



## Neotropical Helminthology



ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

### CAUDOTYLENCHUS INDICUS N. GEN., N. SP. (NEMATODA: TELOTYLENCHIDAE) ASSOCIATED WITH BANANA PLANT FROM WEST BENGAL, INDIA

### CAUDOTYLENCHUS INDICUS N. GEN., N. SP. (NEMATODA: TELOTYLENCHIDAE) ASOCIADO CON PLANTA DE BANANO DE BENGALA OCCIDENTAL, INDIA

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## ABSTRACT

*Caudotylenchus* n. gen. is a newly erected nematode genus in the subfamily Telotylenchinae, Family Telotylenchidae with the type species *Caudotylenchus indicus* n. gen., n. sp. All the members belonging to this subfamily are plant-parasitic in nature and the current species has been described from West Bengal, India in association with banana (*Musa paradisiaca* L. cv Chapa). *Caudotylenchus indicus* n. gen., n. sp. is a small nematode species, measures 0.68-0.85 mm; characterized by inverted club shaped, overlapping oesophageal gland; narrow, rounded-conoid, continuous, feebly sclerotized lip region; long stylet with well-developed basal knob, symmetrical conus and straight lumen. Lateral fields are marked with five incisures; didelphic, amphidelphic ovary; transverse slit-like vulva; unannulated female tail terminus; simple bursa; and forwardly directed gubernaculum. A taxonomic key of the new genus and the compendium among thirteen genera of the subfamily are provided here.

**Keywords:** India – new genus – plant-parasite – taxonomy – Telotylenchinae

## RESUMEN

*Caudotylenchus* n. gen. es un género de nematodo nuevo elegido bajo la subfamilia Telotylenchinae de la familia Telotylenchidae con la especie tipo *Caudotylenchus indicus* n. gen., n. sp. Todos los miembros pertenecientes a esta subfamilia son parásitos de plantas en la naturaleza y la actual especie se ha descrito en Bengala Occidental, India, en asociación con el banano (*Musa paradisiaca* L. cv Chapa). *Caudotylenchus indicus* n. gen., n. sp. es una pequeña especie de nematodo, mide 0,68-0,85 mm; caracterizado por glándula esofágica superpuesta en forma de maza invertida; región labial estrecha, redondeada-conoide, continua, débilmente esclerotizada; estilete largo con protuberancia basal bien desarrollada, cono simétrico y lumen recto; campos laterales marcados con cinco incisiones; ovario didelfo, anfidelfo; vulva en forma de hendidura transversal; extremo de la cola de la hembra sin anillado; bursa simple; y gubernaculum dirigido hacia adelante. Aquí se proporciona una clave taxonómica del nuevo género y el compendio entre trece géneros de la subfamilia.

**Palabras clave:** India – nuevo género – planta-parásito – taxonomía – Telotylenchinae

## INTRODUCTION

Amongst the nematode groups, the order Tylenchida predominantly consists of plant-parasitic nematodes (PPNs) with very few entomopathogenic and free-living members. More than 600 tylenchid species belonging to 56 genera have been described or reported so far from India which is about one-third of the total (1900 species of 116 genera) known PPNs around the world (Khan, 2015). One of the major fruit crops, banana is parasitized by a large number of PPNs. From India, about 40 species have been described from the rhizospheric soil of banana. From West Bengal, five species of tylenchid nematode belonging to four genera have been described as associated with this valuable fruit crop (Roy et al., 2014).

In the present work, a full taxonomic description of a new PPN species, *Caudotylenchus indicus* n. gen., n. sp. has been given from India which is associated with banana (*Musa paradisiaca* L. cv Chapa). Here, a new genus *Caudotylenchus* n. gen. is erected to describe the new species under the subfamily Telotylenchinae. Telotylenchinae is the type subfamily of Telotylenchidae and it was established by Siddiqi (1960). Telotylenchinae is a large nematode subfamily and several different taxonomic concepts have been postulated by different authors regarding the same (Handoo et al., 2014). Fortuner & Luc (1987) recognized the following genera within the subfamily Telotylenchinae: *Tylenchorhynchus* (=

*Bitylenchus*, *Telotylenchus* Siddiqi, 1960, and six other genera), *Trophurus* Loof, 1956, *Trichotylenchus* Whitehead, 1960, *Nagelus* Thorne & Malek, 1968, *Paratrophurus* Arias, 1970, *Merlinius* Siddiqi, 1970, *Triversus* Sher, 1974, and *Amplimerlinius* Siddiqi, 1976 (Jairajpuri, 1963; Eliava, 1964; Sayer, 1966; Paramonov, 1967). However, according to Siddiqi (2000) there are twelve genera exist under the subfamily Telotylenchinae viz. *Histotylenchus* Siddiqi, 1971, *Trichotylenchus* Whitehead, 1960, *Telotylenchoides* Siddiqi, 1971, *Telotylenchus* Siddiqi, 1960, *Trophurus* Loof, 1956, *Neodolichorhynchus* Jairajpuri and Hunt, 1984, *Quinisulcius* Siddiqi, 1971, *Uliginotylenchus* Siddiqi, 1971, *Sauertylenchus* Sher, 1974, *Bitylenchus* Filipjev, 1934, *Paratrophurus* Arias, 1970 and *Tylenchorhynchus* Cobb, 1913. Reflection of all the important diagnostic characteristics of Telotylenchinae viz. annulated cephalic region; non-sclerotized to strongly sclerotized labial framework; small to moderately long stylet (11-40 µm); areolated or non-areolated lateral fields with 3 to 5 incisures; absence of post rectal sac (except *Histotylenchus* Siddiqi, 1971 and *Bitylenchus* Filipjev, 1934) in the present species along with some major unique features have led to the incorporation of a new genus, *Caudotylenchus* n. gen. under this subfamily. Detailed characteristics of *Caudotylenchus* n. gen. and its relationships with the other genera of Telotylenchinae have been elaborately cited in the discussion section.

The family Telotylenchidae also includes the other three subfamilies viz. Macrotylphurinae Fotedar and Handoo, 1978, Meiodorinae Siddiqi, 1976 and Merlininae Siddiqi, 1971 (Siddiqi, 1970). All the members of this family are commonly known as 'stunt nematodes'. They are typical plant ectoparasitic in nature and commonly feed on the root surface tissues; mainly found in vegetable fields, grasslands, and undisturbed forest soils.

## MATERIALS AND METHODS

The study was conducted in Kazidanga village (22° 55' 19.02" N; 88° 22' 19.956" E) of Chinsurah-Magra block of Hooghly district, West Bengal, India (Fig. 1). Soil samples were collected on 23<sup>rd</sup> May 2019 from the rhizospheric zone (about 10 inches depth) of Banana plantation (*Musa paradisiaca* L. cv Chapa). Nematode extraction from soil sample was done in the Ecology and Conservation laboratory of Zoological Survey of India by following Cobb's sieving technique (Cobb, 1918), using sieves with 1.18 mm and 350 BSA pore size. The decanting process was performed by Modified Baermann's funnel technique (Chirstie & Perry, 1951) and further processed by Seinhorst's slow dehydration method (Seinhorst, 1959). Dehydrated nematode specimens were mounted on a glass slide in anhydrous glycerin and sealed with purified paraffin. Taxonomic identification was done by following the identification key of Siddiqi (2000). Images and morphometric measurements were taken by using Nikon Eclipse Ni-U DIC research microscope with attached camera Nikon DS-Fi3 (C-mount 0.55X) and NIS-Elements microscope imaging software. Morphometric data were presented according to De Man's formula (De Man, 1884). Diagrams were drawn with camera lucida attachment from the same microscope. Photomicrographs were processed in Adobe Photoshop7.0. The holotype and paratypes were deposited to the National Zoological Collections (NZC) of Zoological Survey of India, Kolkata with the Registration No. WN 1950.

### Abbreviations

**a**=L/mbd; **abd**=Anal body diameter; **b**=L/Oesophageal length; **b'**=L/Distance from

head to end of oesophageal gland; **c**=L/Tail length; **c'**=Tail length/abd; **L**=Total body length; **m**=(Conus length/Stylet length)×100; **MB**=(Distance between anterior end and center of median oesophageal bulb/Oesophageal length)×100; **mbd**=Maximum body diameter; **O**=(Orifice of dorsal oesophageal gland from stylet base/Stylet length)×100; **T**=(Distance from cloacal aperture to anterior end of testis/Body length)×100; **V**=(Distance from anterior end to vulva/L)×100; **V'**=(V/distance from head to anus)×100.

**Ethical aspects:** The ethical and legal issues are not applicable.

## RESULTS

Classification has been followed here after Siddiqi, 2000

Order Tylenchida Thorne, 1949

Superfamily Dolichodoroidea Chitwood & Chitwood, 1950

Family Telotylenchidae Siddiqi, 1960

Subfamily Telotylenchinae Siddiqi, 1960

*Caudotylenchus* n. gen.

*Caudotylenchus indicus* n. gen., n. sp.

### Diagnosis

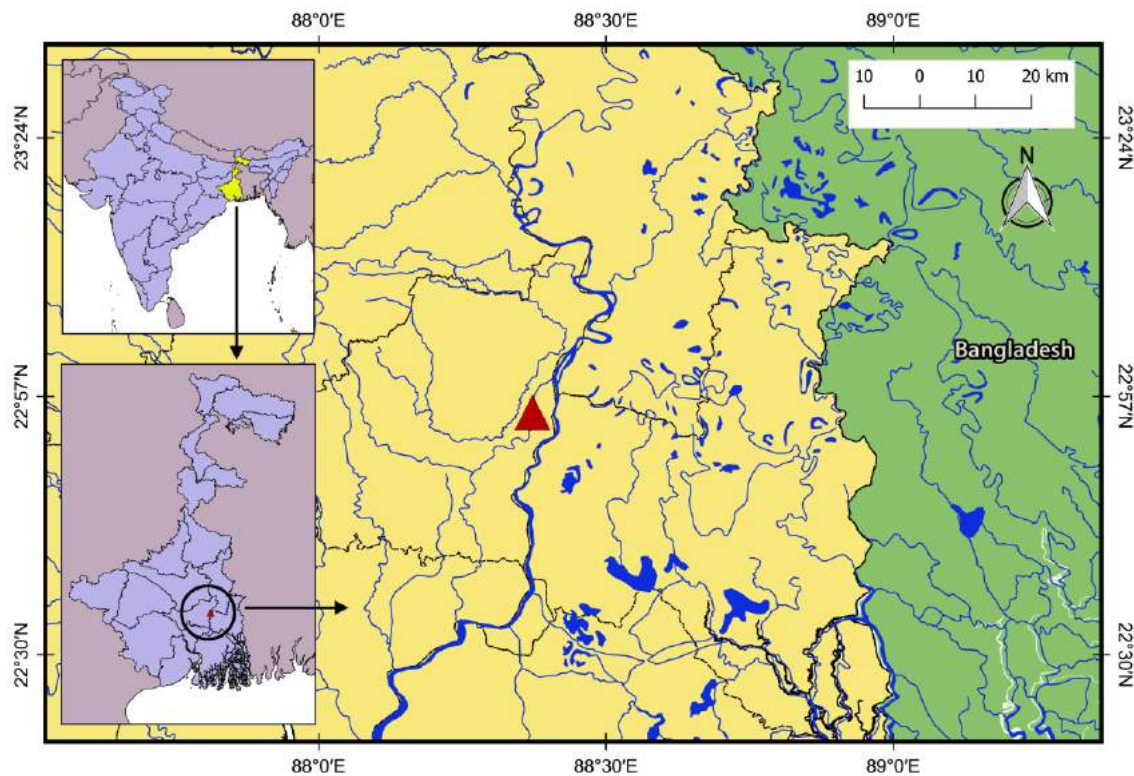
#### *Caudotylenchus* n. gen.

The new genus *Caudotylenchus* of the subfamily Telotylenchinae is characterized by the presence of overlapping oesophageal gland; feebly sclerotized labial framework; well-developed stylet with symmetrical conus and straight lumen; simple intestine without extension over rectum into the tail; areolated lateral fields with five distinct incisures; modified gubernaculum with forwardly directed proximal end and female tail terminus without annulation.

#### *Caudotylenchus indicus* n. gen., n. sp. (Figs. 2-5)

Dimensions are presented in Table 1.

**Body:** Small in size, upon fixation typical 'hook' or 'interrogation mark' in shape. Anterior 1/5<sup>th</sup> of the body is almost straight and the rest part curved ventrally. Cuticle with well-marked transverse striations, the width of annules 2.66-3.15 µm near the mid-body. Lateral fields marked with 5



**Figure 1.** Collection site (marked in triangle) of *Caudotylenchus indicus* n. gen., n. sp. at Kazidanga village, Hooghly, West Bengal, India.

incisures, extended throughout the body length except for lip region, outermost are areolated and occupying about 26% of body diameter near the midbody (Figs. 2d & 3h). Deirids absent.

*Cephalic & buccal region:* Narrow, rounded-conoid, continuous with body contour; labial framework feebly sclerotized; annules inconspicuous and 3-4 in number. Width of lip more than two times its height and about 30% of maximum body width. Stylet long, hypodermic syringe-like, with well-developed protractor muscle. Conus with the straight lumen, about 45% of stylet length. Stylet knob prominent measuring 2.93-4.46  $\mu\text{m}$  wide, projected somewhat downwards. The orifice of the dorsal oesophageal gland lies at close vicinity to the stylet knob (Figs. 2b, 3b-c).

*Intestine & excretory system:* Oesophagus moderately long, occupying about 19% of the body length. Median oesophageal bulb more or less ovoid in shape, well-muscularized, measuring 15.33-16.66 $\times$ 13.26-14.08  $\mu\text{m}$  and occupying about 67% of the corresponding body width. The valve of

the median oesophageal bulb measures about 4.33-4.90  $\times$  3.75-3.92  $\mu\text{m}$  (Fig. 3c). The oesophageal gland appears as an inverted club-shaped, dorso-laterally extending over the intestine with one prominent nucleus towards the apex; it measures 23.38-34.35  $\mu\text{m}$  long and occupying 17-23% of oesophagus. The nerve ring located at 12-13  $\mu\text{m}$  above the excretory pore, encircling narrow isthmus. Excretory pore is well cuticularized; hemizonid about 2 annules wide, located immediately above the excretory pore (Fig. 3d). Anal body width occupying 76-86% of the maximum body width. Post rectal sac absent.

*Tail:* Sexual dimorphism is distinct in tail structure.

*Female* (Figs. 2 & 3)

Vulva transverse, slit-like in ventral view, about 1.96  $\mu\text{m}$  across, located in the posterior half of the body at 6:4 approximate body ratio; epiptygma absent. Vagina almost half-way of corresponding body width. Uterus broad with inconspicuous spermathecae. Gonad didelphic, amphidelphic, reflexed. The anterior ovary is slightly longer than the posterior one. Mature oocytes are arranged in a single row and growing oocytes are clustered at the



reflexed tip of both the ovaries (Figs. 2a, 3e & 3f). Tail narrow, cylindroid, bluntly rounded in shape, and more than five times of the anal body width in length. Tail with 38-44 annules, annulation absent in 4.91-5.39  $\mu\text{m}$  of tail-end; tail hyaline about 9.8  $\mu\text{m}$  thick (Figs. 2c, 3g). Phasmid is located at about 41.16  $\mu\text{m}$  from the tail end (Figs. 2c, 3g).

#### Male (Figs. 4 & 5)

Morphologically closely resembles with the female except for the tail and reproductive structures. Testis is single, outstretched, 202.18-219.84  $\mu\text{m}$  in length (Figs. 4a, 5d & 5e). Spicules paired, well cephalized, 27.66-27.89  $\mu\text{m}$  long, distally flanged, and typical curlew shaped. Gubernaculum 14.63-15.16  $\mu\text{m}$  long, simple, protrusible with flat and forwardly directed proximal end (Figs. 4c & 5f). Bursa simple, non-crenate with maximum width about 19.6  $\mu\text{m}$ ; begins slightly before the base of the spicules and extending up to the tail end (Fig. 5f). Tail pointed, 46.06-47.79  $\mu\text{m}$  long with 30-33 annules; the height of annules about 1.15  $\mu\text{m}$  at tail tip and 1.60  $\mu\text{m}$  towards the base. Phasmid located at about the middle of the tail.

#### Diagnosis:

#### Taxonomic summary

Type-host: Banana (*Musa paradisiaca* L. cv Chapa)

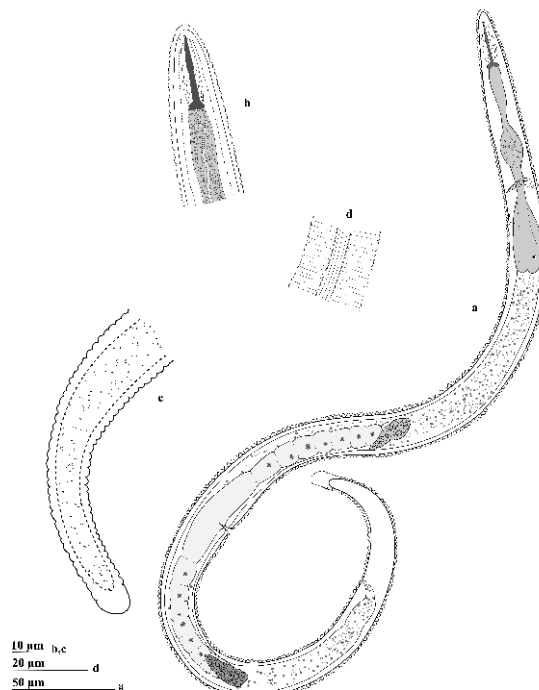
Type-locality: Kazidanga village (22° 55' 19.02" N; 88° 22' 19.956" E) of Chinsurah-Magra block of Hooghly district, West Bengal, India.

Etymology: The specific epithet, *Caudotylenchus* is drawn from two separate words 'Caudo' (Latin: *Cauda*=Tail) and *Tylenchus* (Greek: *tylos*= knob + *enchos*= spear), as this is a well-knobbed stylet bearing nematode and shows peculiarities in tail structure. The specific epithet is used for species as the type species is collected and described from India.

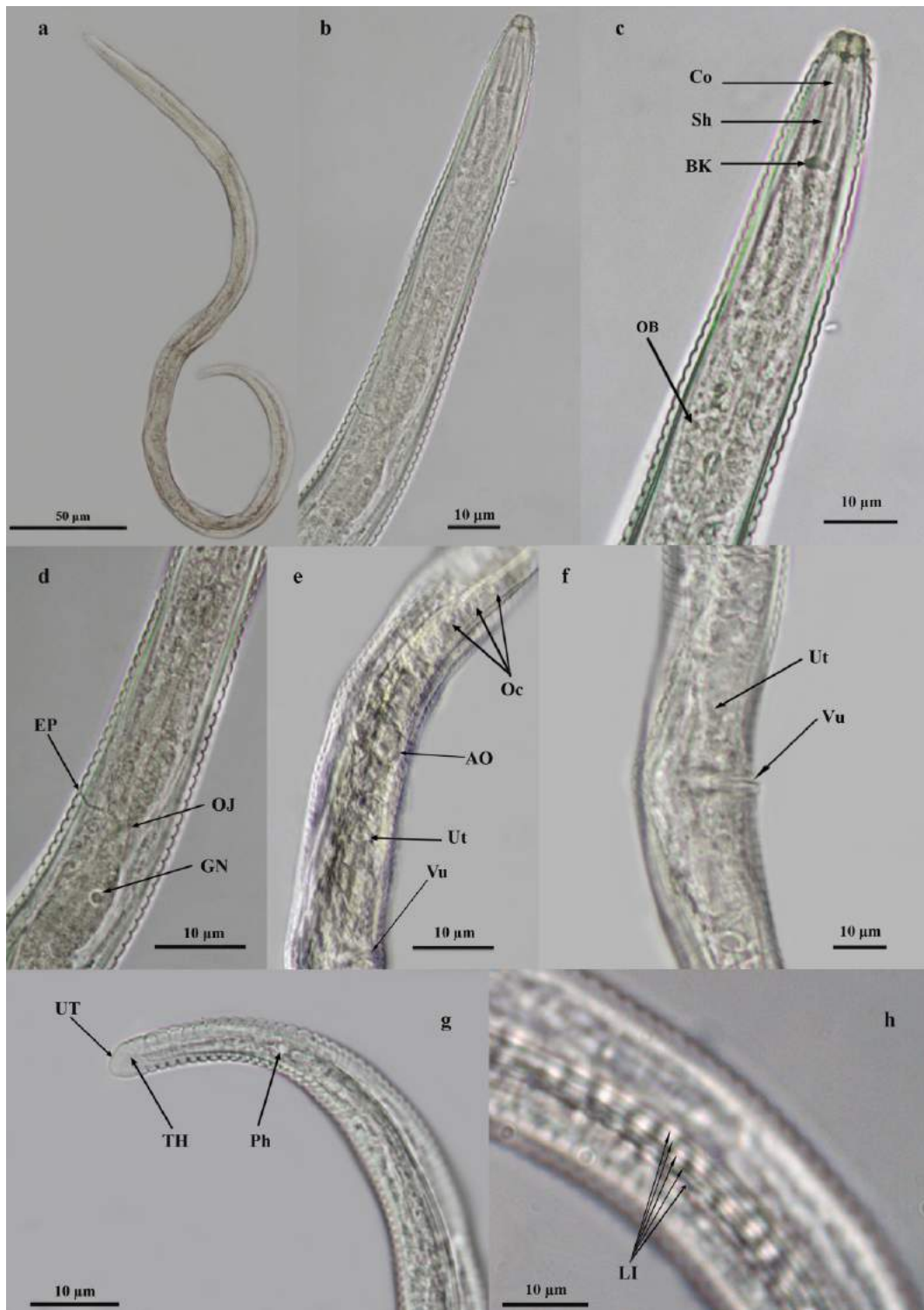
#### Type-materials

Holotype. ♀ holotype collected from the type locality on 23<sup>rd</sup> May 2019. Soil temperature 29.2°C, moisture ~ 6, pH 6.8. The specimen was collected by S. Dey and deposited to the National Zoological Collections of Zoological Survey of India, Kolkata with the Registration number WN 1950.

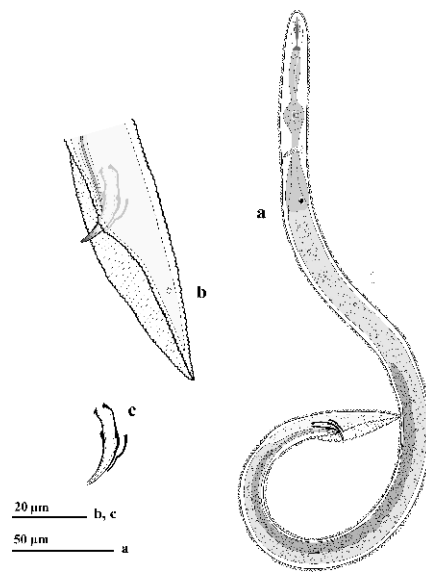
Paratype. 4♀♀, 2♂♂. All related data are the same as holotype.



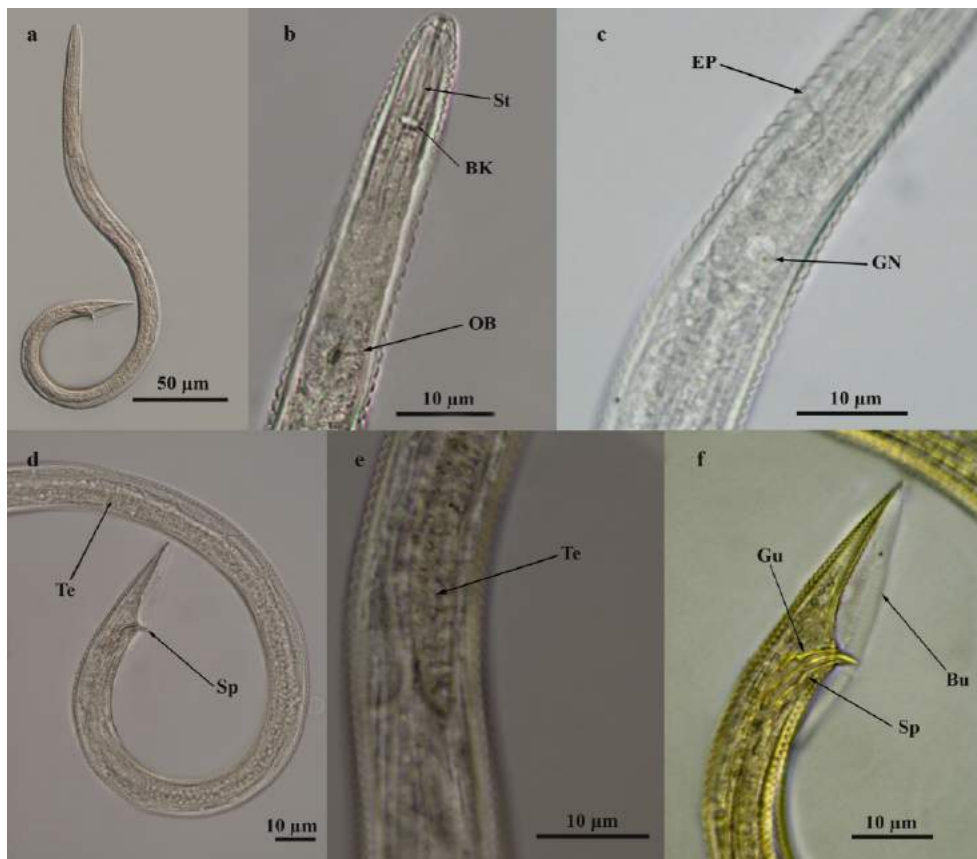
**Figure 2.** Camera lucida illustration of *Caudotylenchus indicus* n. gen., n. sp. (holotype ♀) **a** Entire body, **b** Anterior portion, **c** Lateral field incisures, **d** Tail region with phasmid and tail hyaline.



**Figure 3.** Photomicrographs of *Caudotylenchus indicus* n. gen., n. sp. (holotype ♀) **a** Entire body, **b** and **c** Anterior portion with CO (conus), Sh (shaft), BK (basal knob) of stylet and OB (oesophageal bulb), **d** Oesophageal region with EP (excretory pore), OJ (oesophageal-intestinal junction), OG (oesophageal gland) and GN (gland nucleus), **e** and **f** Genital structure with AO (anterior ovary), Oc (oocytes), Ut (uterus) and Vu (vulva), **g** Tail region with Ph (phasmid), TH (tail hyaline) and UT (unannulated tail-end), **h** Lateral field showing LI (lateral-lines incisures).



**Figure 4.** Camera lucida illustration of *Caudotylenchus indicus* n. gen., n. sp. (paratype ♂♂) **a** Entire body, **b** Tail region, **c** Spicule and gubernaculum.



**Figure 5.** Photomicrographs of *Caudotylenchus indicus* n. gen., n. sp. (paratype ♂♂) **a** Entire body, **b** Anterior region with St (stylet), BK (basal knob) and OB (oesophageal bulb), **c** Oesophageal-intestinal region with EP (excretory pore) and GN (gland nucleus), **d** Posterior region with Te (testis) and Sp (spicule), **e** Anterior terminal portion of Te (Testis), **f** Tail region with Sp (spicule), Gu (gubernaculum) and Bu (bursa).

**Table 1.** Morphometrics (measurements in  $\mu\text{m}$ ) *Caudotylenchus indicus* n.gen., sp. nov., number (n) of paratypes (females and males) shown in brackets.

Morphometric characters	Holotype female	Paratype females (n=4)	Mean $\pm$ SD	Paratype males (n=2)	Mean $\pm$ SD
L	715	683-853	765.5 $\pm$ 73.93	653.09-731.63	692.36 $\pm$ 55.54
A	29.99	30.04-35.62	33.07 $\pm$ 2.52	26.65-28.58	27.62 $\pm$ 1.36
B	4.85	4.72-5.98	5.25 $\pm$ 0.54	4.89-5.26	5.08 $\pm$ 0.26
b'	3.96	3.82-5.14	4.35 $\pm$ 0.57	3.93-4.24	4.09 $\pm$ 0.22
C	6.88	6.92-7.55	7.23 $\pm$ 0.30	13.67-14.88	14.28 $\pm$ 0.86
c'	5.3	5.04-5.49	5.28 $\pm$ 0.19	2.45-2.51	2.48 $\pm$ 0.04
T	-	-	-	50.27-50.76	50.52 $\pm$ 0.35
V	63.66	54.28-63.36	59.80 $\pm$ 4.27	-	-
V'	74.48	62.57-74.06	69.44 $\pm$ 5.39	-	-
M	39.29	40.25-45.89	44.21 $\pm$ 2.65	33.20-34.31	33.76 $\pm$ 0.78
O	12.85	11.89-13.89	12.97 $\pm$ 0.93	15.14-15.40	15.27 $\pm$ 0.18
MB	56.09	45.06-55.58	50.03 $\pm$ 5.72	59.15-59.55	59.35 $\pm$ 0.28
Height of lip region	2.96	2.83-4.12	3.27 $\pm$ 0.58	3.53-3.78	3.66 $\pm$ 0.17
Width of lip region	7.35	6.90-8.02	7.41 $\pm$ 0.50	7.06-7.18	7.12 $\pm$ 0.09
Styilet length	17.51	15.40-19.66	17.54 $\pm$ 1.75	17.23-17.69	17.46 $\pm$ 0.33
Conus	6.88	6.20-8.89	7.78 $\pm$ 1.14	5.72-6.07	5.89 $\pm$ 0.25
Shaft	10.63	9.20-10.77	9.76 $\pm$ 0.70	11.51-11.62	11.57 $\pm$ 0.08
Orifice of dorsal oesophageal gland from styilet base	2.25	2.09-2.73	2.28 $\pm$ 0.31	2.65-2.68	2.67 $\pm$ 0.02
Nerve ring from anterior end	106.64	105.27-108.32	107.0 $\pm$ 1.36	113.81-115.24	114.53 $\pm$ 1.01
Excretory pore from anterior end	115.15	115.02-128.30	119.62 $\pm$ 5.92	127.52-128.41	1274.97 $\pm$ 0.63
Vulva from anterior end	455.17	432.72-463.03	455.52 $\pm$ 15.29	-	-
Anterior genital branch	153.23	145.91 $\pm$ 196.69	167.71 $\pm$ 21.93	-	-
Posterior genital branch	131.34	124.94-183.85	148.45 $\pm$ 25.81	-	-
mbd	23.84	22.74-23.95	23.13 $\pm$ 0.56	24.5-25.60	25.05 $\pm$ 0.78
Body width at vulva	23.84	22.74-23.95	23.13 $\pm$ 0.56	-	-
abd	19.6	19.6-20.58	19.99 $\pm$ 0.42	19.53-19.68	19.61 $\pm$ 0.11
Tail length	103.88	98.72-112.98	105.64 $\pm$ 5.98	47.79-49.18	48.49 $\pm$ 0.98



Table 2. Differential diagnosis and relationships of *Caudotylenchus* n. gen. with all the genera of Telotylenchinae

Genus	<i>Caudotylenchus</i> n. gen.	<i>Histotylenchus</i> Siddiqi, 1971	<i>Trichotylenchus</i> Whitehead, 1960	<i>Telotylenchoides</i> Siddiqi, 1971
Type species	<i>Caudotylenchus indicus</i> n. gen., n. sp.	<i>Histotylenchus histoides</i>	<i>Trichotylenchus falciiformis</i>	<i>Telotylenchoides housei</i>
Body length	0.68-0.85 mm	0.6-1 mm	0.6-1 mm	1 mm or less
Cephalic region	Narrow, rounded-conoid, continuous with 3-4 inconspicuous annules	Rounded, continuous with 3-8 distinct annules	Continuous, rounded with 3-8 distinct annules	Narrow, conoid-rounded, continuous, indistinctly annulated
Stylet	16-20 $\mu$ m, well-developed	21-26 $\mu$ m, asymmetrical	20-28 $\mu$ m, attenuated	20-23 $\mu$ m, well-developed
Lateral fields	Areolated with 5 incisures	Areolated with 3 incisures	Areolated with 3 incisures	Not areolated with 4 incisures
Oesophageal gland	Extended over intestine	Extended over intestine	Extended over intestine	Extended over intestine
Post rectal sac	Absent	Present	Absent	Absent
Female tail	Narrow, cylindroid, bluntly rounded, non-clavate, terminal end unannulation	Cylindroid or subcylindroid, annulated	Cylindroid to subclavate, broadly rounded, annulated	Cylindroid, broadly rounded to bulboid terminus; cuticle abnormally thickened, annulated
Female gonad	Paired, reflexed	Paired, outstretched	Paired, outstretched	Paired, outstretched
Bursa	Well-developed, simple	Well-developed, simple	Moderately developed, simple	Well-developed, simple
Gubernaculum	Protrusible, flat and forwardly directed proximal end	Non-protrusible, proximal end directed dorso-posteriorly	Proximal end directed posteriorly	Protrusible, modified

## Morphometric features

**Table 2** Differential diagnosis and relationships of *Caudotylenchus* n. gen. with all the genera of Telotylenchinae (Cont.)

Genus	<i>Telotylenchus</i> Siddiqi, 1960	<i>Trophurus</i> Loof, 1956	<i>Neodolichoerhynchus</i> Jairajpuri & Hunt, 1984	<i>Quinisolcius</i> Siddiqi, 1971
Type species	<i>Telotylenchus indicus</i>	<i>Trophurus imperialis</i>	<i>Neodolichoerhynchus microphasmis</i>	<i>Quinisolcius capitatus</i>
Body length	0.5–1.1 mm	0.5–1.2 mm	under 1 mm	0.47–0.9 mm
Cephalic region	Hemispherical to broadly rounded, offset with 5-8 distinct annules	Round or truncate, continuous, indistinctly annulated	Round, offset, finely annulated	Round, offset, finely annulated
Stylet	17 µm, moderately developed	10–22 µm, well-developed	12–27 µm, well-developed	12–24 µm, moderately developed
Lateral fields	Plain or areolated, with 4 incisures	Not areolated, with 4 incisures	Variably areolated, with 2–4 incisures	Smooth or partially areolated, with 5 incisures
Oesophageal gland	Extended over intestine	Non extended over intestine	Non extended over intestine	Non extended over intestine
Post rectal sac	Absent	Absent	Absent	Absent
Female tail	Conical to subcylindrical	Cylindroid, subclavate or subconoid, broadly rounded, thick cuticular terminus	Conoid to subcylindroid, with rounded or lobe-like terminus; tail hyaline thick	Conoid, with enlarged annules at terminus
Female gonad	Paired, outstretched	Single, outstretched	Paired, outstretched	Paired, outstretched
Bursa	Crenate	Large, enveloping upto tail end, terminally indented	May or may not be doubly indented at terminus	Well-developed, simple
Gubernaculum	Protrusible; proximal end rounded, not directed posteriorly	Non-protrusible, small, linear	Protrusible	Protrusible, proximal end directed dorsally

**Morphometric features**

**Table 2** Differential diagnosis and relationships of *Caudotylenchus* n. gen. with all the genera of Telotylenchinae (Cont.)

<i>Genus</i>	<i>Uliginotylenchus</i> Siddiqi, 1971	<i>Sauertylenchus</i> Sher, 1974	<i>Bitylenchus</i> Filipjev, 1934	<i>Paratrophurus</i> Arias, 1970
<i>Type species</i>	<i>Uliginotylenchus uliginosus</i>	<i>Sauertylenchus labiodiscus</i>	<i>Bitylenchus dubius</i>	<i>Paratrophurus loofi</i>
<i>Body length</i>	0.4–1 mm	1.4–2 mm	0.4–1.5 mm	0.5–1.2 mm
<i>Cephalic region</i>	Continuous or slightly offset, distinctly annulated	Offset, with 7 fine annules	Offset, finely annulated	Narrow, conoid-rounded, annulations indistinct
<i>Stylet</i>	14–27.5 $\mu$ m, attenuated	33–40 $\mu$ m, attenuated	10–24 $\mu$ m, attenuated or moderately developed	18–25 $\mu$ m, moderately developed
<i>Lateral fields</i>	Areolated, with 3 incisures	Incompletely areolated with 4 incisures	Areolated, with 4 incisures	Not areolated (except oesophageal region) marked with 4 incisures
<i>Oesophageal gland</i>	Not extended over intestine	Not extended over intestine	Not extended over intestine	Not extended over intestine
<i>Post rectal sac</i>	Absent	Absent	Present	Absent
<i>Female tail</i>	Subclavate to cylindrical, broadly rounded annulated terminus	Subcylindrical, terminus annulated	Subcylindrical, or subclavate, terminus thick and annulated	Cylindroid or subclavate, terminal cuticle abnormally thickened, annulated
<i>Female gonad</i>	Paired, outstretched	Paired, outstretched	Paired, outstretched	Paired, outstretched
<i>Bursa</i>	Simple	Simple, crenate	Simple	Simple
<i>Gubernaculum</i>	Protrusible, rod-like, proximal portion directed dorsally	Protrusible, titillae present, recurved distally	Protrusible, large, distally boat-shaped	Protrusible, large, proximal end rounded or bent ventrally

Morphometric features

**Table 2** Differential diagnosis and relationships of *Caudotylenchus* n. gen. with all the genera of Telotylenchinae (*Cont.*)

<i>Genus</i>	<i>Tylenchorhynchus Cobb, 1913</i>
<i>Type species</i>	<i>Tylenchorhynchus cylindricus</i>
<i>Body length</i>	1 mm or less long
<i>Cephalic region</i>	Offset (type genus) or continuous, annulated
<i>Stylet</i>	15–25 µm, well-developed
<i>Lateral fields</i>	Not areolated, with 3–4 incisures
<i>Oesophageal gland</i>	Not extended over intestine
<i>Post rectal sac</i>	Absent
<i>Female tail</i>	Conoid or subcylindroid or cylindroid or subclavate, annulated terminus
<i>Female gonad</i>	Paired, outstretched
<i>Bursa</i>	Simple, crenate
<i>Gubernaculum</i>	Protrusible, well-developed, rod-like

**Morphometric features**



## DISCUSSION

The new genus *Caudotylenchus* has been erected with a description of a new PPN species *Caudotylenchus indicus* n. gen., n. sp. which is associated with the banana plant. *Caudotylenchus* n. gen. completely fits under the family Telotylenchidae Siddiqi, 1960 and subfamily Telotylenchinae Siddiqi, 1960 due to the presence of prominently annulated cuticle, amphidelphic ovary, non-sclerotized vagina, distally flanged arcuate spicules, simple bursa, absence of deirids and hypopygia.

Telotylenchinae includes 12 genera, amongst which four genera viz. *Histotylenchus* (Siddiqi, 1970), *Trichotylenchus* (Whitehead, 1960), *Telotylenchoides* (Siddiqi, 1971) and *Telotylenchus* (Siddiqi, 1960) are grouped together and separated from the other four genera as all these four genera possess overlapping oesophageal gland that extends over the intestine. *Caudotylenchus* n. gen. has been incorporated in this group since it also possesses an overlapping oesophageal gland. However, it differs distinctly from these four congeners due to the presence of significant morphological differences. A recent numerical taxonomic study on the existing genera of Telotylenchidae nematodes from Iran population also demonstrates the close affinity amongst the mentioned genera and their possible natural grouping (Ghaderi *et al.*, 2017).

*Caudotylenchus* n. gen. widely deviates from *Histotylenchus* in having lip region with 3-4 indistinct annules (*vs.* 5-8 distinct annules); moderate-sized stylet that measures under 20  $\mu\text{m}$  (*vs.* 21-26  $\mu\text{m}$ ), symmetrical conus (*vs.* asymmetrical) with a straight lumen (*vs.* angular); reflexed ovaries (*vs.* outstretched) and absence of post rectal sac (*vs.* present and extended up to tail). With the *Trichotylenchus*, it shows similarities basically in the lip region which is continuous with the body contour and feebly sclerotized. However, *Caudotylenchus* n. gen. is separated from *Trichotylenchus* as it possesses well-developed stylet (*vs.* extremely attenuated) with a large basal knob (*vs.* very small); lateral fields with five incisures (*vs.* three incisures); reflexed ovaries (*vs.* outstretched); non-clavate tail (*vs.* subclavate); gubernaculum with a forwardly directed proximal

end (*vs.* dorso-posteriorly directed). The new genus shows a close affinity towards *Telotylenchoides* since both the genera possess indistinctly annulated, small, conoid-rounded, continuous cephalic region; well-developed stylet with a large basal knob and straight lumen; spicules with a rounded proximal end and protrusible gubernaculum; apart from these similarities, the new one differs distinctly from *Telotylenchoides* with respect to the presence of feebly sclerotized labial framework (*vs.* strongly sclerotized); lateral fields with five incisures (*vs.* four incisures); narrow-cylindroid female tail (*vs.* broadly rounded to bulboid); gubernaculum with a flat proximal end (*vs.* rounded proximal end). *Caudotylenchus* n. gen. also deviates morphologically from *Telotylenchus* in having narrow, conoid-rounded (*vs.* hemispherical to broadly rounded), continuous (*vs.* offset) cephalic region with 3-4 indistinct (*vs.* 5-8 distinct) annules; well-developed (*vs.* moderately developed) stylet; lateral fields with five incisures (*vs.* four incisures); reflexed ovaries (*vs.* outstretched); simple bursa (*vs.* crenate), arising just before (*vs.* well anterior) the head of the spicules. Besides, all the morphometric characteristics compared above, the presence of smooth or unannulated tail terminus in female is a unique feature in *Caudotylenchus* n. gen. which is absent in all of its congeners. A complete compendium of the differential diagnostic features and relationships amongst all the genera of Telotylenchinae have been presented in the Table 2.

### Taxonomic key to genera of subfamily Telotylenchinae

1. Oesophageal gland extending over intestine.....2  
- Oesophageal gland not extending over intestine.....6
2. Conus of stylet asymmetrical, with lumen becoming angular near its base; intestine extending over rectum into tail.....*Histotylenchus*  
- Conus of stylet symmetrical, with straight lumen; intestine not extending over rectum into tail.....3
3. Lateral fields with 3 incisures; stylet extremely attenuated; proximal end of gubernaculum directed dorso-posteriorly.....*Trichotylenchus*

- Lateral fields with 4-5 incisures; stylet well-developed; proximal end of gubernaculum not directed dorso-posteriorly.....4
4. Lateral fields with 4 incisures; labial framework either strongly sclerotized or non-sclerotized; posterior portion of female tail marked with transverse annules.....5
- Lateral fields with 5 incisures; labial framework feebly sclerotized; posterior portion of female tail without annule.....*Caudotylenchus n. gen.*
5. Labial framework strongly sclerotized; female tail end with abnormally thickened cuticle.....*Telotylenchoides*
- Labial framework not sclerotized; female tail end without abnormally thickened cuticle.....*Telotylenchus*
6. Posterior branch of female reproductive system reduced to a sac.....*Trophurus*
- Posterior branch of female reproductive system normal.....7
7. Cuticle with prominent longitudinal ridges outside lateral fields.....*Neodolichorhynchus*
- Cuticle without prominent longitudinal ridges outside lateral fields.....8
8. Lateral field with five incisures.....*Quinisulcius*
- Lateral field with three or four incisures.....9
9. Lateral field with three incisures, areolated; vulva in a body depression, with small epiptygma; proximal end of gubernaculum posteriorly directed..... *Uliginotylenchus*
- Lateral field with three or four incisures, if three then not areolated; vulva generally not in a body depression, without epiptygma; proximal end of gubernaculum not posteriorly directed..... 10
10. Cephalic region annules indented laterally; outer bands of lateral field areolated, gubernaculum lacking a crest.....11
- Cephalic region annules not indented laterally; outer bands of lateral field generally not areolated, gubernaculum having a crest.....12
11. Labial disc conspicuous; stylet over 30µm long.....*Sauertylenchus*
- Labial disc not conspicuous; stylet under 30 µm long.....*Bitylenchus*
12. Tail terminal cuticle abnormally thickened.....*Paratrophurus*
- Tail terminal cuticle not abnormally thickened.....*Tylenchorhynchus*
- The stunt nematodes are obligate migratory root-ectoparasites of many plants (Siddiqi, 2000), including banana. The banana is highly nutritious and economically very important fruit crop and India contributes the highest production amongst all the countries. Till now, only six PPN species viz. *Tylenchorhynchus leviterminali* Siddiqi, Mukherjee & Dasgupta, 1982, *T. coffeae* Siddiqi & Basir, 1959, *T. mashhoodi* Siddiqi & Basir, 1959, *T. annulatus* Merny, 1964, *Trophurus imperialis* Loof, 1956 and *Paratrophurus clavicaudatus* Seinhorst, 1963 under the subfamily Telotylenchinae have been described or reported in association with banana plantation from India or around the globe and *Caudotylenchus indicus* n. gen., n. sp. is a new incorporation in this list. The accurate and timely identification of such PPNs is very essential and prerequisite for designing the effective management strategies. Nowadays, many workers are also using integrative (morphological and molecular) taxonomic approaches for quick and reliable identification (Handoo et al., 2014). In the present study, although the mode of damage by the new PPN species to this valuable fruit crop has not been explored, however, it will support the future works to deal with this hidden enemy to minimize its adverse impact on such valuable crops to enhance the gross crop production and to boost the economy of the country.

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