Kashmir valley, Jammu and Kashmir, seven new species and one new record of following species were recovered: *Helicotylenchus siddiqii* sp. nov. from soil around roots of *Glycine max* L. Miller, from Kashmir University Campus, Hazratbal, Srinagar, Kashmir; *H. fotedariensis* sp. nov. from soil around roots of *Brassica oleracea* var. *botrytis* L. from Zadibal, Srinagar, Kashmir; *H. harwaniensis* sp. nov. from soil around roots of *Lycopersicon esculentum* Miller, in Harwan, Srinagar, Kashmir; *H. mushtaqi* sp. nov. from soil around roots of *Brassica oleracea* var. *capitata* L. in Darbagh, Harwan, Kashmir; *Pratylenchus badamwariensis* sp. nov. from the roots of *Prunus amygdalus* Batsch, in Badarnwari, Hawal, Srinagar, Kashmir; *Boleodorus seshadrii* sp. nov. from soil around roots of *Glycine max* (L) Miller, in Aru, Pahalgam, Jammu and Kashmir; *Macroposthonia iqbali* sp. nov. from soil around roots of *Pyrus malus* L., from Kashmir University Campus, Srinagar, Kashmir and *Pratylenchus ekrami* Bajaj and Bhatti, 1984 from the roots of *Solanum tuberosum* L. in Narwara, Srinagar, Kashmir represents a new record of this species from the State of Jammu and Kashmir. Morphological and morphometric details, line drawings along with description, characteristics, diagnosis and relationships of each new species with its closely related species are given.

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Introduction

Soil and root samples were collected and analyzed during a survey of soil and plant-parasitic nematodes of vegetable and fruit crops in Kashmir valley, Jammu and Kashmir.

During the surveys, the senior author encountered

several new species belonging to orders Tylenchida and Dorylaimida. Among them, some of the new species of order Tylenchida are described herein as part 1 of the 2 series of manuscripts compiled, that include the following species: *Helicotylenchus siddiqii* sp. nov. from soil around roots of *Glycine max* (L.) Miller, from Kashmir University Campus, Hazratbal, Srinagar, Kashmir; *H. fotedariensis* sp. nov. from soil

around roots of *Brassica oleraceae* var. *botrytis* (L.), in Zadibal, Srinagar, Kashmir; *H. harwaniensis* sp. nov. from soil around roots of *Lycopersicum esculentum* Miller, in Harwan, Srinagar, Kashmir; *H. mushtaqi* sp. nov. from soil around roots of *Brassica oleracea* var. *capitata* (L.), in Darbagh, Harwan, Kashmir; *Pratylenchus badamwariensis* sp. nov. from the roots of *Prunus amygdalus* Batsch, in Badarnwari, Hawal, Srinagar, Kashmir; *Pratylenchus ekrami* Bajaj and Bhatti, 1984 from the roots of *Solanum tuberosum* (L.), from Narwara, Srinagar, Kashmir represents a new record of this species from the State of Jammu and Kashmir; *Macroposthonia iqbalii* sp. nov. from soil around roots of *Pyrus malus* L., from Kashmir University Campus, Srinagar, Kashmir and *Boleodorus sheshadrii* sp. nov. from soil around roots of *Glycine max* (L) Miller, in Aru, Pahalgam, Jammu and Kashmir. This is a first extensive report on nematodes known to be associated with several economically important vegetables and fruit crops of Kashmir valley, Jammu and Kashmir. A few earlier reports of nematodes in the region dealt primarily with individual species (Fotedar and Handoo, 1974, 1977, 1978a, b, 1979; Fotedar and Kaul, 1985; Handoo, 1977, 1980, 1983; Handoo and Shahin, 1980; Waliullah, 1989). The objectives of this study were (1) to organize a survey so as to more fully characterize, identify and describe nematodes associated with vegetable and fruit crops in Kashmir valley; (2) provide more extensive distribution of genera and species of nematodes, and (3) document their presence to establish their pest status that may have a significant impact on agriculture in the region.

Material and Methods

During surveys of soil and plant-parasitic nematodes, three-inch core soil and root samples were collected and analyzed from vegetable and fruit crops in Kashmir valley, Jammu and Kashmir. Soil samples were collected from time to time from around the roots of fruit trees and vegetable crops. Samples from superficial layers were collected with the help of a borer having 1 inch bore. Usually 3 or 4-inch-deep samples from the field were combined and processed in the laboratory. Soil samples from deeper layers particularly in case of fruit trees were collected by digging the ground with the help of a spade and soil collected with the trowel. Each sample consisted of 5-6 sub samples and the selection of samples were mainly from around the roots. A high number of nematode fauna was separated from soil

by sieving and Baermann funnel extraction, fixed in 3% formaldehyde and processed to glycerin by the formalin glycerin method (Hooper,1970). Line drawings were drawn while looking the specimens on a compound microscope with prism attached to 10x eye piece drawn at 100x objective. All measurements are in micrometers, unless otherwise stated.

Helicotylenchus siddiqii sp. nov.
(Figure 1A-E)

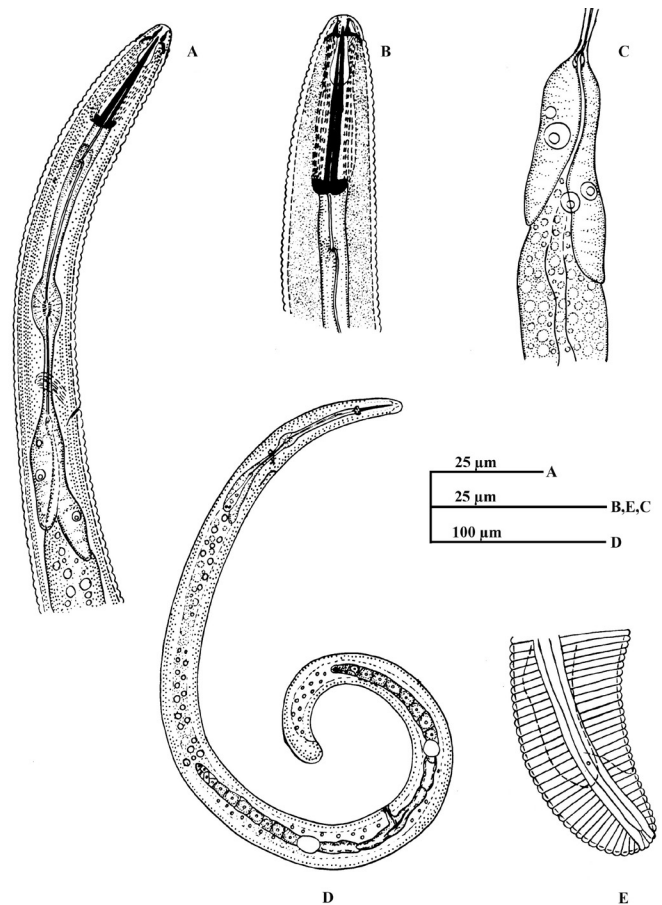


Figure 1: *Helicotylenchus siddiqii* sp. nov. A: Oesophageal region of female; B: Anterior end of female; C: Basal bulb of oesophagus; D: Entire female; E: Tail region female.

Measurements

Female (Holotype): L= 0.62 mm; a= 24.8; b= 5.1; c= 41.3; V= 68%; stylet= 23 µm.

Females (9 paratypes): L= 0.59-0.64 mm; a= 22.1-25.5; b= 4.9-5.8; c= 40-42.7; V= 67-69%; stylet= 23-24 µm.

Description

Female: When killed, the nematodes assume a single spiral shape, the curvature being very strong in the posterior third region of body, especially behind vulva. Body tapers in the anterior region from base of neck

to a conoid head, which measures slightly more than half of the body width at the level of median bulb. Cuticle transversally striated, each stria measuring 1.7 μm at mid body. Lateral field marked by four incisures. The head conoid to truncate with indistinct striations, continuous with the body contour. Labial sclerotization hexa-radiated, not very strong, with lateral margins extending to about two body annules. Vestibulum forms an inverted funnel shaped stylet guide extending up to 6 annules into body. Stylet robust, measuring 23 μm in length. Metonchium measures 12 μm and the telonchium measures 11 μm in length. Basal knobs of the stylet anteriorly cuped. Orifice of dorsal oesophageal gland located at 8 μm behind stylet base. Procorpus cylindrical measures 36 μm in length and 5 μm in width. Metacorpus well-developed, measuring 13x8 μm , filling more than half of the corresponding body width, and extends up to 7 body annules. Nerve ring located at 85 μm from anterior end enveloping the isthmus which measures about 18 μm in length.

Excretory pore located at 90 μm from anterior end and at level with the oesophago-intestinal junction. Hemizonid absent. Terminal bulb ventro laterally enveloping anterior part of intestine. Four gland nuclei observed in the oesophageal overlap.

Vulva, a transverse slit. Vagina at right angles to the body axis with slightly protruded lips. Vulval membrane present. Uteri has offset empty spermatheca. Tail dorsally convex with a bluntly rounded terminus and regularly striated, with six (6-8 in paratypes) striae in the tail on ventral side. Phasmids located at 3 annules anterior to anus. The lateral field merges with the tail striations.

Male: Not found.

Type specimens: Holotype female on Slide No. PN/Hel/9 at Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir, and paratype females on Slide No; PN/Hel/10-12 deposited at same location as above.

Type host and locality: Specimens were collected from soil around roots of *Glycine max* (L.) Miller from Kashmir University Campus, Hazratbal, Srinagar, Kashmir.

Diagnosis and relationship

When compared with the existing species of the

genus the present form comes close to *H. digonicus* Perry *et al.* (1959), *H. delbiensis* Khan and Nanjappa (1970) and *H. canadensis*. It differs from *H. digonicus* by shorter stylet, shape of tail, position of vulva, and by faintly striated lip region.

It can easily be differentiated from *H. delbiensis* by longer stylet, shape of lip region, location of vulva and phasmid and by having the lateral lines extending to the tail region. It can be distinguished from *H. canadiensis* Waseem, 1961 by smaller body size, smaller a, b, and c values, shorter stylet, more posterior position of vulva, position of phasmid and presence of distinct lip annules. In view of the above differences, the present form is considered herein to constitute the new species for which the name *H. siddiqii* is proposed.

Helicotylenchus fotedariensis sp. nov.
(Figure 2A-D)

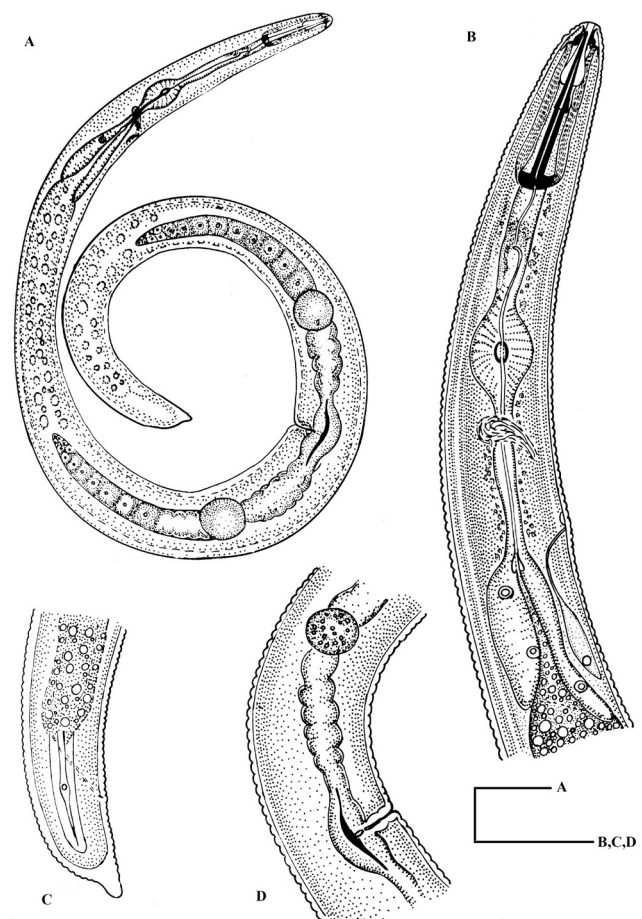


Figure 2: *Helicotylenchus fotedariensis* sp. nov. A: Entire female; B: Oesophageal region of female; C: Tail region of female; D: Vulval region showing gonad.

Measurements

Female (Holotype): L=0.59; a=21.1; b = 4.6; c=32.7;

V=62 %; stylet=27 μ m.

Female (11 paratypes): L=0.51-0.62 mm; a=20.9-22.1; b=4.2-5.2; c=31.4-33.5; V= 60-62%; stylet=26-28 μ m.

Description

Female: Body cylindrical, ventrally strongly arcuate, forming an almost double spiral when killed in hot water. Anteriorly, it tapers from base of neck in front region to head, which becomes about slightly less than $1/3^{\text{rd}}$ as wide as body in the region of metacarpus. Cuticle finely striated, each stria measuring about 1.4 μ m apart at mid body. Lateral field measures slightly less than $1/5^{\text{th}}$ of body width at mid body and is marked by 4 incisures. Lateral field originates from the base of metonchium, distinctly areolated up to the metacarpal region. Head not strongly conoid bearing 4-5 faint striations. Labial frame work moderately cuticularized, hexaradiated, with its outer margins extending 3 annules in the body. Vestibulum inverted funnel like structure extends up to 12 μ m from anterior end. Protractor muscles of the stylet attached to stylet guide. Strong and well-developed stylet, measures 27 μ m in length, with metonchium being 14 μ m and telonchium 13 μ m in length. Orifice of dorsal oesophageal gland located at 10 μ m behind stylet base. Basal knobs of stylet anteriorly cupped, indented, measuring 5 μ m across. Procorpus cylindrical tube measures 62 μ m in length and 5 μ m wide. Metacarpus strongly developed, measuring 25 x 9 μ m in dimension i.e., and occupying more than half of corresponding body width. Cuticular thickening of intermediate bulb prominent. Isthmus cylindrical measures 25 μ m in length and 4 μ m broad, enveloped by nerve ring located in anterior half of the isthmus. Excretory pore located almost at level with oesophago-intestinal-junction. Hemizonid weakly developed, anteriorly adjacent to excretory pore. Basal oesophageal bulb envelops the intestine ventro laterally; 3 gland nuclei observed.

Vulva depressed with a transverse slit. Vagina located at right angles to body axis. Uteri with columellate part distally continuous with a rounded spermatheca filled with rounded sperms. Ovaries paired and outstretched, with ovocytes mostly in double rows. Gonads didelphic and symmetrical.

Tail dorsally convex conoid with a digitate unstriated tail terminus. Tail length more than one anal body widths, bearing 12 striae on its ventral sides, with

terminal striae not of uniform width. Phasmid located at level of anus. Outer incisures of lateral field fusing in anterior half of tail.

Male: Not found.

Type specimens: Holotype female on Slide No. PN/Hel/13 and paratypes females on slide nos. PN/Hel/14-16 deposited at Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Jammu and Kashmir.

Type host and locality: Specimens were collected from soil around roots of *Brassica oleraceae* var. *botrytis* L. from Zadibal, Srinagar, Kashmir.

Diagnosis and relationship

Helicotylenchus fotedariensis sp. nov. is distinctive by having conoid head with 4-5 faint striations, stylet measuring 26-28 μ m, continuous rounded spermatheca filled with minute sperms and dorsally convex conoid tail with a digitate unstriated tail terminus. However, it comes close to *H. crenacauda* Sher, 1966, *H. tropicus* Roman, 1965 and *H. dibytera* (Cobb, 1893; Sher, 1961). It differs from *H. crenacauda* by the shape of lip region. Oesophago intestinal junction at level of excretory pore as opposed to the one anteriorly located in *H. crenacauda*, shape of the tail and by the position of phasmid. It differs from *H. tropicus* by the shape of lip region, number of labial striations in the lip region, in stylet length, position of hemizonid, position of phasmid, fusion of lateral field and by the tail shape. It is also differentiated from *H. dibytera* by the shape of lip region, lesser a, b and c values, in having offset spermatheca without sperms and position of phasmid. In view of the above differences, the present form is considered herein to constitute a new species for which the name *Helicotylenchus fotedariensis* is proposed.

Etymology: The species name is given in honor of Former Head of the Post Graduate Department of Zoology, University of Jammu and Kashmir for his outstanding service to the Department as well as his contributions to our knowledge of Zoology.

Helicotylenchus harwaniensis sp. nov.
(Figure 3A-F)

Measurements

Female (Holotype): L=0.80mm; a=27.5; b=4.7;

c=26.6; V= 60%; stylet= 31µm

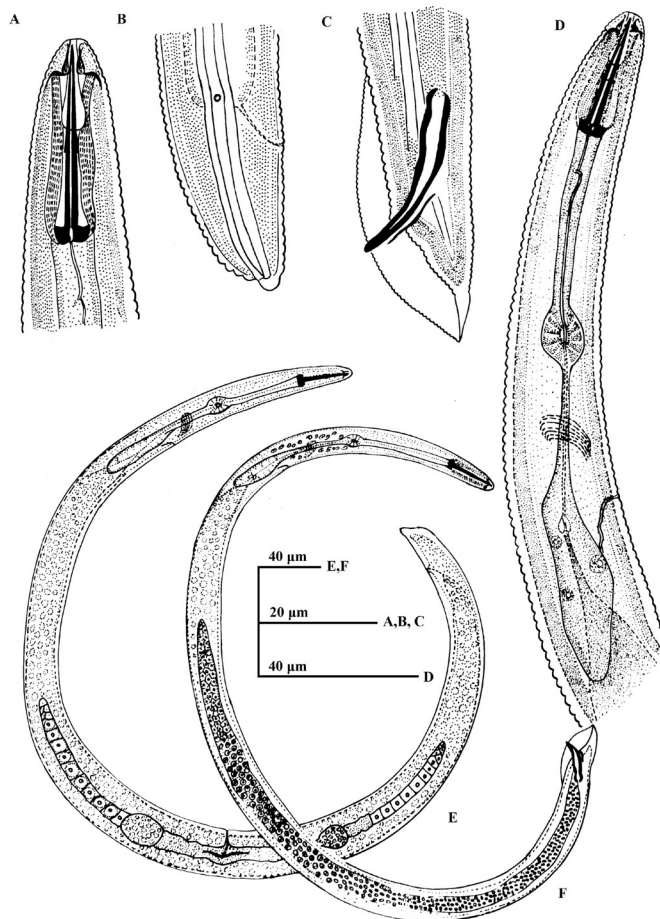


Figure 3: *Helicotylenchus barwanensis* sp. nov. A: Anterior end of female; B: Tail region of female; C: Tail region of male; D: Oesophageal region of male; E: Entire female; F: Entire male.

Females (8 paratypes): L = 0.80-0.85 mm; a = 27.5-29; b = 4.7-4.9; c = 26.6-32.3; v = 59-61%; stylet = 30-32 µm.

Male (Allotype): L=0.72; a= 32.6; b=4.1; c= 38; spicule= 30µm; gubernaculum= 12µm; stylet=31µm.

Male (2 paratypes): L= 0.72-0.76mm; a = 32.6-33.7; b= 4.1-4.7; c= 35-38; spicule= 30-32µm; gubernaculum= 10-12 µm; stylet= 30-31 µm.

Description

Female: Body cylindrical takes a strong ventral curvature assuming the shape of a close “C”. (Paratypes sometimes assume single spiral). Body tapers from the base of the neck gradually into a sharply conoid truncate head, measuring about slightly half of body width at median oesophageal bulb. Labial sclerotization strongly developed and hexaradiate, with lateral margins extending up to 3 body annules posteriorly. Body cuticle coarsely striated, each striae

measuring 1.8 µm at mid body. Lateral field marked by 4 incisures occupying about 1/3rd of body width at mid body. Head conoid, truncated, measuring 10x5 µm in dimension, and marked by six distinct striations. Vestibulum forms an inverted funnel like stylet guide, extending up to 8 body annules posteriorly. Stylet strongly developed, measuring 31 µm in length; its anterior part measures 17 µm in length. Basal knobs of the stylet well developed and anteriorly cupped. Orifice of dorsal oesophageal gland located at 10 µm from base of stylet knobs. Procorpus cylindrical measures 45 µm in length, its maximum width being 7 µm. Median oesophageal bulb well developed and about half of corresponding body width, and measures 16x10 µm in dimension extending up to 9 annules. Isthmus cylindroid, narrower than procorpus, and enveloped by nerve ring at about middle of its length. Excretory pore at level of oesophago-intestinal junction. Hemizonid not seen. Oesophageal gland lobe looks like enveloping intestine dorso-laterally.

Vulva, a transverse slit. Vagina at right angles to body axis, measuring slightly more than half of body width in depth. Uteri with oval rounded spermatheca filled with minute rounded sperms. Both branches of reproductive organs equally developed. Tail straight with the slight dorsal curvature bearing 15 annules on the ventral side. Phasmid located at sixth annule anterior to anus. Lateral field fusing with the terminal tail striations.

Male: Body “C” shaped, smaller than the female. Transverse striae of cuticle measuring 1.7 µm apart at mid body. Head and oesophagus same as described for female.

Testes single, anteriorly outstretched on right side of intestine. Spicule paired, similar, ventrally arcuate. Spicule measuring 30 µm in length. Gubernaculum simple, measuring 12 µm in length. Tail tapering to a ventrally somewhat off-set, subacute terminus.

Type specimens: Holotype female on Slide No: PN/Hel/1 and paratype females on slide no. PN/Hel/2-3 deposited at the Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir.

Male allotype os slide no. PN/Hel/4 and paratype males on slide no. PN/Hel/5 deposited at the same

location as above.

Type host and locality: Specimens were collected from soil around roots of *Lycopersicum esculentum* Miller from Harwan, Srinagar, Kashmir.

Diagnosis and relationship

H. harwaniensis n. sp., is distinctive by having sharply conoid truncate head with six distinct annules, stylet well-developed measuring 31 µm in length, absence of hemizonid, straight tail with short projection at tip bearing 15 annules and lateral fields fusing with the tail annules. It is similar to *H. exallus* Sher, 1966 except that it has a longer stylet, a lip region with a truncated shape (hemispherical in *H. exallus*), 6 lip annules as opposed to 4 in *H. exallus*, shape and number of annules of tail. Tail straight with short projection bearing 15 annules (12 in *H. exallus*) and by the fusion of lateral fields with the tail annules. *H. harwanensis* can also be distinguished from the closely related *H. minzi* Sher, 1966 by longer stylet, lesser b and c values, position of excretory pore and in lesser number of tail annules. In view of the above differences the present form is considered herein to constitute a new species for which the name *H. harwanensis* is proposed.

Etymology: The species name refers to the type locality Harwan, Srinagar, Kashmir.

Helicotylenchus mushtaqi sp. nov.
(Figure 4 A-E)

Measurements

Female (Holotype): L= 0.68 mm; a= 23.4; b= 4.6; c= 48.3; V= 63%; stylet= 25 µm.

Female (10 paratypes): L= 0.66-0.69 mm; a= 22.1-24.2; b= 4.1-5.7; c= 45.1-48.3; V = 62-63%; stylet= 24-26 µm.

Description

Female: Body cylindrical, ventrally forming a single spiral "C" when relaxed in hot water. Anteriorly it tapers regularly in front region to head, slightly less than 1/3rd as wide as body at median oesophageal bulb. Body cuticle finely striated, each stria measuring about 1.4 µm at mid body. Lateral field marked by 4 distinct incisures, occupying slightly more than 1/3rd of body width at mid body. Head conoid truncated, almost continuous with body contour. Labial striations indistinct. Labial framework strongly cuticularized

and hexaradiated, with its outer margin extending to about 1 body annule. Vestibulum forms an inverted funnel shaped stylet guide, which extends up to 8 body annules posteriorly.

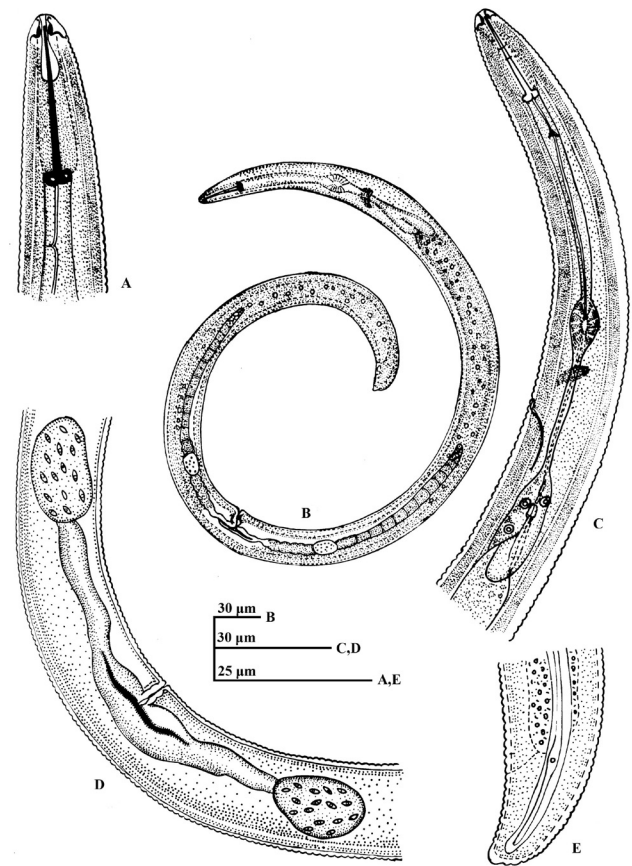


Figure 4: *Helicotylenchus mushtaqi* sp. nov. A: Anterior end of female; B: Entire female; C: Oesophageal region of female; D: Vulval region showing gonads; E: Tail region of female.

Stylet well developed, measuring 25 µm in length; its anterior part slightly larger than the posterior part. Basal knobs rounded, flattened, measuring about 5 µm across. Orifice of dorsal oesophageal gland located at about 11 µm posterior to basal knobs. Oesophagus with a cylindrical procorpus measures 52 µm long x 6 µm wide; median oesophageal bulb measures 14 x 9 µm in dimension, extending up to about 11 annules. Cuticular thickening of median oesophageal bulb not very prominent. Isthmus cylindrical, but narrower than the procorpus, enveloped by the nerve ring in its anterior half, joining the intestine through a rounded valvular junction. Excretory pore located at about 108 µm from anterior end. Hemizonid, found one annule anterior to excretory pore. Oesophageal gland lobe like; its overlap being dorsolateral.

Vulva, a transverse slit. Vagina found at right angle to body axis. Uteri has a proximal muscular and

distinct columnal part, with oval spermatheca containing minute rounded sperms. Ovary paired and outstretched. Phasmid located at anal altitude. Tail dorsally convex conoid with a bluntly acute terminus.

Male: Not found.

Type specimens: Holotype female on slide no. PN/Hel/8 and paratype females on slide no. PN/Hel/5-7 deposited at the Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir.

Type host and locality: Specimens were collected from soil around roots of *Brassica oleracea* var. *capitata* L. from Darbagh, Harwan, Kashmir.

Diagnosis and relationship

When compared with existing species of the genus the present form comes close to *H. exallus* Sher, 1966 and *H. harwaniensis* n. sp. It differs from *H. exallus* by the shape of lip region and indistinct striations on lip, position of phasmid which is at anal latitude as against 3-5 annules anterior to anus in *H. exallus*. It can be differentiated from *H. harwaniensis* by nature of striations on lip; deeply striated in *H. harwaniensis*, having 6 striations as compared to indistinct striations in the new species. Hemizonid, present in *H. mushtaqi* and absent in *H. harwaniensis*. Other differences include position of phasmid (anal latitude in present as against 6 annules anterior to anus in *H. harwaniensis*) and in shape of tail being dorsally convex conoid with a bluntly acute terminus vs straight with the slight dorsal curvature in *H. harwaniensis*. In view of the above differences the present form is considered herein to constitute a new species for which the name *H. mushtaqi* is proposed.

Etymology: The species name is given in honor of senior author's brother Dr. Mushtaq Ahmad Handoo, for his outstanding service and contributions to the Medicine in the United States.

Pratylenchus ekrami Bajaj and Bhatti, 1984 (Figure 5A-G)

Measurements

Female (7 paratypes): L= 0.43-0.51mm; a= 31-36; b= 4.0-5.2; c= 21.3-23.2; V= 78-80%; stylet= 13-14 µm.

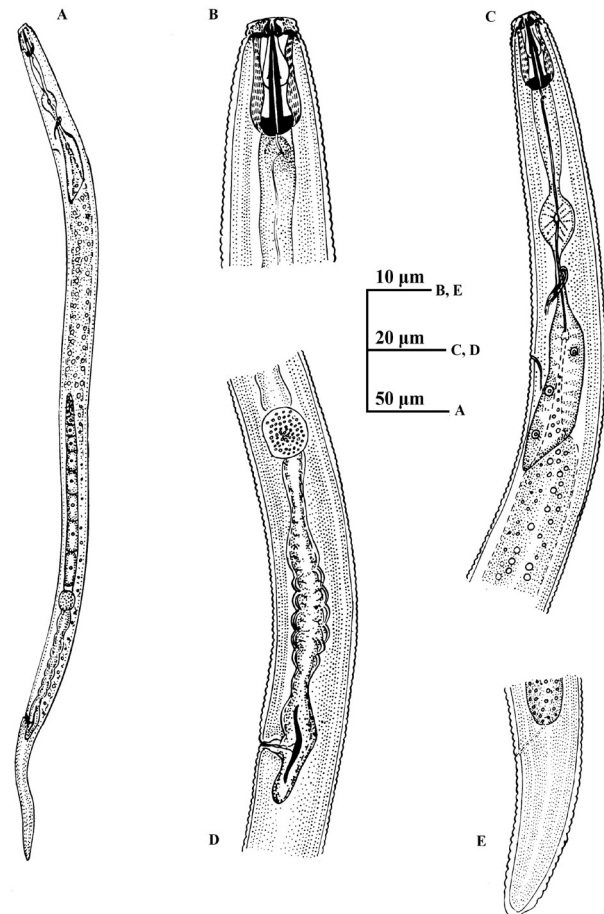


Figure 5: *Pratylenchus ekrami* Bajaj and Bhatti, 1984. A: Entire female; B: Anterior end of female; C: Oesophageal region of female; D: Anterior end of male; E: Vulval region showing anterior gonad; F: Tail region of female; G: Tail region of male.

Male (1 paratype): L= 0.49; a= 35; b=4.7; c= 22.7; stylet= 14 µm; spicule= 17 µm; gubernaculum= 6 µm.

Description

Female: Body cylindrical, slender tapering slightly from mid body to a flat head. When killed, the body assumed “J” shape. The ventral arcuate more in posterior third region of body. Lateral field originates in the region of procorpus assuming a maximum width of 1/3rd the corresponding body width at mid body, marked by 4 incisures. The outer ones slightly crenate.

Head low and massive, flattened anteriorly, set off from the body by distinct depression, and marked by 3 labial annules. Lateral margins of cephalic sclerotization extend to about 2 annules into the body. Stylet well developed (13-14 µm) and made up of 2 parts (while the anterior part measures about 8 µm in length with rounded basal knobs measuring 3 µm across. Excretory pore located at 73 µm from anterior end and slightly posterior to oesophago-intestinal

junction. Hemizonid not seen. Nerve ring located at 53 μm from anterior end. Procorpus a cylindrical tube measuring 28 μm in length and 3 μm in wide. Median oesophageal bulb measures 12 x 9 μm in dimension and has a powerful valve in the middle region. Isthmus short measures 12 μm in length distally forming overlapping lobe like oesophageal bulb which overhangs the intestine on the ventro-lateral side. Three distinct gland nuclei have been observed in the oesophageal overlap.

Vulva, a depressed transverse slit. Vagina extends to a little less than one third of the corresponding body width into the body. Uteri has a muscular reniform region continuing distally into the columellate region, the later bearing a distinct oval off-set spermatheca filled with minute sperms. Oocytes mostly in a single row. Ovary single and anteriorly outstretched. Post-uterine sac little over one vulvar body width in length without rudimentary posterior ovary. Tail an elongated conoid with a subacute unstriated terminus measuring 2 anal body width in length, and bears about 24 fine striations on ventral side.

Male: Slightly slender than the female. Head comparatively much higher than the females, otherwise resembles female in general body morphology except gonads. Testis outstretched with spermatocytes arranged in single row. Spicule arcuate measuring 17 μm and gubernaculum measuring 6 μm in length.

Specimens of female and male paratypes on slide no. PN/Praty/1-3 deposited at the Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir.

Remarks

Morphological and morphometric characters of the specimens, collected from the roots of *Solanum tuberosum* L. from Narwara, Srinagar, Kashmir, correspond well to the original description and measurements of *Pratylenchus ekrami* given by [Bajaj and Bhatti, 1984](#) with slight variations in some characters: Body assumed "J" shape when killed vs C shaped body; distinct oval spermatheca with minute sperms vs elongate-oval spermatheca filled with sperms; 24-25 tail annules vs 20-40 annuli in tail. It represents a new record of this species in the State of Jammu and Kashmir.

Pratylenchus badamwariensis sp. nov.
(Figure 6A-E)

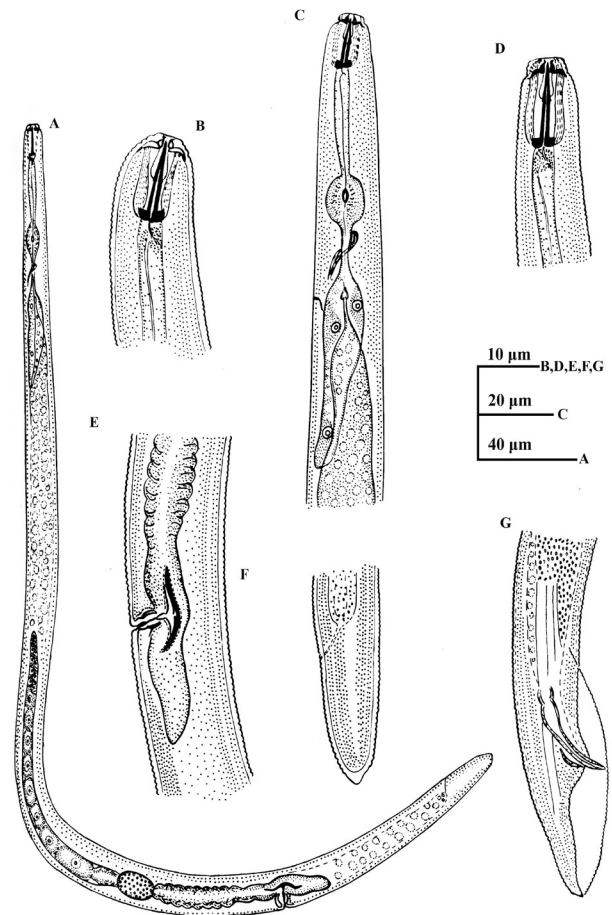


Figure 6: *Pratylenchus badamwariensis* sp. nov. A: Entire female; B: Anterior end of female; C: Oesophageal region of female; D: Vulval region of female showing anterior gonad; E: Tail region of female.

Measurements

Female (Holotype): L= 0.54 mm; a= 25; b= 4.9; c= 20.7; V= 77%; stylet= 16 μm .

Female (11 paratypes): L= 0.54-0.59mm, a= 24-26; b= 4.9-5.7; c= 20.5-21.3; V= 76-77%; stylet = 16-17 μm .

Description

Body only slightly arcuate after being killed by hot water with a cylindrical, slightly tapered anteriorly to form a low flat head. Posteriorly behind the vulva the reduction in the body width is gradual to form the tail. Body annulations coarse. Each stria 1.6 μm apart at mid body. Lateral field originates in the region of procorpus, assuming a maximum width of 1/3rd body width at mid body, marked by five to six incisures, one of which occasionally gets fused in the region of vulva.

Head low and massive, offset from the body contour, bearing 2 unequal annules, the anterior one larger.

Head measures 8 x 3 μm in dimension i.e., 1/2 of the body width at metacarpus. Labial sclerotization strongly developed, with lateral margins extending to about 2 annules into the body. Stylet well-developed measuring 16 (16-17) μm in length, with anterior portion measuring about 7 μm and the posterior being slightly longer and measuring 9 μm in length. Stylet knobs massive and anteriorly cupped, measuring 5 μm across. Orifice of dorsal oesophageal gland located at 4 μm posterior to base of stylet knobs. Vestibulum forms an inverted funnel like stylet guide, extending up to 11 μm from anterior end. Procorpus cylindrical tube measures 25 μm in length and is about 4 μm in width. Metacarpus located at 44 μm from anterior end, oval in shape, measuring 8 μm x 5 μm . Isthmus cylindrical, 10 μm in length, ending into overlapping oesophageal bulb which overhangs intestine ventro laterally. Oesophago-intestinal-junction located at about 4 μm anterior to excretory pore. Nerve ring located at 42 μm from anterior end, excretory pore located 12 μm posterior to nerve ring.

Vulva, a depressed transverse slit. Vagina has newly developed lips. Lateral vulval membrane absent. Uteri has a muscular part, distally continuous with columellate region, the later having at its distal end an oval rounded continuous spermatheca filled with sperms. Gonads single, anteriorly outstretched. Oocytes mostly arranged in single a row. Post-uterine branch small and undifferentiated, measuring less than one vulval body width in length. Tail elongated and cylindrical, measuring slightly more than two anal body widths in length, bearing 17 annules on its ventral side. Tail tip smooth and sub-acute. Phasmid located slightly anterior to middle of tail. Lateral field in tail aerolated and continues up to tail terminus.

Male: Not found.

Type specimens: Holotype female on slide no. PN/Praty/7 and paratype on slide no. PN/Praty/5-6 deposited at the Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir.

Type host and locality: Specimens were collected from the roots of *Prunus amygdalus* Batsch. From Badarnwari, Hawal, Srinagar, Kashmir.

Diagnosis and relationship

Pratylenchus badamwariensis sp. nov. is distinctive by

having flat head, offset from the body contour. The head bears two unequal annules with a larger anterior one. Lateral field 5-6 incisures, one of which gets fused in region of vulva. Tail tip smooth and sub-acute. *Pratylenchus badamwariensis* sp. nov. comes close to *P. loosi* Loof, 1960 from which it differs by having a robust body (a= 24-26 vs 28-36), coarse body striations, anteriorly located vulva, and by the presence of shorter tail. It also comes close to *P. macrostylus* Wu, 1971 with some variations. Stylet small, anteriorly located vulva, location of hemizonid and excretory pore, tail shape and tail annules (stylet= 16-17 vs 22-24 μm ; V= 76-77% vs 85-89%; hemizonid obscure vs conspicuous; excretory pore posterior to oesophago-intestinal-junction vs slightly anterior or at oesophago-intestinal junction; tail= elongate, cylindrical vs conoid; tail annules= 16-17 vs 17-26; male= absent vs present). In view of the above differences, the present form is considered here to constitute a new species for which the name *Pratylenchus badamwariensis* sp. nov. is proposed.

Etymology: The species name refers to the type locality Badamwari, Kashmir.

Boleodorus seshadrii sp. nov.

(Figure 7A-E)

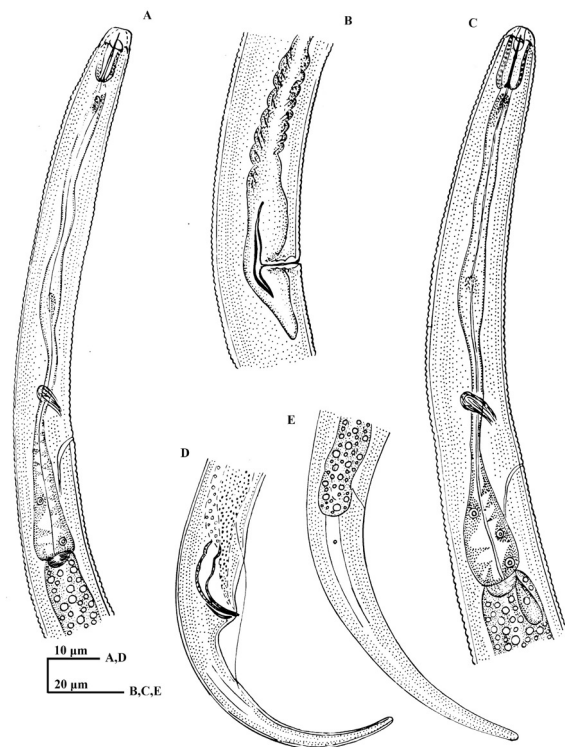


Figure 7: *Boleodorus seshadrii* sp. nov. A: Oesophageal region of male; B: Vulval region showing posterior uterine sac; C: Anterior end of female; D: Tail region of male; E: Tail region of female showing phasmid.

Eleven females and three males were recovered from soil around roots of *Glycine max* (L) Miller from Aru, Jammu and Kashmir. These are considered herein to constitute new species.

Measurements

Female (Holotype): L= 0.43 mm; a= 29.3; b= 4.7; c= 7.5; V= 68%; stylet= 12 μ m.

Female (10 paratypes): L= 0.41-0.51mm; a= 28.2-29.4; b= 4.2-4.9; c= 6.0-8.1; V= 67-68%; stylet= 12-13 μ m.

Male (Allotype): L=0.45 mm; a= 28.1; b= 4.11; c= 9.1; stylet= 17 μ m; gubernaculum= 5 μ m.

Description

When killed by hot water body assumes an open "C" shape. Body tapers at either ends anteriorly from neck base to a conoid head, while posteriorly behind vulva to arcuate tail with a rounded terminus. Body cuticle finely striated, each stria measuring about 0.7 μ m apart at mid body (.07-1 μ m in paratypes). Lateral field arises in the region of anterior half of procorpus, assuming a maximum width of about 1/4th of body width at mid body, having 4 refractive incisures in two bands. Head conoid, with distinctly converging lateral sides, ends with a flat, slightly depressed contour. Lip region continuous with body, not striated. Labial sclerotization weak. Lateral margins not distinct. Vestibulum forms a small inverted funnel shaped stylet guide, extending about 4 μ m from head end. Stylet slender measures 12 μ m in length, anterior region measuring 5 μ m, whereas the posterior part measures 7 μ m in length and distally provided with inverted Y shaped knobs with thickened arms. Opening of dorsal oesophageal gland located at about 3 μ m behind stylet base. Procorpus cylindrical tube measures 28 μ m in length having a maximum width of about 4 μ m, distally continuing with a fusiform valveless spindle shaped swelling slightly wider than procorpus. Isthmus slightly set off from the anterior fusiform structure and measures about 25 μ m in length, ending distally into a cylindrical basal oesophageal bulb, the later measuring about 22 μ m and assuming maximum width of 10 μ m with two gland nuclei. Nerve ring located at about middle of isthmus, excretory pore located 11 μ m behind nerve ring. Excretory duct fairly cuticularized, convoluted, ending into a renette cell located behind the cardia. Hemizonid not seen. Basal bulb and part of isthmus enclosed in a clear area.

Vulva transverse slit with lateral vulval membrane. Vagina found at right angles to body axis extending across 1/3rd of body. Post uterine sac small, less than one vulval body in length. Uteri has a muscular part continuing distally into a columellate region, the latter with a set off oval spermatheca filled with minute sperms. Ovary single, short, anteriorly outstretched with oocytes in multiple rows. Tail dorsally curved with elongated ending to a rounded terminus. Tail measures about 5½ times the anal body width, striated uniformly till the tip. Phasmid located about one anal-body-width behind anus.

Male: Body shape smaller than that of female. Head more elevated and broader, measuring 5 x 5 μ m in dimension. Amphid broad over rounded slit, measuring 2 μ m across. Stylet 10 μ m in length, having an inverted Y shaped base. Procorpus and fusiform valveless structure typical of female. Basal bulb more elongated and cylindrical with a slightly overlapping base. Carida small, conoid rounded. Excretory pore and nerve ring almost same as in female. Testes single, anteriorly outstretched. Spermatocytes organized in multiple rows. Spicules tylenchoid measures 17 μ m in length (across the median curved line); gubernaculum trough shaped measures about 5 μ m in length. Spicular lips raised and prominent. Tail dorsally convex, about 5 times cloaca body diameter in length, striated uniformly till the tip. Bursa adanal arises slightly anterior to head of the spicule and extends to about 1 spicular length behind the cloaca.

Type specimens: Holotype female on slide no. PN/BOL/3 and paratype females on slide no. PN/BOL/1-2 deposited at the Post Graduate Department of Zoology, University of Kashmir, Hazratbal, Srinagar, Kashmir. Allotype male on slide no. PN/BOL/4 deposited at same location as above.

Type host and locality: Specimens were collected from soil around roots of *Glycine max* (L.) Miller from Aru, Pahalgam, Jammu and Kashmir.

Diagnosis and relationship

Boleodorus seshadrii sp. nov. is distinctive from all the nominal species of genus *Boleodorus* by the inverted Y shape stylet base. However, with regards to general body morphology it comes close to *B. pakistanensis* Siddiqi, 1963; *B. azakashmirensis* Maqbool et al., 1990 and *B. teres* Nanjappa and Khan, 1970. It differs from *B. pakistanensis* in having smaller body length (L=

0.41-0.51 vs 0.54-0.58), smaller a value ($a= 28.2-29.4$ vs $31.5-34$), longer stylet (stylet= $12-13$ vs $11-12$ μm), more anterior position of the opening of dorsal gland (DGO= 3 μm vs more than 3 μm), phasmid present (Phasmid= posterior to anus vs absent). From *B. azakashmirensis* it is differentiated in the following characters: longer stylet length (Stylet= $12-13$ vs $10.5-12$ μm), more posterior position of the opening of dorsal gland (DGO= 3 vs $1.5-2.5$ μm), tail shape (Tail= elongated, dorsally curved with rounded terminus vs elongate-conoid, ventrally arcuate forming a hook). It also comes close to *B. teres* but differs from the same by finer body striations, closely located opening of dorsal oesophageal gland, longer post uterine sac and shape of the spermatheca (body striations 1.5 μm wide, opening of dorsal oesophageal gland located at 5 μm from stylet base, post uterine sac $2/3^{\text{rd}}$ body width and spermatheca rounded in *B. teres*).

In view of the above differences the present form is considered herein to constitute new species for which the name *B. seshadri* is proposed.

Etymology: The species name is given in honor of Dr. A.R. Seshadri, Former Head of the Division of Nematology, Indian Agricultural Research Institute (IARI), New Delhi, India, for his outstanding contributions to knowledge of Nematology and for providing the senior author the Lab facilities to work in the Nematology Division during the course of this study.

Macroposthonia iqbali sp. nov.
(Figure 8A-E)

Measurements

Female (Holotype): L= 0.47 mm; $a= 12$; $b=3.6$; $c= 15-17$; V= 91% ; total number of body annules= 65

Females (10 paratypes): L = $0.45-0.51$ mm; $a= 12-15$; $b = 3.6-4.3$; $c= 15-17$; V = $91-93\%$; total number of body annules = $65-72$; stylet= 70 μm .

Description

Nematode specimens when killed assume a slightly ventrally arcuate shape. Body cylindrical fusiform, tapering in the anterior region from the neck base to a flat head, which measures about $1/4^{\text{th}}$ of body at neck base. Body cuticle strongly annulated, numbering 65 ($65-72$ in paratypes), of which the first body annule has a rounded edge, whereas the rest of body annules

have retrorse. The outer margins of annules have slightly coarse and rough margins. Head annule single measures 12 μm across. Labial sclerotization strongly developed. En-face view shows a centrally located “Y” shaped oral aperture enclosed in an oval labial disc, which lodges the slit like amphidial apertures on its lateral margins. Sub median lobes strongly developed, fusing on the dorsal and ventral slides. Stylet robust measures 70 μm in length, the anterior part measuring 55 μm in length, whereas posterior part considerably smaller and measures only 15 μm in length. The later bears distally well-developed anchor shaped stylet knobs measuring 11 μm across. Oesophagus typical criconematid. Basal bulb measures 32×22 μm in dimension with strongly developed cuticularized valve and convoluted oesophageal gland lumen. The opening of dorsal oesophageal gland located at about 7 μm behind base of stylet. Isthmus indistinguishable. Basal bulb spatulated. Nerve ring located at about 110 μm from anterior end i.e., on the 16^{th} body annule. Excretory pore located on the 18^{th} body annule with one annule anterior to oesophageal base. Cardia small rounded.

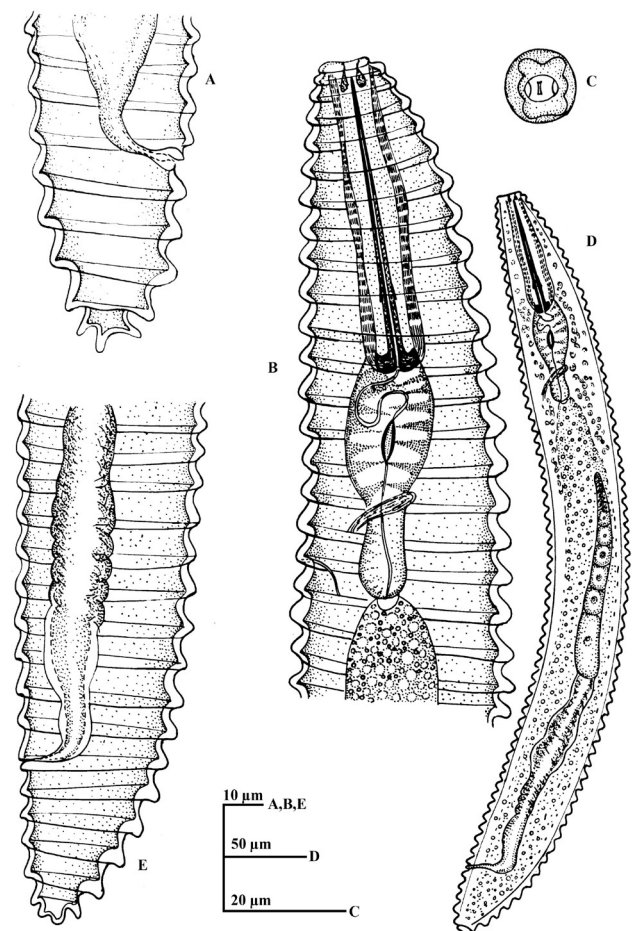


Figure 8: *Macroposthonia iqbali* sp. nov. A: Female tail lateral view; B: Anterior end of female; C: En-face view of female; D: Entire female; E: Female tail lateral view.

Vulva, a transverse slit with open lips located on 6th annule (5-6 in paratypes) from tail terminus. Vagina sigmoid. Uterus continues distally into a columellae region. Spermatheca not seen. Ovary single, anteriorly outstretched. Oocytes mainly in single row. Body gradually tapers behind the vulva to a conoid rounded tail. Tail has a button like terminus.

Male: Not found.

Type specimens: Holotype female on slide no. PN/MAC/4 in author's collection and paratype females on slide no. PN/MAC/1-3 deposited in the Department of Zoology, University of Kashmir.

Type host and locality: Specimens were collected from soil around roots of *Pyrus Malus* L. from Kashmir University Campus, Hazratbal, Srinagar, Kashmir.

Diagnosis and relationship

Macroposthonia iqbali sp. nov. is distinctive by having a strongly annulated cuticle numbering 65-72 annules, robust stylet measuring 70 µm in length, with well-developed anchor shaped knobs, and by the presence of a conoid rounded tail. However, it comes close to *M. similis* (Cobb, 1918), De Grisse and Loof, 1965 and *M. xenoplax* (Raski, 1952), De Grisse and Loof, 1965. From *M. similis*, the present species differs by lesser number of body annules, longer stylet, location of vulva (body annules 90-100; stylet 60-64 µm and vulva on 7th annule in *M. similis*). From *M. xenoplax* it can easily be differentiated by lesser number of body annules and in the shape of the sub-median lobes (annules 87-100; sub-median lobes separate in *M. xenoplax*). In view of the above differences the present form is considered herein to constitute a new species for which the name *M. iqbali* is proposed.

Etymology: The species name is given in honor of the senior author's brother Dr. Mohammad Iqbal Handoo, Former Director of Agriculture, for the state of Jammu and Kashmir, for his outstanding contributions to knowledge of Agriculture and who inspired the senior author to peruse the Ph. D studies.

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Novelty Statement

Current manuscript describes seven new plant parasitic nematodes of agricultural importance from Kashmir Valley. This discovery is significant because new morphological information obtained from these new species will facilitate future identifications of these plant-parasitic nematodes. This report will serve as a useful guide to researchers and diagnosticians identifying important nematodes from the various nematode genera.

Authors Contribution

Zafar Ahmad Handoo, collection and description of the species. Mihail Radu Kantor and Ekramullah Khan, figures and text editing.

Conflict of interest

The authors have declared no conflict of interest.

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