A NEW AND A KNOWN SPECIES OF *XIPHINEMA* COBB, 1913 (DORYLAIMIDA: XIPHINEMATIDAE) FROM WEST BENGAL, INDIA WITH A KEY TO THE MONO-OPISTHODELPHIC SPECIES OF THE GENUS

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Summary. *Xiphinema manasiae* sp. n. and *X. americanum* Cobb, 1913 *sensu lato* were collected from the soil around the roots of litchi at South 24-Parganas district, West Bengal, India. *Xiphinema manasiae* sp. n. is one of the species of this genus having a mono-opisthodelphic reproductive system with undifferentiated anterior uterine sac. The new species comes closer to *X. chambersi* Thorne, 1939, *X. radicicola* Goodey, 1936 and *X. monohysterum* Brown, 1968, having a mono-opisthodelphic reproductive system with or without anterior genital branch reduced to a uterine sac but with some distinctly different morphometric measurements (body shorter than *X. chambersi* and *X. monohysterum*, vulva more posterior than *X. chambersi,* 'a' less than in *X. monohysterum* and tail longer than *X. radicicola* with greater c′) and hence deserves to be proposed as a new species. It also differs from the closely related species in having a distinct anterior uterine sac, much shorter pre-rectum and different tail shape. This is also the first record of *X. americanum sensu lato* from the South 24-Parganas district of West Bengal. A diagnostic key of fourteen species of the genus with opisthodelphic gonad has been provided.

Keywords: *Xiphinema manasiae* sp. n., *X. americanum sensu lato, Litchi chinensis*, key to the opisthodelphic species of *Xiphinema*.

A small population of *Xiphinema manasiae* sp. n. along with a single male specimen and a good number of female specimens of *X. americanum* Cobb, 1913 *sensu lato* were collected from the soil around litchi (*Litchi chinensis* Sonn.) from South 24-Parganas district, West Bengal, India. Although *X. americanum* is very common in North America, its distribution is localized in South Africa and the presence of *X. americanum sensu stricto* in India has also been reported (Lamberti *et al*., 2000). *Xiphinema americanum* is cosmopolitan and widely reported from India but, at present (EPPO, 2009), it is considered that *X. americanum sensu stricto* is restricted to North America and Africa. So the present population of *X. americanum* is being designated as *X. americanum sensu lato*. Lamberti *et al*. (2000) also concluded that these and other records of *X. americanum* from various localities throughout the world require the specific identification to be confirmed. As *Xiphinema manasiae* sp. n. has a mono-opisthodelphic gonad, it has been compared with the other closely related mono-opisthodelphic species of *Xiphinema* under Group 1 without having a pre-uterine sac as proposed by Loof and Luc (1990). Ganguly *et al.* (2000) have also provided a diagnostic key and compendium of twelve species on the basis of Loof and Luc's (1990) categorization of the species of *Xiphinema*. However, in the present study, a key to the fourteen mono-opisthodelphic species of *Xiphinema*, with or without anterior uterine sac, has been incorporated. The formulae, to locate the positions of pharyngeal gland nuclei and the terms to denote them, were used as given by Andrássy (1998).

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MATERIALS AND METHODS

Nematodes were extracted from soil samples by means of Cobb's sieving and decantation technique (Cobb, 1918) followed by modified Baermann funnel technique (Christie and Perry, 1951). Specimens were killed and fixed in hot FA 4:1 solution and mounted in anhydrous glycerin, sealed by paraffin wax. They were then observed under a compound microscope (Olympus BX 41), drawings were made with the help of a drawing tube attached to the microscope, and specimens were measured and photographed.

DESCRIPTION

XIPHINEMA MANASIAE sp. n.
(Figs 1 and 2, Table I)

Measurements. See Table I. The measurements given hereafter are based on holotype. Minimum-maximum ranges of measurements of paratypes are given in parenthesis.

Female. Body slender, ventrally curved, tapering gradually towards the extremities, assuming an open 'C' posture when killed. Cuticle smooth, 1.2-2.5 µm thick at mid-body, 3.5-4.9 µm on tail and 7.0-11.0 µm on tail ter-

minus. Lip region rounded, slightly set off from adjoining body by a depression, 4.9 µm high and 11.0 (9.8-11.0) µm wide in holotype or 1/3.1 (1/2.7-1/3.5) of neck base width. Amphids stirrup-shaped, located at 12.0 µm in holotype (6.1-9.8 µm) from anterior end. Odontostyle 8.9 (8.9-10.7) lip region widths long. Odontophore 0.6 (0.56-0.60) times the odontostyle length, basal flanges 12.0 (7.3-12.0) µm wide. Guide ring prominent, located

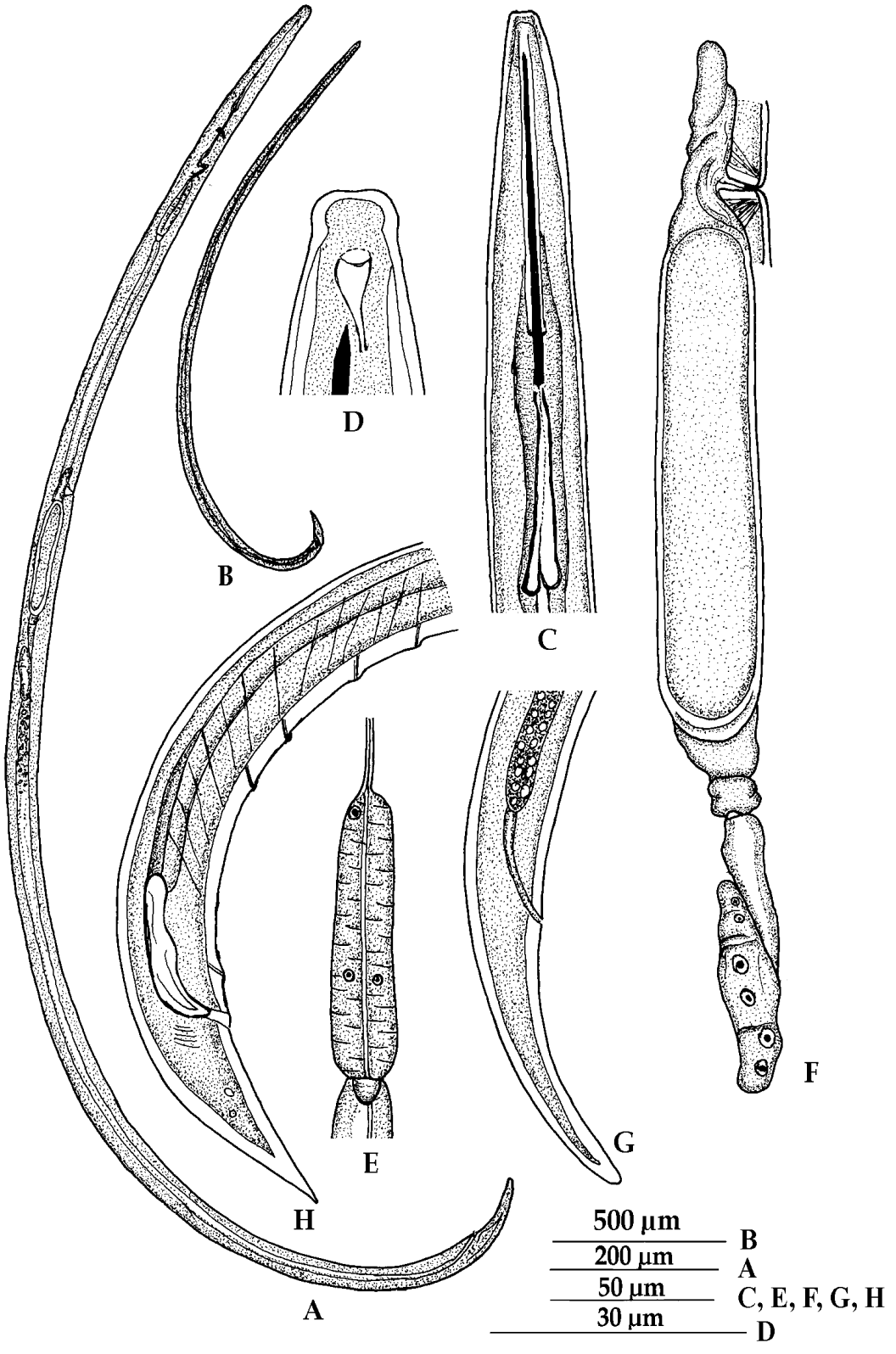

Fig. 1. *Xiphinema manasiae* sp. n. Female: A, **e**ntire body; C and D, **a**nterior end showing odontostyle and amphid; E, expanded part of pharynx and cardia; F, mono-opisthodelphic reproductive system showing anterior uterine sac and intra-uterine egg, G. Tail. Male: B, entire body; H, posterior end showing vetromedian supplements, spicule and tail shape.

at posterior half of odontostyle, at 8.4 (8.2-9.5) labial widths from oral aperture. Nerve ring surrounding the anterior slender part of pharynx, located at 184.0 µm in holotype (176.0-193.5 µm) from anterior end. Cardia short, rounded, 8.8-11.7 µm long. Basal expanded portion of pharynx 24.6 (20.5-24.8)% of the total pharyngeal length. Glandularium 89.7 (85.7-90.9)% of the cylindrus. Locations of pharyngeal gland nuclei are: D = 80.3 (74.2-80.7)%; AS1 = 59.2 (40.0-58.5)%; AS2 = 61.8 (42.5-69.0)%. Vulva transverse, distinctly pre-equatorial. Vagina unsclerotized, occupying 1/2 (1/1.6-1/2) of the corresponding body diameter. Reproductive system mono-opisthodelphic. Anterior branch of gonad only in the form of an undifferentiated uterine sac, 1.16 (0.75-1.71) times the vulval body-width long. Posterior branch of gonad well developed and functional. Sphinc-

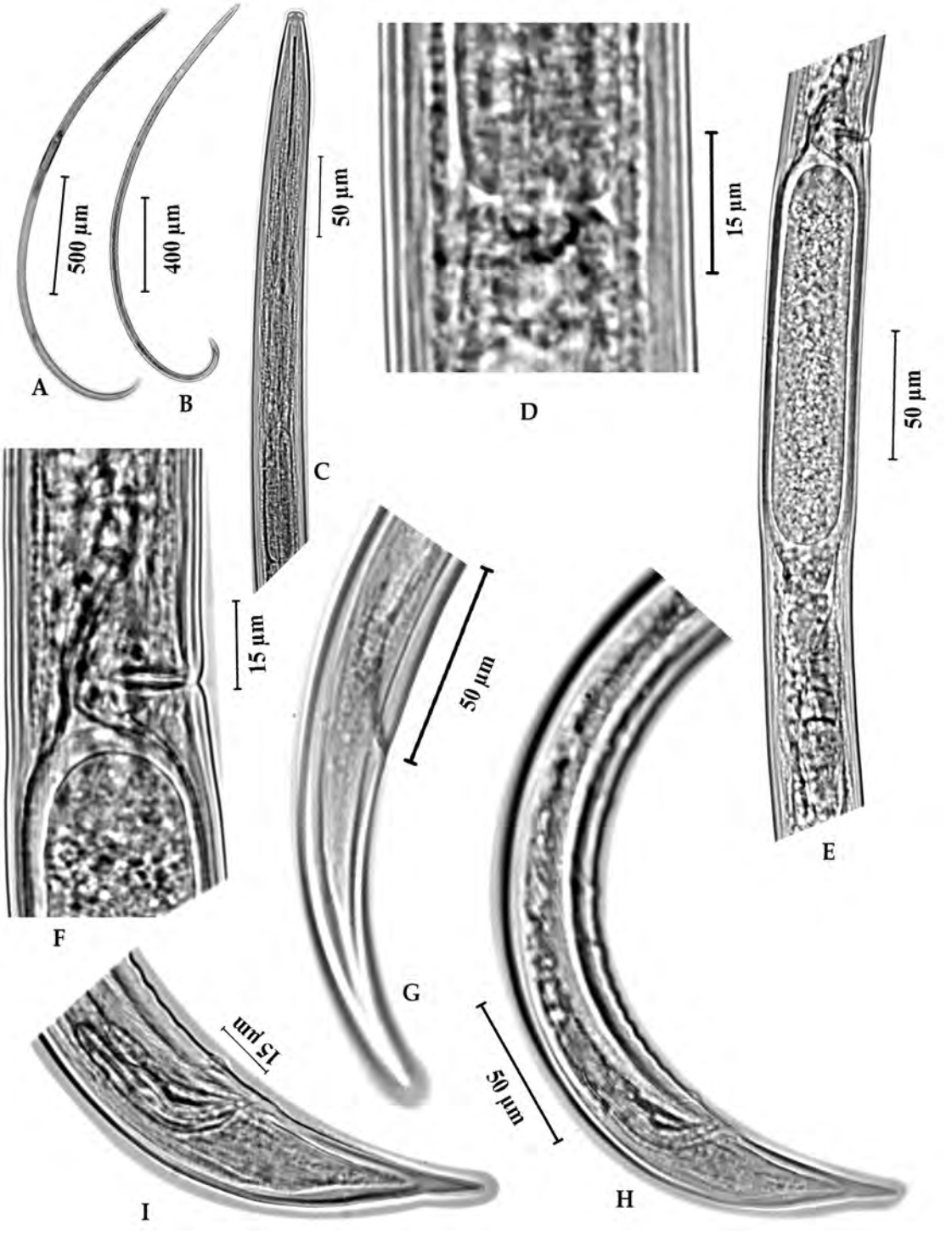

Fig. 2. Photomicrograph of *Xiphinema manasiae* sp. n. Female: A, entire body; C, anterior end; D, oesophago-intestinal junction and cardia; E, mono-opisthodelphic reproductive system with anterior uterine sac and intra-uterine egg; F, vulva and anterior uterine sac; G, tail end. Male: B, entire body; H, tail end showing vetromedian supplements; I, spicule.

Table I. Morphometric data for *Xiphinema manasiae* sp. n. (All measurements are in mm except L (in mm) and body ratios. Number of paratypes examined are given in parenthesis).

Character	Holotype female	Paratype females (9)					Male (1)
		Min	Max	Mean	± SD	SE	
L	2.04	1.89	2.13	2.04	0.07	0.02	2.06
a	55.3	52.2	62.8	58.0	3.32	1.17	60.8
b	6.0	5.4	6.0	5.6	0.19	0.07	5.6
c	23.8	24.1	31.0	27.0	2.69	0.95	35.0
c′	3.9	3.1	4.1	3.6	0.4	0.14	2.4
V%/T %	32.5	30.2	33.0	31.9	0.85	0.3	50.3
G_1% (uterine sac)	1.9	1.3	2.8	1.8	0.48	0.17	--
G_2 % (functional)	16.3	9.9	25.7	15.7	6.23	2.35	--
Odontostyle length	98.0	98.0	105.3	100.4	2.27	0.8	100.5
Odontophore length	58.8	56.3	61.2	59.4	1.68	0.59	61.0
Length of basal flange of stylet	9.8	7.3	12.0	10.2	1.93	0.86	--
Width of basal flange of stylet	4.9	4.9	9.8	6.7	2.17	0.76	11.0
Anterior end to guide ring	93.0	90.6	95.5	92.1	1.8	0.64	92.0
Maximum body width	37.0	33.0	39.0	35.3	2.02	0.71	34.0
Body width below head	10.8	9.8	10.8	10.4	0.57	0.33	10.8
Body width at neck base	34.3	30.6	34.3	33.2	1.51	0.53	32.0
Body width at vulva	34.3	32.0	39.0	34.8	2.38	0.9	--
Pharyngeal length	338.0	348.0	375.0	361.0	8.79	3.1	365.0
Expanded part of pharynx	83.0	76.0	93.0	83.5	5.86	2.07	83.3
Length of glandularium	74.5	60.7	80.4	73.3	7.34	2.59	71.0
Length of cardia	11.0	8.82	11.8	10.3	2.07	1.47	9.8
Length of anterior uterine sac	40.0	27.0	59.0	36.9	10.31	3.64	--
Length of posterior gonad	333.5	189.0	524.0	323.0	128.97	48.75	--
Anterior end to vulva	666.0	620.0	683.5	652.8	23.04	8.14	--
Length of vagina	17.0	17.0	19.6	18.3	1.34	0.47	--
Tail length	86.0	61.0	86.0	76.2	8.48	3	59.0
Anal body width	22.0	19.6	22.0	21.1	1.05	0.37	24.5
Length of pre-rectum	102.9	73.5	120.0	97.6	18.49	6.99	110.0
Length of rectum	29.4	26.9	32.0	30.0	2.18	0.77	32.0
Testis length	--	--	--	--	--	--	1041
Length of spicules	--	--	--	--	--	--	46.5

ter present at the uterus-oviduct junction. Posterior ovary reflexed, in some specimens very long, its length 64.0 µm in holotype (53.9-237.0 µm), oocytes arranged in a single row. A single, large intra-uterine egg present in the posterior branch of the holotype measuring 147.0 µm × 24.5 µm. Pre-rectum containing numerous granules, 4.7 (3.5-5.4) and rectum 1.3 (1.2-1.63) anal body-widths long. Tail ventrally bent, regularly tapering towards posterior extremity, conoid with finely rounded terminus, 3.9 (3.11-4.09) anal body-widths long; cuticle on tail tip thickened.

Male. Generally similar to females, with the posterior region of the body more coiled ventrally. Testis extending anteriorly about half of the body length. Spicules almost straight, very minutely arcuate at distal end, 1.9 anal body-widths long. Supplements consist of an adanal pair and four regularly spaced ventromedian pairs**.** Tail shorter than in females, 2.4 anal body-widths long, ventrally curved, convex-conoid with pointed terminus.

Type specimens. Holotype registration No. WN 1037 with two female paratypes on same slide. Paratype registration No. WN 1038 (four females) and WN 1039 (three females and a male). Deposited in National Zoological Collection, Zoological Survey of India, Kolkata, India.

Etymology. The new species has been named after Mrs. Manasi Sen, the wife of the first author.

Type habitat and locality. Collected from soil around the roots of litchi (*Litchi chinensis* Sonn.) at Natunpara and Khanpara of Baruipur block on 27. 07. 2005.

Diagnosis and Relationship. *Xiphinema manasiae* sp. n. is characterized by the presence of unsclerotized vagina, mono-opisthodelphic reproductive system with distinct but undifferentiated anterior uterine sac, wide range of the length of posterior ovary, short pre-rectum and by its tail shape. It is also distinguished by the shorter tail length in male than in females and dissimilar tail shape between sexes.

Xiphinema manasiae sp. n. comes close to *X. chambersi* Thorne, 1939, *X. radicicola* Goodey, 1936 and to *X. monohysterum* Brown, 1968, having mono-opisthodelphic reproductive system with or without anterior genital branch reduced to a uterine sac.

Primarily, *X. manasiae* sp. n. can be differentiated from the closely related species by the distinct presence of an anterior uterine sac and in having much shorter pre-rectum (anterior uterine sac completely absent in *X. chambersi* and *X. monohysterum* with 10-14 anal body-widths long pre-rectum. Anterior uterine sac, if present, one-third of vulval body width in *X. radicicola* with 12-15 anal body widths long pre-rectum).

Moreover, the new species differs from *X. chambersi* in having shorter body, more posteriorly placed vulva and different tail shape (L = 2.5 mm; V = 24%; tail elongate-conoid in *X. chambersi*). It differs from *X. monohysterum* by possessing shorter body, lesser 'a' value and by different tail shape (L = 2.42-2.83 mm; a = 59-73; tail dorsally convex-conoid with sub-digitate terminus in *X. monohysterum*). Finally, *X. manasiae* sp. n. can be differentiated from *X. radicicola* in having longer tail, evident from greater $c^{/}$ value, and different tail shape (tail = 41-54 µm; $c^{/}$ = 1.4-2.5; tail dorsally convex-conoid with digitate terminus in *X. radicicola*).

Key to the mono-opisthodelphic species of the genus *Xiphinema* Cobb, 1913
(Modified after Ganguly *et al*., 2000)

1. Anterior uterine sac completely absent……....2
– Undifferentiated anterior uterine sac present or absent……12
2. Tail elongate, filiform, $c^{/} > 7.0$ to $c^{/} < 14.0$ …… ……..…… *X. orthotenum* Cohn *et* Sher, 1972
– Tail not filiform, $c^{/} < 7.0$……3
3. Tail short with hemispherical terminus, $c^{/} < 1.0$; V = 36-39% ….. *X. ensiculiferum* (Cobb, 1893) Thorne, 1938
– Tail terminus not hemispherical, $c^{/} > 1.0$ V < 35%...4
4. Tail rounded with a median terminal peg, $c^{/}$ = 1.2…….. *X. brasiliense* Lordello, 1951
– Tail dorsally convex-conoid without terminal peg…5
5. Tail elongate conoid……6
– Tail dorsally convex-conoid with a terminal digitate projection……8
6. Tail length 100-200 µm; Body 'J'- shaped …… 7
– Tail < 100 µm; body arcuate…… *X. monohysterum* Brown, 1968
7. Average $c^{/}$ = 5.2; stylet = 210 µm; body slightly arcuate……*X. winotoi* Razak *et* Loof, 1998
– Average $c^{/}$ = 4.0; Stylet = 169 µm; body 'J'-shaped ……...*X. chambersi* Thorne, 1939
8. Lip region continuous……9
– Lip region slightly set off by depression…… 10
9. L = 1.9-2.5 mm; c = 37-53; dorsal and ventral cervical body pores absent; 3 pairs of caudal pores …… *X. digicaudatum* (Singh *et* Khan, 1997) Ganguly *et al.*, 2000
– L = 2.4-2.8 mm; c = 53-77; dorsal and ventral cervical body pores 5 pairs; 6 pairs of caudal pores……*X. bhutanense* Ganguly *et al*., 2000
10. c = 38-31; 3 lateral body pores in lip region and 3 behind the odontophore…… *X. gracilicaudatum* (Singh *et* Khan, 1997) Ganguly *et al.*, 2000
– c > 31; body pores present or absent……11
11. $c^{/}$ = 2.3-2.7; a = 57-70; stylet < 170 µm …… ……*X. neoradicicola* Dhanam *et* Jairajpuri, 1997
– $c^{/} \leq 2.3$; a = 41-47; stylet 173-200 µm ….…….... *X. bambusi*, Ganguly *et al*., 2000
12. Anterior uterine sac at least three-fourth or greater than one vulval body width long; $c^{/}$ = 3.11-4.0……*X. manasiae* sp. n.
– Anterior uterine sac distinctly less than vulval body width; $c^{/} \leq 2.5$...……13
13. Anterior uterine sac, if present, one-third of vulval body-width; tail long (41-54 µm); c = 31-32 ……*X. radicicola* Goodey, 1936
– Anterior uterine sac distinctly present, usually about 3/4th. of vulval body width; tail short (24-29 µm); c = 66-90 …… *X. loosi* Southey *et* Luc, 1973

XIPHINEMA AMERICANUM **Cobb, 1913** *sensu lato*
(Fig. 3)

Measurements

*Female*s (No. 15). L = 1.66 ± 0.08 (1.56-1.8) mm; a = 46.7 ± 3.88 (36.5-48.8); b = 5.6 ± 0.31 (5.2-6.1); c = 45.5 ± 3.84 (38.3-51.4); $c^{/}$ = 1.6 ± 0.14 (1.4-1.8); V = 51.6 ± 2.41 (48.3-56.1)%; G_1 = 12.6 ± 1.7 (10-14.5)%; G_2 = 13.6 ± 1.59 (10.9-15.2)%; odontostyle = 77.7 ± 3.78 (71.0-83.0) µm; odontophore = 49.5 ± 1.1 (49-51.5) µm; width of basal knob (across) = 7.6 ± 0.38 (7-8) µm; maximum body width = 35.9 ± 3.53 (32.0-44.0 µm); length of pharynx = 295.4 ± 12.55 (274.5-314.0) µm; body width at neck base = 32.3 ± 2.92 (29.4-39.0) µm; body width at vulva = 36.0 ± 3.67 (32.0-44.0) µm; expanded part of pharynx = 68.5 ± 3.83 (64.0-73.5) µm; glandularium = 48.6 ± 2.32 (45.0-52.0) µm; distance of vulva from anterior end = 859.3 ± 33.64 (821.0-911.5) µm; vaginal length = 14.1 ± 0.88 (12.7-14.7) µm; length of anterior gonad = 211.3 ± 23.52 (176.0-235.0) µm; length of posterior gonad = 227.7 ± 19.08 (195.0-247.5) µm; pre-rectum = 79.8 ± 13.99 (69.0-108.0) µm; rectum = 24.7 ± 4.63 (22.0-34.3) µm; tail length = 36.7 ± 2.63

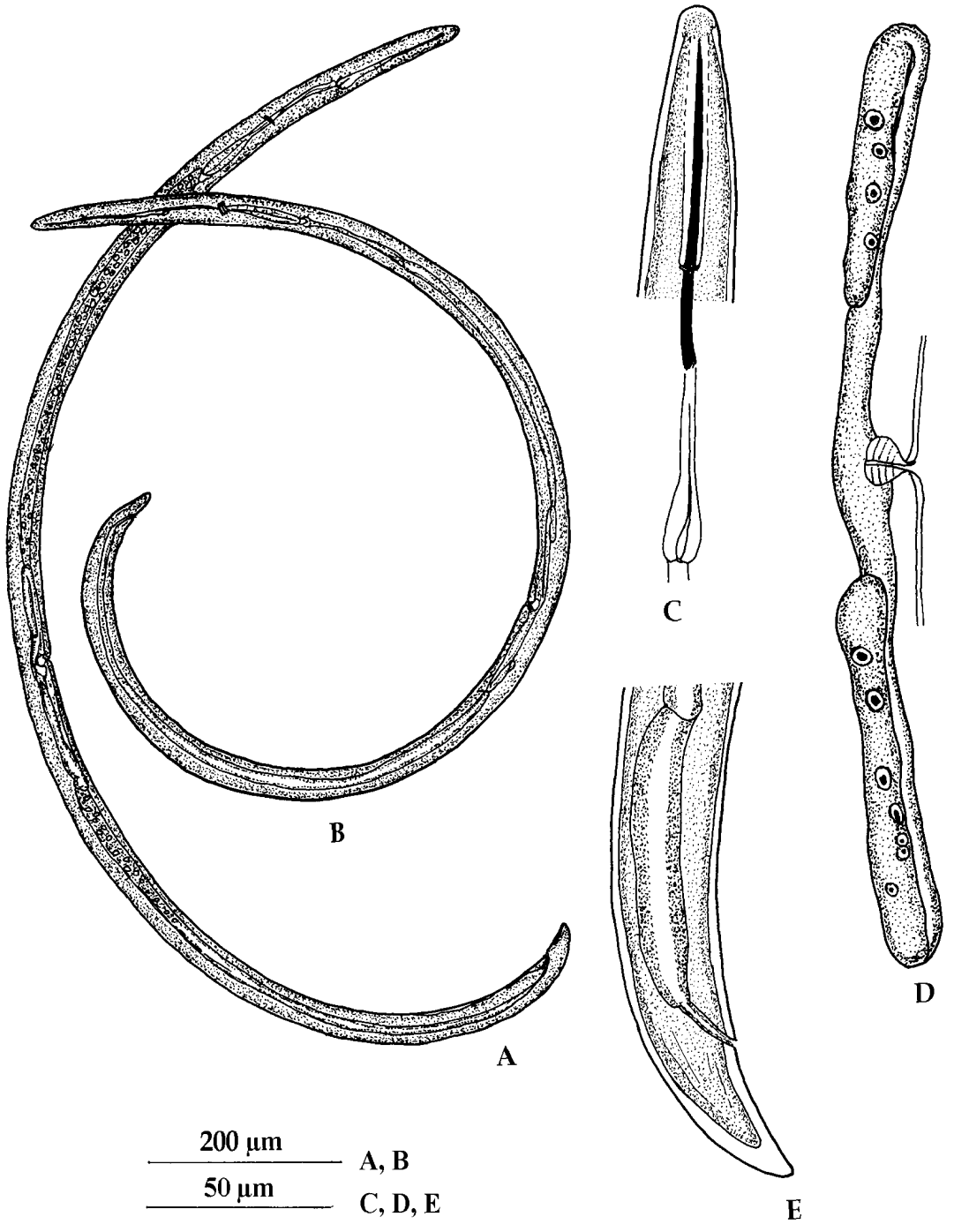

Fig. 3. *Xiphinema americanum sensu lato*. Female: A and B, variation in body shape, C, anterior end; D, reproductive system; E, tail.

(34.0-42.0) µm; anal body diameter = 23.4 ± 1.31 (22.0-24.5) µm.

Description

Female. Body slender, tapering gradually towards the extremities, assuming a 'C' posture or ventrally curved when killed. Cuticle 1.5-1.9 µm thick at mid-body and 1.9-4.9 µm on tail. Lip region rounded, very minutely set off by mild depression or almost continuous with the adjoining body, 3.9-5.9 µm high and 9.8-10.8 µm wide. Amphids stirrup-shaped, located at 5.9-7.3 µm from anterior end. Odontostyle 7.0-8.0 times lip region-width long. Odontophore 0.59-0.72 times odontostyle length, its basal flanges 7.3-9.8 µm wide. Fixed and prominent guide ring located at 61.2-66.0 µm or 5.7-6.7 labial widths from oral aperture. Nerve ring encircling the anterior slender part of pharynx, located at 154.0-164.0 µm from anterior end. The cylindrus or expanded part of pharynx 21.9-25.4% of the total pharyngeal length. Glandularium 63.9-78.0% of the cylindrus. Cardia short, rounded. Locations of pharyngeal gland nuclei are: D = 81.3-87.1%; AS_1 = 44.9-56.2%; AS_2 = 44.9-

70.0%. Vulva slightly posterior to the mid-body. Reproductive system amphidelphic. Uterus short. Vagina about half to one-third of the corresponding body width long. Both ovaries reflexed, anterior ovary 54.0-100.5 µm and posterior ovary 64.9-110.0 µm long. Prerectum 2.8-4.9 and rectum 0.89-1.4 anal body-widths long. Tail short, convex-conoid with finely rounded terminus, 1.4-1.8 anal body-widths long.

Male. Not found.

Habitat and locality. Collected from soil around the roots of litchi at Padmajala, Natunpara and Ramnagar on 27. 07. 2005, and from Madhyam Kalyanpur on 13. 12. 2005 of Baruipur block.

Remarks. The present specimens agree well with the description given by Thorne (1961). The specimens also conform well to those reported by Bajaj and Jairajpuri (1979) from different places of India and by Chaturvedi and Khera (1979) from Howrah district, West Bengal, India. However, *X. americanum*-group appears to be comprised of the closely related species and a collection of geographical variants exhibiting basic similarities with some divergent morphological characters (Tarjan, 1969). The males of this species have been reported only occasionally and are rare. This is the first report of the species from South 24-Parganas district.

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