

# Four new species of *Xiphinema* Cobb, 1913 (Nematoda : Dorylaimida) from East Africa

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## SUMMARY

*Xiphinema neobasiri* sp. n. and *X. michelluci* sp. n. are described from cultivated soils of Malawi and *X. heynsi* sp. n. and *X. mammatum* sp. n. from a lucerne field in South Kilimanjaro, Tanzania. *X. neobasiri* sp. n. and *X. michelluci* sp. n. are close to *X. basiri* and *X. seredouense*, respectively. *X. heynsi* sp. n. is close to *X. clavatum* but differs in having a continuous lip region, a shorter odontostyle and a non-clavate female tail. *X. mammatum* sp. n. has a hemispherical tail end bearing an offset terminal peg directed dorsally and stellate spines in the uterus. Numerous spore-like bodies occur in the uterus of *X. michelluci* sp. n. Males are described for *X. heynsi* sp. n. and *X. mammatum* sp. n.

## RÉSUMÉ

Quatre nouvelles espèces de *Xiphinema* Cobb, 1913 (Nematoda : Dorylaimida) provenant de l'Afrique de l'Est

L'auteur décrit *Xiphinema neobasiri* sp. n. et *X. michelluci* sp. n. provenant de sols cultivés du Malawi. Les femelles de l'une et l'autre espèce ont une queue mucronée ; ces espèces sont proches de *X. basiri* et *X. seredouense*, respectivement. *X. michelluci* sp. n. possède de nombreux corps spiniformes localisés dans l'utérus et supposés appartenir à un parasite. *X. heynsi* sp. n. et *X. mammatum* sp. n. provenant d'un champ de luzerne du South Kilimanjaro (Tanzanie) sont également décrits. *X. heynsi* sp. n. est proche de *X. clavatum* dont il diffère par sa région labiale continue avec le reste du corps, un odontostyle plus court et la queue non claviforme chez les femelles. Les femelles de *X. mammatum* sp. n. ont une queue hémisphérique terminée par un mucron dirigé dorsalement ; l'utérus comporte des épines en forme d'étoiles. Les mâles sont décrits chez *X. heynsi* sp. n. et *X. mammatum* sp. n.

Four new species of the genus *Xiphinema* Cobb, 1913 (fam. Longidoridae) are described here — *X. neobasiri* sp. n. and *X. michelluci* sp. n. from cultivated soils of Malawi and *X. heynsi* sp. n. and *X. mammatum* sp. n. from a lucerne field in Tanzania. The nematodes were killed by applying gradual heat and fixed in F.A. 4 : 10 except *X. michelluci* which was fixed in TAF. The specimens were processed through warm lactophenol and mounted in dehydrated glycerine containing traces of picric acid.

The long tubular portion of the uterus of *X. michelluci* is packed with numerous spine-like bodies which are thought to be spores of some parasite but no evidence is available to prove this. The uterus of *X. mammatum* contains a few scattered stellate spines with 4-5 radiating processes. The parasitism of *Xiphinema* ovaries by bacteria is well known (Adams & Eichenmuller, 1963 ; Siddiqi, 1973 ; Luc & Williams, 1978) and it is very likely that the uterus also serves as a suitable site for parasitism by micro-organisms.

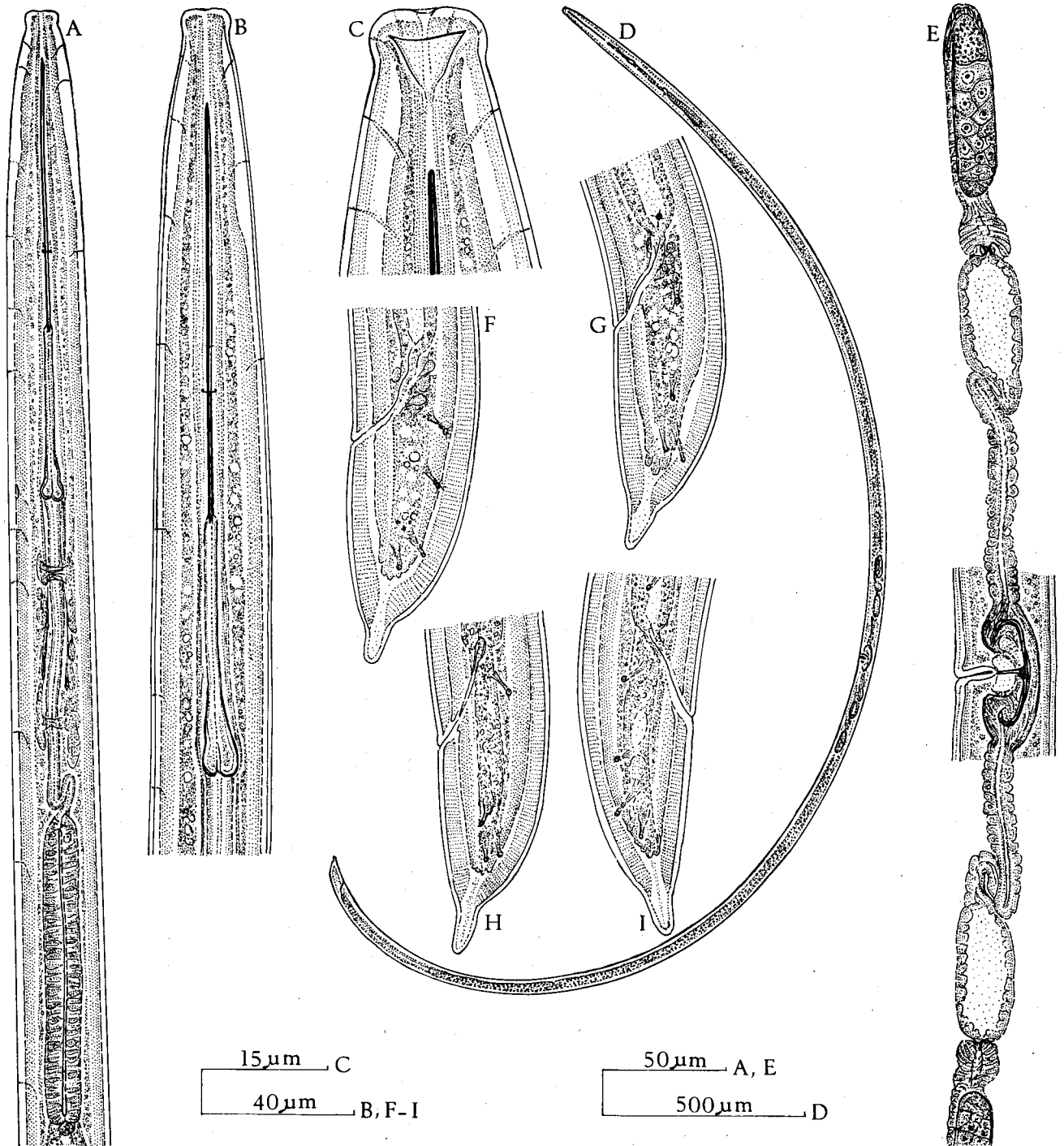


Fig. 1 : *Xiphinema neobasiri* sp. n., females. A : Oesophageal region. B, C : Anterior ends. D : Female. E : Reproductive organs. F-I : Tails. A, C-F : Holotype female.

***Xiphinema neobasiri* sp. n.**

(Fig. 1, A-I &amp; Fig. 2, A-H)

MEASUREMENTS. 15 ♀♀ (paratypes): L = 3.29-3.92 (average 3.68) mm; a = 83-101 (92); b = 6.8-9.9 (8.7); c = 55-71 (61); c' = 1.8-2.1 (1.9); V = 49.5-53.0 (51.3); odontostyle (ods) = 105-115 (111)  $\mu$ m; odontophore (odp) = 68-72 (70)  $\mu$ m; total length of stylet (st) = 177-185 (181.5)  $\mu$ m; stylet basal guiding ring (sbgr) = 80-102 (92)  $\mu$ m from anterior end.

Holotype ♀: L = 3.77 mm; a = 94; b = 8.3; c = 64; c' = 1.8; V =  $6.5 \cdot 50^{7.3}$ ; ods = 114  $\mu$ m; odp = 72  $\mu$ m; sbgr = 101  $\mu$ m.

20 JJ (paratypes): See Table 1.

## DESCRIPTION

*Female*

Body long and slender (maximum width 38-43 (41)  $\mu$ m), spirally curved to a close C-shape in which the posterior half is more curved than the anterior, strongly tapering from near mid-stylet region towards anterior end and expanding in the lip region rather abruptly; towards the tail it tapers very slightly to the terminus which has a short digitate peg. Lip region knob-like, offset from body due to its expanded nature, 12.5-15  $\mu$ m in diameter; labial papillae not raised (Fig. 1, C). Cuticle surface finely striated, inner layers showing fine radial striations especially on tail where these layers are thickened. Amphid

stirrup-shaped, with aperture about 0.6 times width of lip region at that level. Series of ventral and dorsal body pores begin 10-14 (12)  $\mu$ m and 12-18 (15)  $\mu$ m from anterior end, respectively. Ventral pores number 9-12 (11 in holotype) in oesophageal region, 9-17 (17 in holotype) between oesophagus and vulva and 8-20 (12 in holotype) between vulva and anus. Dorsal pores 3-5 in number present only in stylet region. In the holotype, 16 lateral pores in a line are present on one side in the oesophageal region behind which the pores lie in two rows until tail which has three pores on each side. Lateral hypodermal chords about 1/3 of body width. Stylet and oesophagus typical for the genus. Large flanges on odontophore base measure 11-12  $\mu$ m across. Distance between anterior end of body and stylet basal guiding ring varies from 80  $\mu$ m in specimens with protruding stylet to 102  $\mu$ m in those with retracted stylet. Enlarged part of oesophagus 108-127  $\mu$ m long by 14-18  $\mu$ m wide. Cardia rounded. Nerve ring about 30  $\mu$ m behind hemizonid which lies opposite base of odontophore. A mucro resembling a stylet tip present in anterior slender part of oesophagus 40-76  $\mu$ m from base of odontophore.

Gonads paired, symmetrical, opposed, reflexed. Ovaries with 1-4 rows of oocytes. Oviduct and uterus junction with a distinct sphincter; an organ-Z not seen. Uterine pouch adjacent to the sphincter large and oval. Uterine chamber very muscular and conspicuous. Vagina slightly over half body width long. Vulva median, transverse, with slightly protuberant lips.

Table 1

Juvenile stages of *Xiphinema neobasiri* sp. n.

	<i>I-stage</i> (n = 4)	<i>II-stage</i> (n = 4)	<i>III-stage</i> (n = 6)	<i>IV-stage</i> (n = 6)
L (mm)	0.93-1.03 (0.98)	1.1-1.3 (1.2)	1.8-2.3 (1.95)	2.6-3.0 (2.8)
a	52-61 (55.6)	50-68 (57)	46-86 (65)	73-93 (83.5)
b	3.7-4.2 (3.9)	4.0-5.2 (4.6)	5.1-6.1 (5.7)	7.5-7.9 (7.7)
c	18-21 (19.6)	21.3-22.7 (22)	31-38 (33)	42-49 (45)
c'	4.0-4.7 (4.2)	3.6-4.0 (3.75)	2.7-3.1 (2.9)	2.4-2.7 (2.5)
ods ( $\mu$ m)	46-49 (47)	55-62 (58)	72-80 (76.5)	88-96 (93.6)
odp ( $\mu$ m)	35-42 (37.6)	37-44 (41.5)	49-55 (52.5)	58-64 (61)
replacement ods ( $\mu$ m)	57-60 (58)	69-80 (74.5)	88-99 (95.3)	110-117 (113.8)
sbgr ( $\mu$ m)	38-41 (40)	43-46 (44.7)	54-70 (64.6)	72-87 (82.4)
Tail length ( $\mu$ m)	46-52 (50)	52-60 (55)	56-62 (58.6)	60-66 (63)
h $\mu$ m	5-6 (5.5)	6-11 (8.5)	13-16 (14.5)	17.5-20.0 (19)
Tail/h as %	10.5-11.5 (10.9)	11.5-18.3 (15.5)	22.5-27.6 (24.5)	28-33 (30)

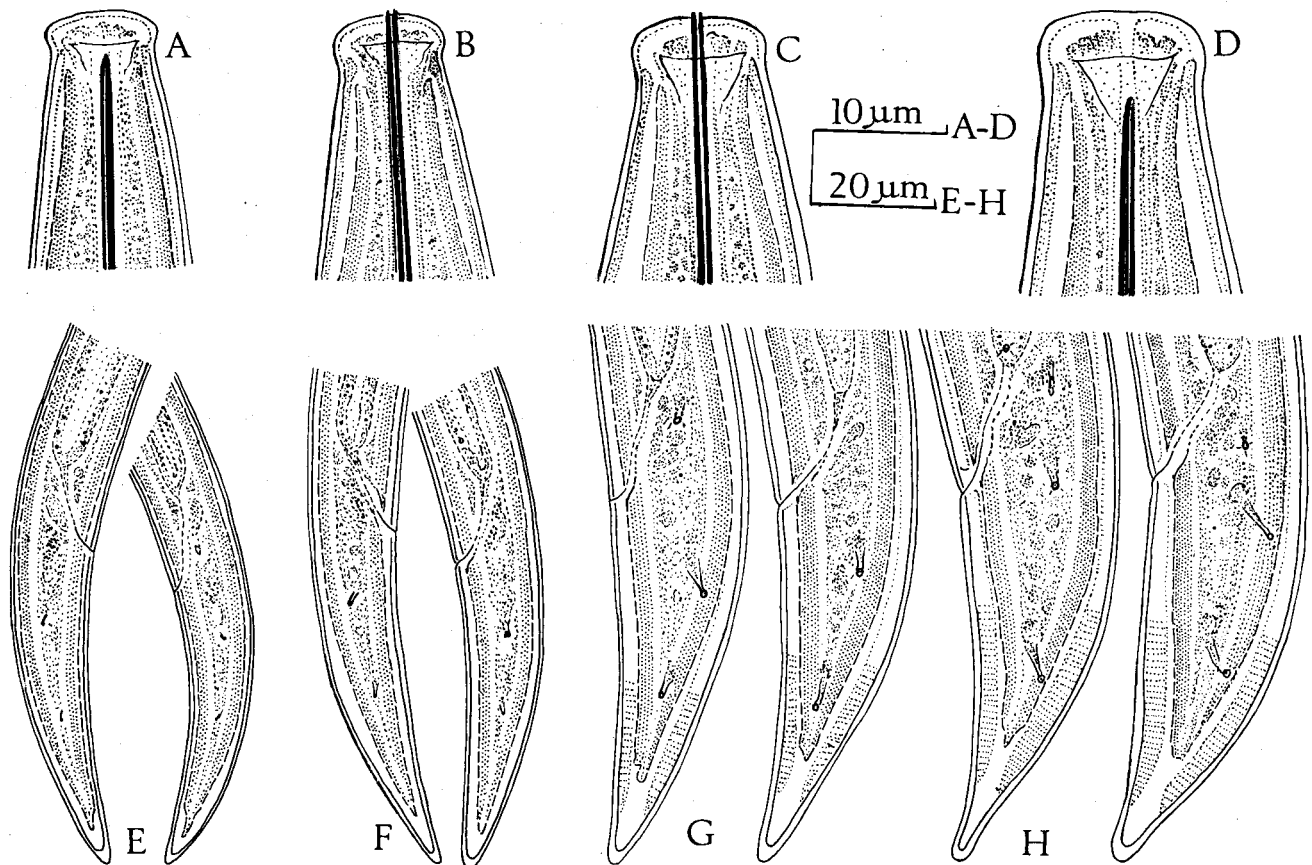


Fig. 2 : Juveniles of *Xiphinema neobasiri*. A-D : Anterior ends showing expanded lip regions. E-H : Tails. A & E : I-stage juveniles. B & F : II-stage juveniles. C & G : III-stage juveniles. D & H : IV-stage juveniles.

Prerectum 280-475  $\mu\text{m}$  long. Rectum about anal body width long. Tail sub-cylindroid to mammillate end, with greater curvature on dorsal side, narrowing terminally to a digitate peg 10-12  $\mu\text{m}$  or about one-fifth of tail long ; terminal hyaline portion (h) 20-24  $\mu\text{m}$  long ; tail length 52-60 (56.3)  $\mu\text{m}$  or 1.8-2.1 (1.9) times anal body width.

*Male*

Not found, and the females were not fertilised.

*Juveniles*

Ratios a, b and c show a gradual increase with the increase in the body length, while the tail length increases slightly from averaging 50  $\mu\text{m}$  in the I-stage juveniles to 63  $\mu\text{m}$  in those of the IV-stage. The length of the terminal

hyaline portion of the tail (h) and h as a percentage of tail length also show a gradual increase from I- to IV-stage juveniles. The tail shape of the IV-stage juveniles is similar to that of the female tail ; other stages have a conoid tail in which a terminal peg is not developed (Fig. 2, E-H).

*Type habitat and locality.* Soil around roots of potato (*Solanum tuberosum* L.) at Bvumbwe Experimental Station, Limbe, Malawi. Juvenile stages also found around tomato roots in the same locality.

*Type material.* Collected and forwarded by Dr. M. A. Siddiqi in 1969. Holotype ♀, 4 ♀♀ paratypes and 20 juvenile paratypes at CIH, St. Albans, England. 2 ♀♀ paratypes at each of these centres : Department of Nematology, Rothamsted Experimental Station, Harpenden, England ; Department of Nematology, Landbou-

whogeschool, Wageningen, The Netherlands; Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris, France; USDA Nematode Collection, Beltsville, Maryland, USA; Division of Nematology, Indian Agricultural Research Institute, New Delhi, India.

RELATIONSHIP. *Xiphinema neobasiri* sp. n. comes close to *X. basiri* Siddiqi, 1959, but differs in having a larger body-size, a more expanded lip region and female tail measuring over 1.5 body widths long. The tail peg in *X. neobasiri* sp. n. is about one-fifth of the tail length, whereas in *X. basiri* it is about one-third of the tail. In *X. neobasiri* sp. n. the ventral and dorsal series of body pores begin 10-14 (12)  $\mu\text{m}$  and 12-18 (15)  $\mu\text{m}$  from anterior end, respectively, whereas in *X. basiri* (eight paratype females) they begin 23-44 (30)  $\mu\text{m}$  and 25-43 (29)  $\mu\text{m}$  from anterior end respectively. From *X. basilgoodeyi* Coomans, 1965 and *X. vuittenezi* Luc *et al.*, 1964 it differs in having an expanded lip region, a smaller odontostyle and female tail measuring over 1.5 times anal body-width long. It differs from *X. index* Thorne & Allen, 1950 and *X. coxi* Tarjan, 1964 by its more posterior vulva and a longer and differently shaped female tail.

***Xiphinema michelluci* sp. n.**

(Fig. 3, A-I & Fig. 4, A-D)

MEASUREMENTS. 13 ♀♀ (paratypes): L = 3.3-3.9 (3.59) mm; a = 55-68 (60); b = 7.7-8.6 (8); c = 53-65 (60); c' = 1.2-1.7 (1.45); V = 45.3-49.6 (47.5); ods = 122-129 (125)  $\mu\text{m}$ ; odp = 77-85 (81)  $\mu\text{m}$ ; total st = 201-211 (205)  $\mu\text{m}$ ; sbgr = 96-119 (109)  $\mu\text{m}$ .

Holotype ♀: L = 3.58 mm; a = 59; b = 7.9; c = 58; c' = 1.47; V =  $17.648.6^{17.8}$ ; ods = 125  $\mu\text{m}$ ; odp = 82; sbgr = 96  $\mu\text{m}$ .

25 JJ (paratypes): See Table 2.

DESCRIPTION

*Female*

Body long and robust (maximum width 50-65 (60)  $\mu\text{m}$ ), spiral to C-shaped in relaxed position,

gradually tapering anterior to oesophageal base up to mid-odontostyle region and then rather abruptly to lip region which is about 17  $\mu\text{m}$  wide or approximately one-third as wide as body at oesophageal base. Cuticle 2.9-3.7  $\mu\text{m}$  thick at mid-body, and up to 11  $\mu\text{m}$  thick at tail. Ventral and dorsal series of body pores begin 21-28 (24)  $\mu\text{m}$  and 29-43 (35)  $\mu\text{m}$  from anterior end, respectively; lateral body pores begin just behind the amphids and number about 14 on each side in oesophageal region. Ventral body pores number 8-13 (11) in oesophageal region, 10-17 (13) between oesophagus and vulva and 7-18 (11) between vulva and anus. Dorsal body pores are 3-5 (4) occurring in stylet region. Lateral hypodermal chords about one-fourth of body width. Lip region low, in lateral view appearing angular and offset by increased width at level of amphid apertures, with somewhat flattened sides inclined at 45° to body axis and round to truncate anterior surface; outer labial papillae occur at about middle of these flattened side areas and are not raised above surface (Fig. 3, B). Amphids stirrup-shaped, with crescent-shaped apertures about 50-60 percent of maximum width of lip region long.

Odontostyle robust, with furcate base. Odontophore usually 80-85  $\mu\text{m}$  long when not contracted, with large flanges 13-16 (14.5)  $\mu\text{m}$  across. Stylet basal guiding ring usually about 112-119  $\mu\text{m}$  from anterior end, but when the stylet is protruding it could be only 96  $\mu\text{m}$  from anterior end. Oesophagus about 440-460  $\mu\text{m}$  long, its basal bulb about 90-100  $\times$  20-22  $\mu\text{m}$ ; nucleus of dorsal oesophageal gland about 15-17  $\mu\text{m}$  from anterior end of basal bulb. Oesophago-intestinal valve rounded. A triangular mucro resembling the stylet tip usually 60-72  $\mu\text{m}$  behind stylet base, but it could be as near as 28  $\mu\text{m}$  to stylet base. A flat inconspicuous hemizonid about 16-36  $\mu\text{m}$  behind stylet base.

Gonads paired, symmetrical, opposed, reflexed at oviduct. Ovaries with a few oocytes. Oviduct with a large pouch with folded walls which is joined to a large oval uterine pouch through sphincter. An organ-Z not seen. Uterus long and thin-walled, joined to the large uterine chamber or ovijector which is slightly more than a body width long. Numerous spine-like bodies fill the lumen of uterus between uterine pouch and the ovijector (Fig. 3, D & F). These are straight to

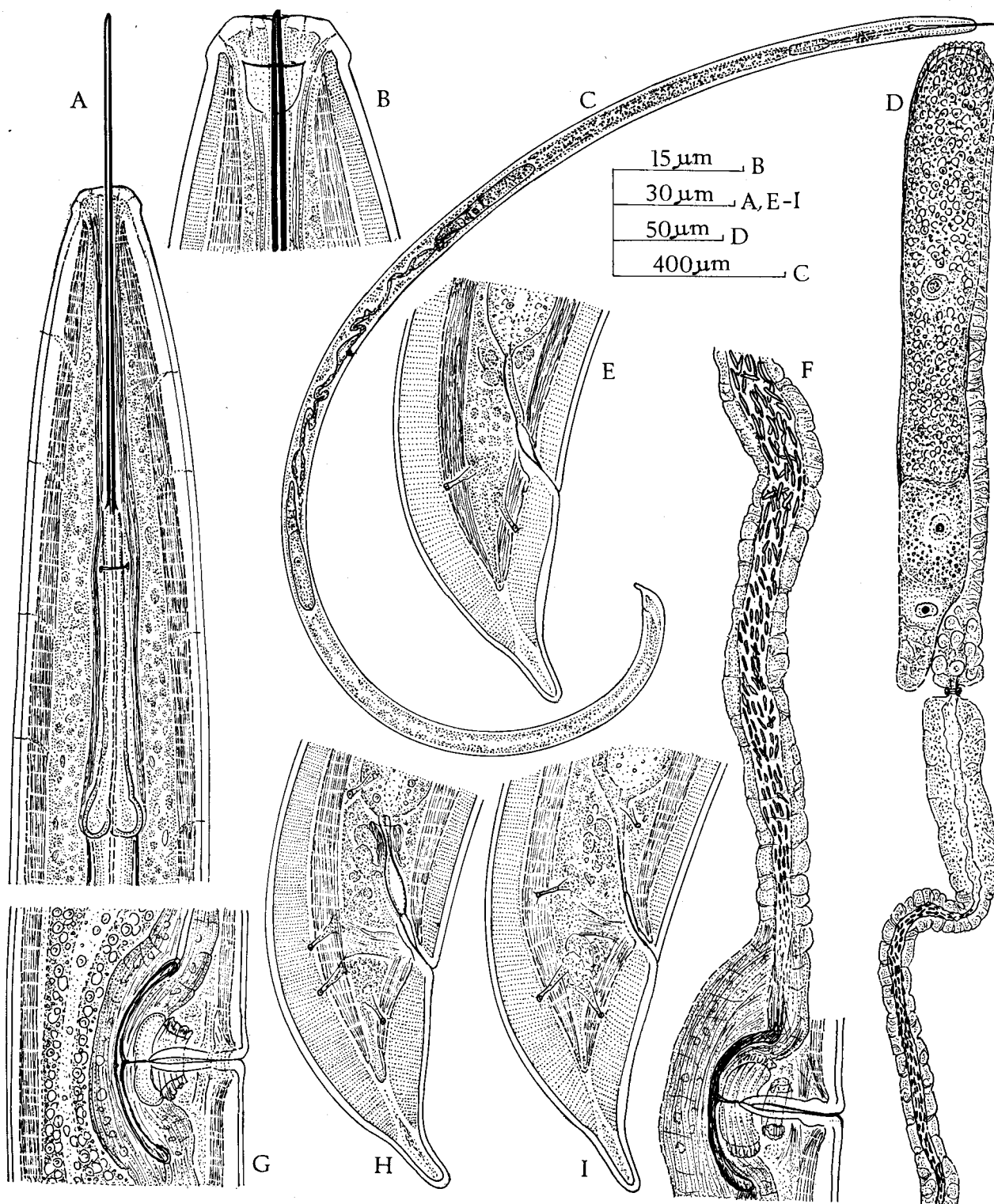


Fig. 3. : *Xiphinema michelluci* sp. n., females. A & B : Anterior ends. C : Female. D & F : Portions of anterior branch of reproductive organs. E, H & I : Tails. G : Vulval region. A, C, D & I : Holotype female.

Table 2  
 Juvenile stages of *Xiphinema michelluci* sp. n.

	I-stage (n = 6)	II-stage (n = 5)	III-stage (n = 8)	IV-stage (n = 6)
L (mm)	0.95-1.18 (1.11)	1.37-1.59 (1.46)	1.89-2.35 (2.07)	2.45-2.88 (2.68)
a	40-47 (44.5)	44-48 (46)	40-58 (50)	50-64 (56)
c	12-14 (13)	15-17 (16)	22-27 (24.6)	30-42 (35)
c'	4.4-5.5 (4.8)	4.1-4.3 (4.2)	2.5-3.4 (2.8)	1.8-2.5 (2.1)
ods ( $\mu\text{m}$ )	55-64 (61)	70-74 (72.4)	86-95 (91)	102-107 (105)
odp ( $\mu\text{m}$ )	44-47 (46)	49-55 (51)	58-66 (60)	65-74 (71)
replacement ods ( $\mu\text{m}$ )	72-74 (73)	86-93 (91)	104-110 (107.5)	115-125 (122)
sbgr ( $\mu\text{m}$ )	46-58 (53)	60-62 (61)	70-85 (79)	85-100 (92)
Tail length ( $\mu\text{m}$ )	78-88 (82)	82-96 (90)	77-90 (83.5)	69-80 (75)
h ( $\mu\text{m}$ )	13-24 (19)	19-26 (23)	21-32 (26)	31-33 (32)
Tail/h as %	16-27 (22)	19.7-28.5 (25)	27-35 (31)	40-45 (42)



Fig. 4 : Juvenile tails of *Xiphinema michelluci* sp. n. A : I-stage juveniles. B : II-stage juveniles. C : III-stage juveniles. D : IV-stage juveniles.

arcuate with bluntly rounded tapering ends, 4-6 (5)  $\mu\text{m}$  long, reducing in size towards the ovijector. These bodies may stick to the uterine wall but as they are not rooted in it. I believe them to be spores of some parasite rather than spines such as those reported by Luc (1973) for *X. malagasi* and *X. spinuterum*. Vagina at right angles to body axis, about 0.4 times body width long. Vulva just premedian, with slightly raised lips.

Prerectum indistinct. Rectum about anal

body width long. Tail convex-conoid to a subdigitate peg directed ventrally to body axis, 1.2-1.7 (1.45) times anal body width long, with two to three pairs of caudal pores; terminal hyaline portion of tail 24-37 (32)  $\mu\text{m}$  long or 40-62 (51)% of tail length; terminal peg 15-19 (16.5)  $\mu\text{m}$  long or 25-32 (28)% of tail length (fig. 3, E, H & I).

#### Male

Probably absent as females were not fertilised.

*Juveniles*

The tail length does not vary markedly between the juvenile stages but the c ratio of the body length to the tail length shows a clear differentiation. The tail becomes fatter so that the c' ratio reduces with progressive juvenile stages (Fig. 4).

This species is named after Dr. Michel Luc in recognition of his excellent work of more than 20 years on the taxonomy of *Xiphinema*.

*Type habitat and locality.* Soil around roots of unthrifty and stunted castor bean plants (*Ricinus communis* L.) at Zomba Experiment Station, Zomba, Malawi; collected on 13th November, 1962. A female was also collected on 16th December, 1963 around roots of potato (*Solanum tuberosum* L.) in Secondary School Garden at Dedza, Malawi. Another female was found on 9th July, 1963 in a sample of moss growing on a rocky ledge at Kampata Village, near Dedza, Malawi.

*Type material.* Collected by Dr. D. C. M. Corbett. Holotype ♀, 3 ♀♀ paratypes and 25 juvenile paratypes at CIH, St. Albans, England. 2 ♀♀ paratypes at each of these centres: R.E.S., Harpenden, England; Landbouwhogeschool, Wageningen, the Netherlands; Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris, France; USDA Nematode Collection, Beltsville, Maryland, USA; I.A.R.I., New Delhi, India.

**RELATIONSHIP.** *Xiphinema michelluci* sp. n. resembles *X. seredouense* Luc, 1975 in several details. However it differs from it in having a low lip region which is angular and offset by an expansion at the base, a shorter odontostyle (146-162 (154) µm long in *X. seredouense*), longer odontophore (62-76 (72) µm long in *X. seredouense*), a more anteriorly placed stylet basal guiding ring (130-144 (139) µm from anterior end in *X. seredouense*), a slightly more anterior vulva and the uterus filled with spores or spine-like bodies. It differs from *X. basiri* Siddiqi, 1959 and *X. tarjani* Luc, 1975 by its differently shaped lip region, longer odontophore (57-63 (60.6) µm long in *X. basiri* and 59-69 µm long in *X. tarjani*) and female tail peg directed ventrally to the body axis.

***Xiphinema heynsi* sp. n.**

(Fig. 5, A-P)

**MEASUREMENTS.** 3 ♀♀ (paratypes): L = 3.1-3.5 (3.34) mm; a = 62-68 (64); b = 7.1-8.8 (8.1); c = 106-125 (113); c' = 0.69-0.88 (0.78); V = 46.4-49.5 (48); ods = 107-114 (110) µm; odp = 71-77 (74) µm; total st = 178-191 (184) µm; sbgr = 92-100 (96) µm.

Holotype ♀: L = 3.5 mm; a = 64; b = 8.4;

Table 3  
Juvenile stages of *Xiphinema heynsi* sp. n.

	<i>I-stage</i> (n = 10)	<i>II-stage</i> (n = 7)	<i>III-stage</i> (n = 5)	<i>IV-stage</i> (n = 3)
L (mm)	1.02-1.13 (1.07)	1.32-1.48 (1.36)	1.77-1.98 (1.91)	2.55-2.70 (2.63)
a	46-52 (49)	51-56 (53)	56-65 (60)	58-64 (61)
b	4.1-4.5 (4.3)	4.6-5.6 (4.8)	5.5-6.4 (5.9)	6-7 (6.5)
c	15-18 (16.5)	18-21 (19)	51-58 (55)	64-85 (77)
c'	3.7-5.0 (4.1)	3.4-4.0 (3.7)	1.28-1.50 (1.36)	0.96-1.29 (1)
ods (µm)	54-58 (56)	58-68 (65)	79-86 (82.5)	96-97 (96.3)
odp (µm)	35-39 (37)	44-48 (46)	56-60 (57)	56-62 (59)
replacement ods (µm)	62-68 (65)	78-84 (81)	96-99 (97.4)	109-112 (111)
sbgr (µm)	37-43 (41)	49-58 (52)	56-72 (66)	70-82 (76)
Tail length (µm)	63-70 (66)	68-73 (71)	32-38 (35)	32-40 (34.6)
h (µm)	9-13 (11)	31-35 (32)	7-8 (7.8)	8-11 (8.9)
Tail/h as %	12.8-20.0 (15.7)	43-49 (45.7)	21.0-23.5 (22)	20-33 (26)

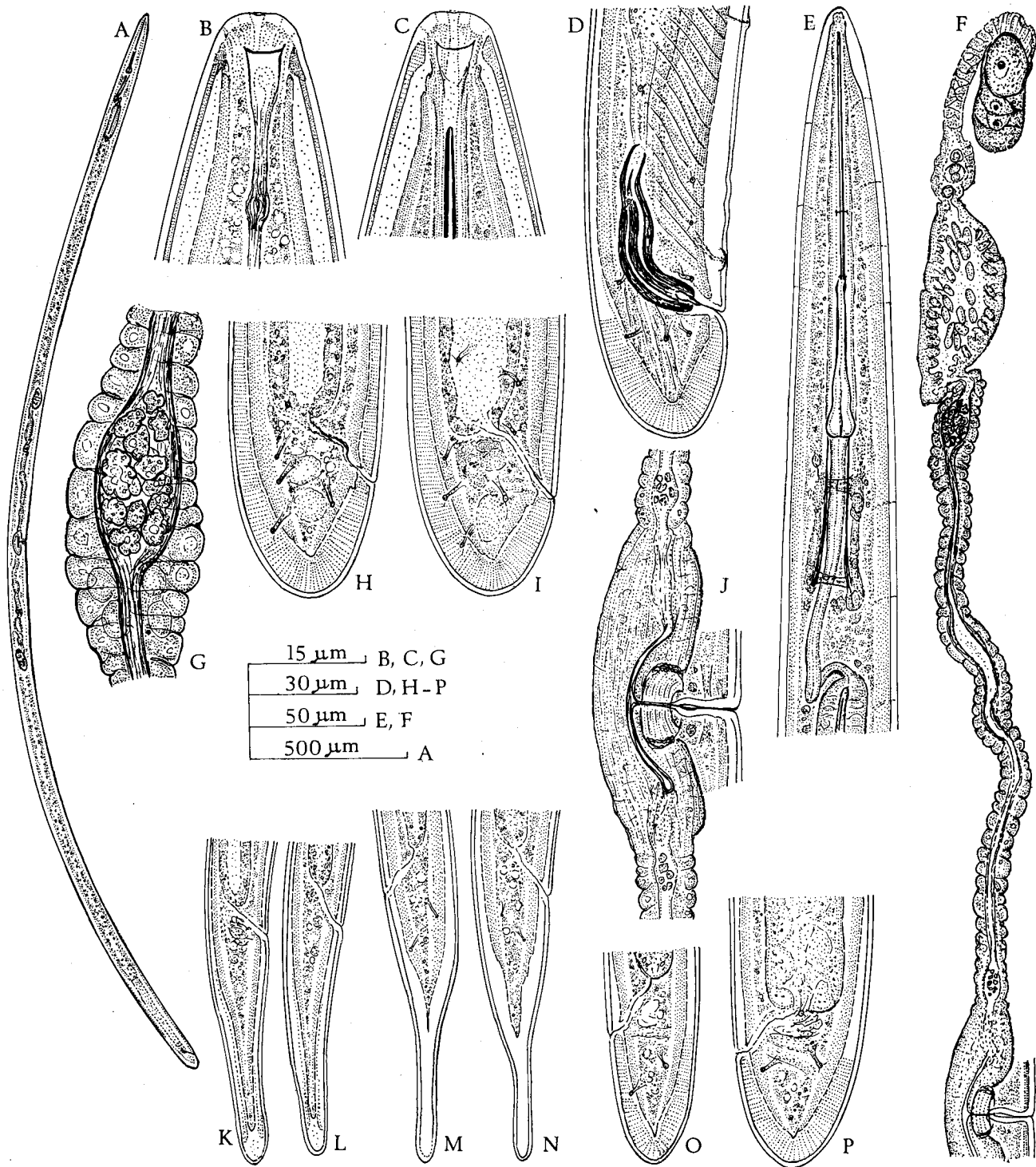


Fig. 5 : *Xiphinema heynsi* sp. n. A : Female. B & E : Female anterior ends. C : Male anterior end. D : Male tail end. F : Anterior branch of female reproductive organs. G : Pseudo-organ-Z. H & I : Female tails. J : Vulval region. K & L : Tails of I-stage juveniles. M & N : Tails of II-stage juveniles. O : Tail of III-stage juvenile. P : Tail of IV-stage juvenile. A, E, F, I & J : Holotype female.

$c = 132$ ;  $c' = 0.69$ ;  $V = 14 \cdot 49.3^{12}$ ;  $ods = 111 \mu\text{m}$ ;  $odp = 72 \mu\text{m}$ ;  $sbgr = 93 \mu\text{m}$ .

4 ♂♂ (paratypes):  $L = 3.1-3.4 (3.23) \text{ mm}$ ;  $a = 63-72 (67)$ ;  $b = 7.4-8.5 (8.1)$ ;  $c = 94-107 (100)$ ;  $c' = 0.8-1.02 (0.95)$ ;  $T = 52-56 (54)$ ;  $ods = 103-114 (110) \mu\text{m}$ ;  $odp = 72-76 (73) \mu\text{m}$ ;  $total \text{ st} = 175-190 (183) \mu\text{m}$ ;  $sbgr = 92-103 (100) \mu\text{m}$ ;  $spicules \text{ (along cord)} = 54-59 (56) \mu\text{m}$ .

25 JJ (paratypes): see Table 3.

## DESCRIPTION

### Female

Body elongate-slender (maximum width  $51-56 (53) \mu\text{m}$ ), arcuate, tapering slightly towards extremities but more strongly from mid-odontostyle region to lip region which is conoid-rounded, continuous with body contour,  $11.0-11.5 \mu\text{m}$  in diameter at its base; labial papillae indistinct. Amphid apertures crescent-shaped, occupying 40-45 percent of corresponding body width. Dorsal body pores 2-3 in odontostyle region, anteriormost  $51-53 \mu\text{m}$  from anterior end. Series of ventral body pores begins  $38-41 \mu\text{m}$  from anterior end and the pores number 12-13 in oesophageal region, 19-25 between oesophagus and vulva and 23-25 between vulva and anus. Lateral hypodermal chord  $12 \mu\text{m}$  wide. Stylet and oesophagus typical of the genus. Basal flanges of odontophore  $11 \mu\text{m}$  across. Basal oesophageal bulb  $107-115 \mu\text{m}$  long by  $20-22 \mu\text{m}$  wide. Oesophago-intestinal valve rounded.

Vulva just pre-median, with slightly raised lips. Vagina extending half-way into body. Two branches of reproductive system equally developed, opposed, reflexed at the oviduct. Ovijector about 1.5 body-widths long. Uterus a narrow tube with "knotted" walls, enlarged into a large pouch near sphincter. Near this uterine pouch there is a pseudo-organ-Z containing 7-9 irregularly rounded globular bodies or "apophyses" (Fig. 5, F & G). Similar but smaller "apophyses" were also seen in the uterine lumen adjacent to ovijector (Fig. 5, J). These "apophyses" are somewhat similar in shape and structure to the globular bodies in organ-Z described for *X. diversicaudatum* by Pitcher, Siddiqi and Brown (1974).

Pre-rectum  $255-325 (290) \mu\text{m}$  long; rectum sigmoid,  $28-32 (30) \mu\text{m}$  long; pre-rectum and

rectum together occupy 8.2-11.2 (9.4) per cent of body length. Tail end not clavate. Tail tapering to a broadly obtuse terminus,  $28-32 (29.6) \mu\text{m}$  or 0.69-0.88 (0.78) times anal body-width long, with 3 pairs of caudal pores; no "blind canal" in inner layers of cuticle which are thick.

### Male

Body arcuate with greater curvature in tail end. Testes paired, one outstretched, the other reflexed. Spicules rather slender proximally, ventrally bent behind middle; median stiffening piece slender reaching close to proximal tip. Lateral guiding piece of spicule  $10-13 (12) \mu\text{m}$  long. Strong diagonal copulatory muscles present in region of supplements. Paired subventral supplements  $15-18 (17) \mu\text{m}$  in front of cloacal aperture. 4-6 ventromedian supplementary papillae present, first being  $64-91 (74) \mu\text{m}$  anterior to paired supplements; distance between I-II, II-III, III-IV, IV-V and V-VI ventromedian papillae varies as  $30-40 (34) \mu\text{m}$  (in one individual  $74 \mu\text{m}$ );  $26-34 (29) \mu\text{m}$ ;  $23-32 (28) \mu\text{m}$ ;  $30-34 (32) \mu\text{m}$  and  $23-46 (39.5) \mu\text{m}$ , respectively.

Tail  $30-36 (32.5) \mu\text{m}$  or about one anal body width long, tapering to a broadly obtuse terminus; inner cuticle thickened, radially striated, without terminal "blind canal"; inner protoplasmic core conoid (Fig. 5, D). Caudal pores 3-4 on each side, close to cloacal level. Tail end not clavate.

### Juveniles

Lip region in all juveniles is small, conoid-round and continuous with body contour. The tail of I-stage juveniles slightly tapers to a rounded terminus; its inner protoplasmic core is convex-conoid in first  $2/5$ th of its length, then it tapers to become elongate-slender (Fig. 5, K & L). The tail length in I- and II-stage juveniles is almost double the tail length of III- and IV-stages. The inner protoplasmic core drastically contracts in the II-stage with the result that the "h" value is highest in this stage. The tail in III-stage juveniles rounds off with further contraction of the core which is conoid; the tail length becomes almost half of the previous stage. Finally the IV-stage juvenile tail looks

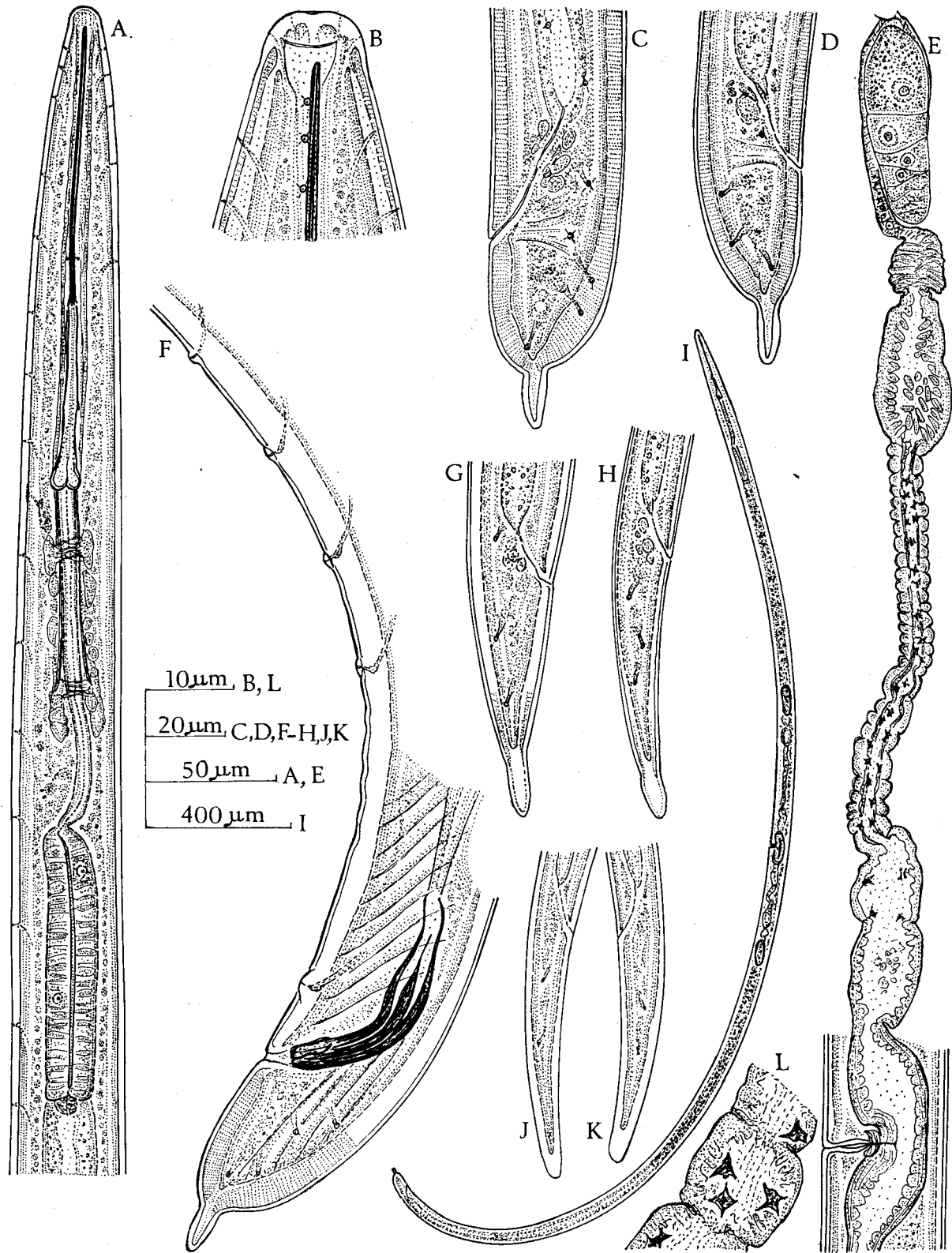


Fig. 6 : *Xiphinema mammatum* sp. n. A : Female oesophageal region. B : Female anterior end. C : Female tail. D : Tail of IV-stage juvenile. E : Anterior branch of female reproductive organs. F : Male tail end showing spicule and supplements. G : Tail of III-stage juvenile. H : Tail of II-stage juvenile. I : Female. J & K : Tails of I-stage juveniles. L : A portion of uterus with stellate spines. A-C, E, I & L : Holotype female.

similar to that of the female except it is slightly longer as compared to the anal body width.

This species is named after Professor J. Heyns of Rand Afrikaans University, Johannesburg, South Africa, in recognition of his valuable work on the Longidoridae.

*Type habitat and locality.* Soil around roots of lucerne (*Medicago sativa*), South Kilimanjaro, Tanzania.

*Type material.* Collected and submitted by C. Critchett in 1969. Holotype ♀ and 25 JJ paratypes at CIH, St. Albans, England; 1 ♀ and 1 ♂ paratypes at each of these centres: Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris, France; USDA Nematode Collection, Beltsville, Maryland, USA.

**RELATIONSHIP.** *Xiphinema heynsi* sp. n. comes closest to *X. clavatum* Heyns, 1965 from which it differs in having a conoid rounded, continuous lip region (hemispherical, slightly offset by expansion in *X. clavatum*), a non-clavate tapering female tail (hemispherical in *X. clavatum*), shorter odontostyle and odontophore (odontostyle 107-127 (119) µm and odontophore 78-90 (84) µm in females of *X. clavatum*; a paratype female and a paratype male of *X. heynsi* sp. n. at Rothamsted Experimental Station, Harpenden have these measurements: ♀: odontostyle 126 µm; odontophore 87 µm; ♂: odontostyle 131 µm; odontophore 86 µm); smaller and more slender spicules which are distinctly angular behind middle, more ventromedian supplementary papillae, the first of which begins at less than 100 µm anterior to the paired supplements, and in the juveniles having shorter functional and replacement odontostyles and differently shaped tails in corresponding stages. A somewhat similar organ-Z as described for *X. heynsi* sp. n. was also seen in the paratype of *X. clavatum* in the "quadricolumellar" section of the uterus described by Heyns (1965). Dorsal and ventral body pores were also seen in the paratype female of *X. clavatum*.

*X. heynsi* sp. n. is also related to *X. yapoense* Luc, 1958 and *X. guirani* Luc & Williams, 1978. From *X. yapoense* it differs in having a conoid-rounded continuous lip region, a shorter odontostyle (138 µm long in *X. yapoense*), a more posterior vulva and a larger number of caudal pores.

From *X. guirani* it differs in having a larger body-size (♀: L = 1.99-2.5 mm in *X. guirani*), a continuous lip region, a pseudo-organ Z, no "blind canal" in the inner cuticle of the tail, smaller spicules and more ventromedian supplementary papillae beginning closer to the cloaca.

### ***Xiphinema mammatum* sp. n.**

(Fig. 6, A-L)

**MEASUREMENTS.** Holotype ♀: L = 3.16 mm; a = 67; b = 7.5; c = 64.5; c' = 1.7; V = 1344.6<sup>10</sup>; ods = 110 µm; odp = 73 µm; sbgr = 99 µm.

3 ♂♂ (paratypes): L = 3.02-3.52 (3.19); a = 70-81 (76); b = 7.1-7.3 (7.2); c = 61-76 (70); c' = 1.3-1.6 (1.4); T = 49-57 (51); ods = 109-111 (110) µm; odp = 68-72 (70) µm; total st = 178-183 (180) µm; sbgr = 85-94 (89) µm; spicules = 58-63 (61) µm.

5 JJ (paratypes): See Table 4.

### **DESCRIPTION**

#### *Female*

Body elongate-cylindrical, slightly tapering in the posterior region, markedly tapering from mid-odontostyle region to lip region which is 11.5 µm in diameter or about one-fourth as wide as body at oesophageal base; ventrally arcuate, more so in posterior region (Fig. 6, I). Cuticle smooth, 3.7 µm thick, but on tail up to 8 µm thick. Lateral hypodermal chords one-fourth body width. Ventral and dorsal series of body pores begin 14 µm from anterior end; 5 dorsal body pores in odontostyle region; ventral body pores are 15 in oesophageal region, 21 between oesophagus and vulva and 27 between vulva and anus. Lateral body pores begin close to amphid base and lie in a row in the oesophageal region behind which they form two rows.

Lip region hemispherical, slightly marked off by expansion; labial papillae indistinct. Amphids with crescent-shaped apertures, about 3/5th lip region width. Stylet and oesophagus typical of the genus. Basal flanges of odonto-

Table 4  
Juvenile stages of *Xiphinema mammatum* sp. n.

	I-stage (n = 2)	II-stage (n = 1)	III-stage (n = 1)	IV-stage (n = 1)
L (mm)	0.78-0.8	1.06	1.66	2.17
a	46-47	48	49	58
b	3.6-3.7	4.9	5.6	6
c	13.4-14.8	15.6	28	44
c'	5.0-5.7	4.4	2.8	1.95
ods ( $\mu\text{m}$ )	45	59	70	90
odp ( $\mu\text{m}$ )	33-36	42	53	58
replacement ods ( $\mu\text{m}$ )	53-56	70	90	107
sbgr ( $\mu\text{m}$ )	32	40	58	67
Tail length ( $\mu\text{m}$ )	54-58	68	59	49
h ( $\mu\text{m}$ )	6.5-8	14	18	16.5
Tail/h as %	12-13.8	20.5	30.5	33.6

phore 11  $\mu\text{m}$  across. Enlarged part of oesophagus 102  $\mu\text{m}$  long by 21  $\mu\text{m}$  wide. Oesophago-intestinal valve rounded. Hemizonid at base of odontophore. Nerve ring 205  $\mu\text{m}$  from anterior end, a little behind odontophore base.

Vulva a transverse slit, on a slight protuberance of body. Vagina straight, leading half-way into body. Strongly muscular ovijector 1.6 times body width long. Two branches of reproductive organs equally developed, opposed. Uterus with small widely scattered stellate spines, each with four to five radiating processes, appearing to be attached to uterine wall (Fig. 6, E & L). Uterine pouch large, with sperms, joined to oviduct through sphincter. An organ-Z not seen. Ovaries with 10-12 oocytes.

Pre-rectum clearly marked from intestine, 750  $\mu\text{m}$  long. Rectum just over anal body-width long. Tail 46  $\mu\text{m}$  long (including terminal peg), subcylindrical to a hemispherical region bearing a central, terminal, offset, lozenge-shaped peg measuring 13  $\mu\text{m}$  long and directed slightly dorsally to body axis; inner protoplasmic core subcylindrical in first three-fifths then conical; 3 pairs of caudal pores (Fig. 6, C).

#### Male

Body more strongly curved in posterior region than in female (maximum width 39-43  $\mu\text{m}$ ). Lip region, stylet and oesophagus as in female. Testes paired, one outstretched, the other reflexed. Spicules ventrally bent a little

behind middle. Lateral guiding pieces 12-13  $\mu\text{m}$  long. Paired preanal supplementary papillae 14-18 (16)  $\mu\text{m}$  in front of cloacal aperture. Four ventromedian supplementary papillae present in two individuals while the third has only three. Distance between paired supplements and first ventromedian papillae, between first and second, between second and third and between third and fourth ranges as 74-96 (82)  $\mu\text{m}$ ; 20-29 (24)  $\mu\text{m}$ ; 27-42 (33)  $\mu\text{m}$  and 28-29  $\mu\text{m}$ , respectively. Tail similar to that of female, 44-49  $\mu\text{m}$  long, with 11-14 (12.6)  $\mu\text{m}$  long offset peg directed slightly dorsally; hyaline portion of tail 14-17 (15.6)  $\mu\text{m}$  long; four to five pairs of caudal pores (Fig. 6, F).

#### Juveniles

The tail shape also differentiates these stages (Fig. 6). A lozenge-shaped mucro appears in the II-stage juvenile but the tail is elongate-conoid as in the I-stage. The IV-stage tail is similar to that of the female, while the III-stage tail is intermediate between the II-stage and the IV-stage tails. The lip region in all stages is slightly offset by expansion and this characteristic helped to single out these juveniles from those of *X. heynsi* sp. n. which occurred in the same sample.

*Type habitat and locality.* Soil around roots of lucerne (*Medicago sativa*), South Kilimanjaro, Tanzania.

*Type material.* Collected and submitted by

C. Critchett in 1969. Holotype ♀, 1 ♂ and 5 JJ paratypes at CIH, St. Albans, England. 1 ♂ paratype at Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris, France; 1 ♂ paratype at USDA Nematode Collection, Beltsville, Maryland, USA.

RELATIONSHIP. *Xiphinema mammatum* sp. n. is recognized by its hemispherical tail end bearing a large, offset, terminal peg and by the presence of stellate spines in the uterus. It is related to *X. mammillatum* Schuurmans Stekhoven & Teunissen, 1938; *X. vuittenezi* Luc *et al.* 1964; *X. coxi* Tarjan, 1964 and *X. index* Thorne & Allen, 1950. From *X. mammillatum* it differs in having a more slender body and a longer tail with larger terminal peg ( $a = 43-51$ ;  $c' = 0.7-0.8$ ); tail = 28-38  $\mu\text{m}$  in *X. mammillatum*, after Luc & Tarjan, 1963). *X. vuittenezi* has a round female tail with or without a short peg, a longer odontostyle and a more posterior vulva. *X. coxi* and *X. index* have less rounded female tail with less offset, ventrally placed peg which is not directed dorsally, and slightly longer odontostyle.

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