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REDESCRIPTION OF *XIPHINEMA LONGICAUDATUM* LUC, 1961 AND OBSERVATIONS ON *XIPHINEMA KRUGI* LORDELLO, 1955 (NEMATODA: LONGIDORIDAE)

BY

MICHEL LUC [1]) and D. J. HUNT

Laboratoire des Vers, associé au C.N.R.S., Muséum national d'Histoire naturelle, 43 rue Cuvier, Paris, and WINBAN, P.O. Box 115, Castries, St. Lucia, West Indies

Xiphinema longicaudatum Luc, 1961, previously described from a single female, is redescribed from 29 additional females from different locations in West Africa. The structure of the reduced anterior female genital branch was especially studied. Thirteen populations of *Xiphinema krugi* Lordello, 1955, from Africa, Asia, North and South America were also studied. The structure of their reduced anterior female genital branch, consisting of three parts (reduced uterus, sphincter and remnant of the oviduct) as in *X. longicaudatum*, conformed to the original description. The length, shape and structure of the tail tip varied, even within the same population. Mainly on the basis of these points, the synonymy of *X. denoudeni* Loof & Maas, 1972 and *X. loosi* Southey & Luc, 1973 with *X. krugi* is confirmed.

Xiphinema longicaudatum Luc, 1961
Figs. 1, 2

Xiphinema longicaudatum Luc, 1961 was described from one female from the rhizosphere of a pepper-plant in the Ivory Coast. Since then Cohn & Sher (1972) have studied several populations from Nigeria and one from Sri-Lanka, without giving additional information about the species. Three more populations of *X. longicaudatum* were found in the Ivory Coast and Dr. F. E. Caveness kindly sent several samples from Nigeria to one of us (M.L.). From all these the species is more fully described.

Material studied

Nematodes from soils about the following host plants were studied:

— Population1: pepper-plant, BAFECAO Estate, M'Brimbo, Ivory Coast: 1 ♀ (holotype)
— Population 2: rice and wild grasses, humid low ground, Station de Recherches Agricoles, Man, Ivory Coast: 10 ♀♀
— Population 3: coffee and wild grasses, near Baleko, Ivory Coast: 6 ♀♀
— Population 4: banana, BANACOMOE Estate, Abengourou, Ivory Coast: 2 ♀♀ 2 juv.
— Population 5: composite population from eight samples ("bush", cocoa, banana, plantain, maize, okra, yam) in various locations in Ondo, Oyo and Benin Provinces, W. Nigeria: 11 ♀♀

Females

Dimensions: Numerical data and ratios are in Table I. Length of the anterior genital branch and its ratio to vulval diameter are also given.

[1]) Nematologist of O.R.S.T.O.M.

Description: Heat-relaxed specimens are curved in an open C-shape. Body slender, attenuated at the anterior end, but more so posteriorly.

TABLE I

Xiphinema longicaudatum *Luc, 1961. Numerical data on females and juveniles. h = length of hyaline (non protoplasmic) part of tail, in µm. h% = same, expressed in percentage of tail length. a.g.b. = length of anterior genital branch, in µm. a.g.b./v.d. = same, expressed in vulval diameter.*

	Pop. 1 (holotype) Ivory Coast	Pop. 2 Graminaceae Ivory Coast	Pop. 3 Coffee Ivory Coast	Pop. 5 Nigeria	Pop. 4 Banana, Ivory Coast		
n	1 ♀	10 ♀♀	6 ♀♀	11 ♀♀	1 ♀	J 1	J 3
L (mm)	2.89	2.92 2.80-3.07	2.69 2.48-2.84	2.65 2.27-3.27	2.45	1.05	1.55
a	48.1	53.4 48.1-56.1	53.2 49.6-56.8	48.5 44.3-61.1	51.0	45.6	47.0
b	5.6	6.7 5.6-7.0	6.5 5.9-7.7	5.4* 4.8-6.6	5.8	4.2	5.2
Tail length (µm)	166	216** 188-231	208 176-225	173 154-241	224	206	210
c	17.4	13.7** 13.0-14.9	13.0 11.8-16.1	13.7 11.1-16.8	12.4	5.1	7.4
c'	6.3	7.0** 6.0-7.5	7.4 6.7-8.1	6.6 5.1-8.0	7.7	12.9	11.0
V	35.1	34.6 33.1-37.5	36.2 35.0-38.2	36.7 33.8-39.4	34.1	—	—
Od. style (µm)	151	158 144-164	149 146-152	152 135-162	152	71	108
Od. phore (µm)	81	84.5* 80-90	82 76-86	82 77-89	78	49	63
Total spear l. (µm)	232	242.5* 230-250	231 222-238	234 212-246	230	120	171
Replacement od. style (µm)	—	—	—	—	—	87	126
h (µm)	114	152** 144-162	149 108-173	126 90-163	—	80	70
h%	68	70** 63-77	73 67-86	65 58-75	—	39	33
a.g.b. (µm)	71	76.5* 66-85	84* 51-92	152 76-187	71	—	—
a.g.b/v.d.	1.2	1.4* 1.2-1.7	1.6* 1.3-1.8	2.8 1.4-3.4	2.8	—	—
		*n = 8 **n = 7	*n = 5	*n = 10			

Cuticle with fine transverse striae and apparently in two layers. Cuticle thickness: 3-3.5 μm at the middle of the body, 6-7 μm at the neck and 6-8 μm on the dorsal side of the tail. Cervical pores in four rows. The dorsal row consists of four pores while the ventral row contains four pores in front of the hemizonid and then extends by many widely spaced pores to the vulva or slightly behind. The lateral cervical row is prolonged as the latero-subdorsal row along the whole body. There are 2-4 latero-subventral pores. Lateral chord occupying about 1/4 of the body diameter at the level of vulva.

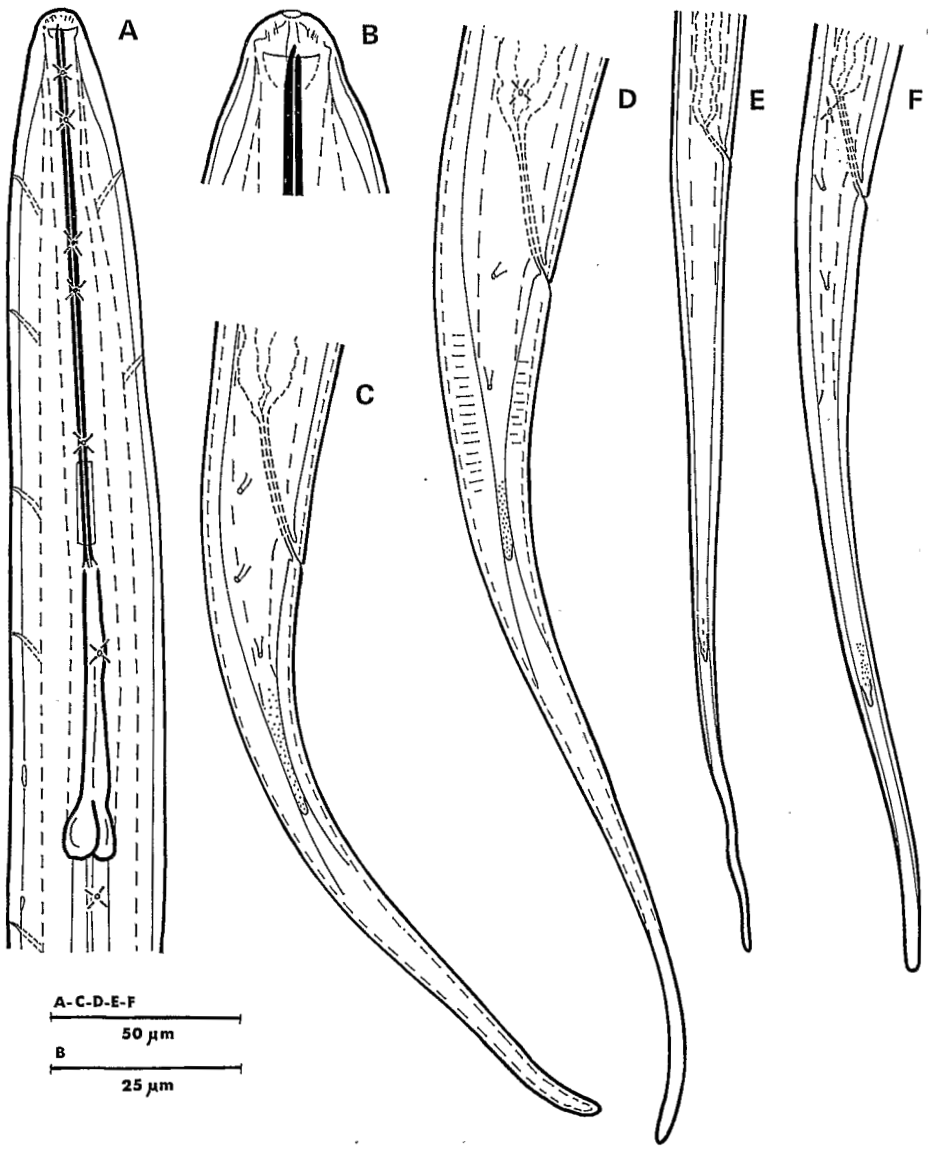

Fig. 1. A-F: *Xiphinema longicaudatum* Luc, 1961: female: A: anterior end; B: labial region; C, D: tail; E: J I: tail; F: J 3: tail.

Labial region rounded, not quite continuous with the body contour as it is separated by a very small depression. Amphid aperture slit-like, situated 4-5 μm from the anterior end.

Spear typical of the genus; basal flanges well developed, 15-19 μm wide. Tubular guide variable in length (5-20 μm) of which the base is 130-144 μm from the anterior end. Hemizonid 6-8 μm, situated at 200-212 μm from anterior end; hemizonion 2.5 μm, at 290-300 μm from anterior end. Nerve-ring 10-14 μm, situated at 12-25 μm behind the basal flanges.

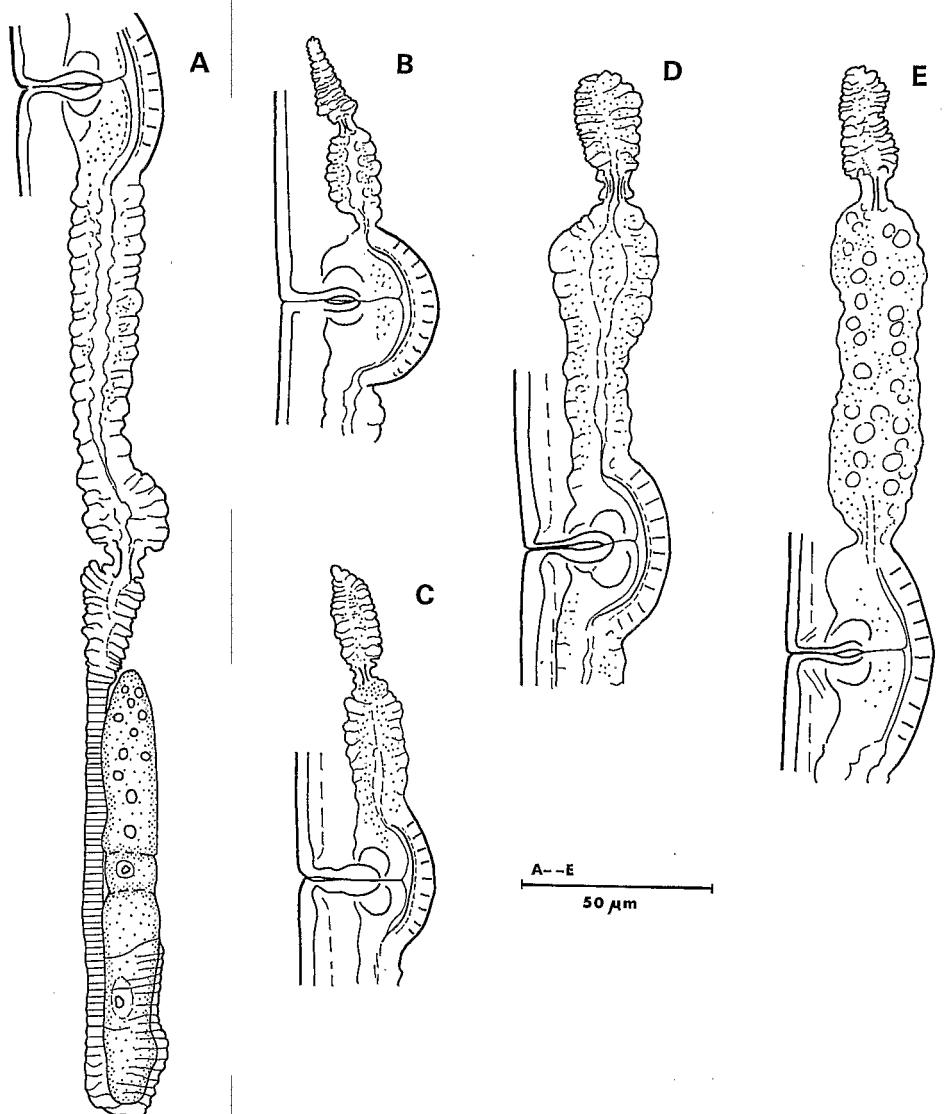

Fig. 2. A-E: *Xiphinema longicaudatum* Luc, 1961: female: A: posterior genital branch; B-E: anterior genital branch: B: holotype; C: pop. 2 (graminaceae, Ivory Coast); D: pop. 3 (coffee, Ivory Coast); E: pop. 5 (Nigeria).

Oesophageal basal bulb measuring 90-96 × 22-29 μm. Intestine without any particular features.

Vulva slightly posterior to the first third of the body. Vagina extends inward for about one third of the body diameter. Two genital branches present differing in development. Posterior branch normally developed: uterus formed by a tubular pseudo-quadricolumellar part followed by a uterine pouch with less distinct cells; sphincter well developed; oviduct pouch with walls finely folded followed by a tubular part with regular transverse striations; ovary normal. No Z-organ, pseudo Z-organ or other peculiar differentiation present. Anterior branch reduced and atrophied. Its structure is constant in all observed females but variations may occur in the development and size of the various parts. This anterior branch is formed of three parts: a reduced uterus, an easily recognisable sphincter and a remnant of the oviduct corresponding to the pouch of a normal oviduct. The total length of the anterior genital branch may vary (see Table I) from 51 to 187 μm (1.2 to 3.4 vulval diameters) and this variation is mainly due to differences in length of the uterus. The reduced uterus may or may not be separated from an ovijector-like portion by a constriction, but no muscular structure is visible at this level (Fig. 2, B, E). It is often enlarged, clearly composed of distinct cells (Fig. 2, B) and frequently has an enlarged lumen (Fig. 2, D). In the Nigerian population (with the exception of two of eleven females), the uterus is very long but no clear structure has been seen as the cells appear full of vacuoles that make observation difficult (Fig. 2, E). In each female studied the muscular sphincter is strongly differentiated, but its volume is variable and roughly proportional to the whole length of the genital branch. The remnant of the oviduct appears as a finely crinkled blind pouch, the shape and the volume of which varies.

Tail long (c′ more than 5), initially conoid and then attenuated with the extremity often curved. The length can vary but the general shape appears constant. Hyaline (non protoplasmic) part very long (60% of the total tail length, or more). Two pairs of caudal pores, the anterior being near the level of the anus.

Juveniles

Dimensions: cf. Table I.

Description: The two juveniles observed (JI and J3) have roughly the same characteristics.

The body (heat relaxed) is slender and slightly narrowed at the anterior end; the posterior part being more attenuated. Body slightly curved. No constriction between the body and lip region in JI but a slight constriction is present in the J3. Replacement odontostyle of the JI is inserted into the base of odontophore, as usual. Tail long, tenuous, filiform at its extremity. Hyaline (non protoplasmic) part less well developed than in females. Caudal pores not seen in JI but two exist in J3 and are located as in females.

Male: not known.

Amended diagnosis

Xiphinema longicaudatum Luc, 1961 is distinguished from all species but *X. filicaudatum* Loof & Maas, 1972 by the structure of the anterior female genital branch (which consists of a reduced uterus, a sphincter and a vestigial oviduct pouch) and by a relatively long thin tail (c′ more than 5). *X. filicaudatum* females are longer (3.7-4.7 mm vs 2.3-3.3 mm), with a longer spear (298-330 μm vs 212-250 μm), a longer tail (363-545 μm vs 154-231 μm) a bigger c′ ratio (10-15 vs 5.1-8.0) and a more nearly median vulva (V = 40-47 vs 33-39).

In the lattice of Luc and Dalmasso (1975), *X. longicaudatum* is quoted: A2. B4. C2. D(1)2. E1. F(2)3. G3. H2 I2/3. J?. K1. L1.

Remarks

Roy & Gupta (1974) placed *X. filicaudatum* (type) and *X. longicaudatum* in their new subgenus *Fillinema* (sic), making nine such subgenera with the eight erected by Cohn & Sher (1972). These groupings seem artificial as the only two reliable characters (tail shape and structure of the anterior female genital branch) probably evolved separately (Luc & Dalmasso, 1975). Of course, species assembled in these "subgenera" possess similarities, but we prefer to call them "groups" and to discard the term "subgenera" which have more precise connotations than the groupings justify and do not facilitate species determination.

Xiphinema krugi Lordello, 1955
Figs. 3-5

The identity of *Xiphinema krugi* Lordello, 1955 and its relationships with both *X. denoudeni* Loof & Maas, 1972 and with populations originally referred to as *X. ensiculiferum* (Cobb, 1893) Thorne, 1937 by Loos (1949) and by Williams (1959) have been much discussed (Cohn & Sher, 1972; Southey & Luc, 1973; Lamberti & Tarjan, 1974; Frederick & Tarjan, 1974; Luc & Dalmasso, 1975) so a historical account is unnecessary.

Table II summarizes some opinions.

TABLE II

Variations in systematic position of species or populations considered now as Xiphinema krugi

	Cohn & Sher, 1972	Southey & Luc, 1973	Lamberti & Tarjan, 1974	Luc & Dalmasso, 1975
X. krugi	*krugi*	*krugi*	*krugi*	*krugi*
X. denoudeni	not cited	not cited	*krugi*	*denoudeni*
X. ensiculiferum apud Loos (1949)	*krugi*	*loosi*	*krugi*	*loosi*
X. ensiculiferum apud Williams (1959)	*krugi*	*loosi?*	*krugi*	not cited

Some points should be noted: — *X. ensiculiferum* as redescribed by Southey & Luc (1973) from topotype material, is not the same species as that worked on by Loos or Williams.

— Lamberti & Tarjan (1974) synonymized *X. loosi* and *X. denoudeni* with *X. krugi* and later Frederick & Tarjan (1974) showed that *X. krugi* from Florida varied much.

— Luc & Dalmasso (1975) unaware of Frederick & Tarjan's (1974) work retained the three species because although Lordello (1955) described the anterior genital branch of *X. krugi* as reduced but clearly differentiated (Fig. 3, D), *X. denoudeni* and *X. krugi* were drawn by Loof & Maas (1972) and Frederick & Tarjan (1974) respectively, with longer but undifferentiated anterior reduced genital branches: *X. loosi* by contrast, was described with an anterior genital branch reduced to uterine sac. Secondly, *X. loosi* has a hemispherical tail with a very slight terminal bulge, *X. denoudeni*'s is more conical with a prominent bulge or even distinctly digitate ("Cultuurtuin population"), but tail shape in *X. krugi* is intermediate. Furthermore *X. loosi* has a very large "blind canal" not observed in *X. denoudeni* or *X. krugi*. Luc & Dalmasso (1975) therefore left synonymies undecided until a more extensive study could be made, which is given below and confirms that *X. krugi, X. denoudeni* and *X. loosi* should be considered a single species.

Material studied

More than 130 females belonging to thirteen populations from Asia, Africa, South and North America were examined.

These were from soil about roots of the following plants:

— Population 1. Sri-Lanka: Easter lily plant (*Lilium longiflorum*) and grasses (*rec.* C. A. Loos; paratypes of *X. loosi*).
— Population 2. Sri-Lanka: Easter lily, St. Coombs (*leg.* S. A. Sher).
— Population 3. Brazil: Sugar cane, Sao Paulo (*leg.* L. E. G. Lordello).
— Population 4. Paraguay: Sugar cane, Taquara.
— Population 5. Surinam: *Citrus* sp., Geyersvlijt (*leg.* P. A. A. Loof; paratypes of *X. denoudeni*).
— Population 6. Surinam: Botanical Garden, Agric. Exp. Stat. Paramaribo (*leg.* P. A. A. Loof; *X. denoudeni*, "cultuurtuin population").
— Population 7. Mauritius: Sugar cane, La Russie (*leg.* J. R. Williams).
— Population 8. Mauritius: Sugar cane, Beau Climat (*leg.* J. R. Williams).
— Population 9. Sénégal: *Citrus* sp., Sor. (*rec.* D. P. Taylor).
— Population 10. U.S.A. Alabama: inundated soil, Tallassee (*leg.* A. C. Tarjan).
— Population 12. U.S.A. Florida: Bahia grass (*Paspalum notatum*) and weeds, roadside Agric. Farm, Gainesville (*leg.* A. C. Tarjan).
— Population 13. U.S.A., Florida, grain Sorghum, Escamba County (*leg.* A. C. Tarjan).

Population 1 provided the type of *X. loosi* Southey & Luc, 1973; numerical data were given on population 2 by Cohn & Sher (1972); populations 5 and 6 were described in detail as *X. denoudeni* Loof & Maas, 1972; populations 7 and 8 were studied by Williams & Luc (in press); populations 10, 11, 12 and 13 were compared by Frederick & Tarjan (1974) with the syntypes of *X. krugi* previously studied by Tarjan.

TABLE

Xiphinema krugi *Lordello, 1955, Numerical data on females. a.g.b. = length of* [ ] *calculated*

	Pop. 1 Sri-Lanka (*X. loosi*) from Southey & Luc, 1973	Pop. 2 Sri-Lanka (spec. Sher)	Brazil (*X. krugi*) from Lordello (1955)	Brazil from Tarjan (orig.)	Pop. 3 Brazil (orig.)	Pop. 4 Paraguay (orig.)
n	11	7	?		5	20
L (mm)	2.07 1.78-2.18	1.98 1.72-2.23	2.12-2.22	2.33-2.35	1.9 1.58-2.06	2.24 2.07-2.56
a	32.9 27.5-37.5	42.5 41.2-44.4	37.9-43.8	46.0-50.6	35.9 30.2-42.9	40.8 31.2-56.9
b	— 	5.4 4.9-6.7	5.2-5.6	5.6-5.7	5.3 5.2-5.8	5.1 4.5-6.4
Tail length (µm)	26.5 24-29	27 25-30	?	29-31	35 33-40	35 30-44
c	78 66-90	74.2 59.3-85.8	66.3-69.6	75.0-80.9	54.4 47.8-62.4	64.1 54.2-80.5
c'	0.71 0.57-0.80	0.8 0.7-1.0	[1]	1.0-1.1	1.2 1.1-1.5	0.9 0.8-1.1
V	31.0 28.6-33.3	32.9 31.2-35.5	33.4-34.2	32-34	33.0 30.8-34.9	34.5 33.6-35.9
Od. style (µm)	122 118-127	116 110-120	116-120	119-127	106 94-116	116 102-123
Od. phore (µm)	71 68-74	68 63-71	68-72	71-72	68 65-78	76 70-84
Total spear l. (µm)	192 186-195	184 179-191	184-192	189-199	167 154-181	192 176-207
a.g.b. (µm)	63* 51-74*	72* 64-78*		80	—	69* 49-102*
a.g.b./v.d.	0.95* 0.8-1.1*	1.6* 1.4-1.8*	[2.2]	1.7	—	1.25* 0.9-1.5*
	*n = 3 (orig.)	*n = 3 (orig.)				n = 17

Females

Dimensions. The usual numerical data and ratios are in Table III. The length of the anterior genital branch and its expression as a ratio of the vulval diameter are added. These data generally vary little between the several populations, but there are exceptions and they are discussed below.

*Description. X. krug*i has been sufficiently described to make a new description

III

anterior genital branch, in µm. a.g.b./v.d. = same, expressed in vulval diameter. on drawings

Pop. 5 Surinam (*X. denoudeni*) (from Loof & Maas) pop. type	Pop. 6	Pop. 7 Mauritius La Russie (orig.)	Pop. 8 Beau Climat (orig.)	Pop. 9 Sénégal (orig.)	Pop. 10 Alabama	Pop. 11 U.S.A. Florida *Bauhinia*	Pop. 12 Florida Bahia gr.	Pop. 13 Florida Gr. Sorghum
50	29	12	20	15	4	7	4	4
2.15 1.93-2.41	2.01 1.74-2.18	1.83 1.71-1.95	1.94 1.81-2.06	2.12 1.91-2.32	1.89 1.86-1.93	1.85 1.55-2.05	2.13 2.09-2.20	2.45 2.31-2.59
45 39-49	49 44-53	42.7 40.6-45.4	41.3 35.8-45.9	54.4 49.3-59.5	—	41.8 36.8-45.6	44.0 41.8-45.1	—
5.4 4.8-6.5	5.4 4.9-5.8	4.7 4.3-5.1	4.7 3.8-5.2	5.1 4.2-5.8	5.0 4.6-6.0	5.0 4.2-5.3	5.7 5.3-6.1	5.9 5.5-6.9
31.5* 28-34*	35* 30-40*	30 27-32	29 25-33	31 29-34	33* 32-33*	32 28-34	44.5 43-45	38 36-40
65 55-74	52 44-61	61.2 55.2-64.0	67.6 61.5-75.6	68.4 62.6-73.1	57.9* 56.4-58.5*	58.5 54.1-64.1	48.0 46.4-49.5	63.4 57.7-67.5
 1.2-1.3	1.5 1.3-1.7	0.93 0.84-1.0	0.89 0.76-1.03	1.1 1.0-1.2	1.07* 0.97-1.14*	1.10 1.00-1.27	1.52 1.48-1.61	—
34 32-36	34 33-36	32.9 31.2-35.1	33.0 32.0-34.6	34.0 31.9-35.9	34.6 33.0-35.5*	34.2 33.2-35.3	34.2 33.5-35.5	33.1 32.1-34.2
120 114-126	107 102-114	117 114-122	119.5 115-129	119 111-124	110* 105-114*	116.5 110-123	108.5 103-113	114 112-115
74 69-79	65 63-69	73 71-76	72.5 67-75	69 63-72	63* 60-66*	69 66-72	68.5 68-69	71 70-73
194 186-205	172 165-181	190 186-194	192 185-196	188 180-195	173* 165-177*	185.5 177-189	177 171-181	185 184-186
95* 85-107*	75* 59-105*	51 38-52	61.5 42-74	102* 90-113*	 108*	85* 75-99*	82 70-94	—
2.1* 1.9-2.3*	1.7* 1.4-2.1*	1.2 0.9-1.5	1.3 0.9-1.6	2.6* 2.2-2.9*	—	2.0* 1.8-2.2*	1.7 1.5-1.9	—
* n = 4 (orig.)	* n = 14 (orig.)			* n = 10	* n = 3	* n = 4		

unnecessary. Only two structures need more study: the reduced anterior genital branch and the tail.

The structure of the reduced anterior genital branch is not always easy to discern, because the intestinal cells are often filled with refractive (lipoid?) granules (starved specimens are preferable) or the genital tractus is not "on the right side" (Cobb's slides are necessary for this type of study). Also, the anterior branch

may be coiled which obscures detail. Nevertheless, a similar structure has been observed in all thirteen populations examined (except for the last where specimens were too flattened). The anterior branch is in three parts: a shortened uterus, a very weakly developed sphincter and a vestigial oviduct.

The total length of this anterior branch, expressed either in μm or as a ratio of the vulval diameter, varies according to the population. Populations 1 and 2 (Sri-Lanka) and 7 and 8 (Mauritius) show the shortest type (see Table III), whereas population 9 (Senegal) and North American populations show the longest, with other populations intermediate. The length of the anterior genital branch varied from 38 to 108 μm, or 0.8-2.9 vulval diameters in the 62 females measured.

The vestigial uterus consists of indistinct cells. A lumen is often visible and may be enlarged (Fig. 3, F, N) or contain granules. The lumen may be visible for a short distance (Fig. 3, I) or may be practically absent or even indistinguishable (Fig. 3, E, K).

The sphincter separating the uterus and the oviduct is somewhat degenerate and seldom appears as the clear muscular structure that is the posterior branch. However, it can be recognized by a difference in the structure of the wall which at this level is not granular but contains some radial fibrillae. At the level of the sphincter the tractus is generally constricted, but in some cases (Fig. 3, L, M) the sphincter is very difficult to distinguish and its presence can be assumed only by observation of some radial fibrillae.

The vestigial oviduct is usually undifferentiated and only granules can be seen in most cases. In some specimens (Fig. 3, H, K, N) the structure is crinkled and resembles the pouch of the normal oviduct.

In other cases (Fig. 3, L, M) the three parts of the anterior genital branch are very difficult to separate and it is only by comparison with other specimens with a clearer structure that the three parts can be recognized.

The relative size of the uterus and oviduct varies; most often the uterus is longer and wider, but these two parts may be comparably developed (Fig. 3, G, J) or the oviduct can even be more developed than the uterus (Fig. 3, K).

We found the structure of the anterior genital branch to be that given by Lordello (1955) when describing *X. krugi* (Fig. 3, D). This structure seems to represent a similar, but more advanced, stage of regression than is evident in *X. longicaudatum* as the sphincter in *X. krugi* is more degenerate.

The tail in *X. krugi* varies in length, shape and tip structure.

The mean length is from 26.5 μm (population 1, Sri-Lanka) to 44.5 μm (population 12, Florida, Bahia grass).

The shape varies from almost regularly ogival with a very slight bulge at its extremity (Fig. 4, A, E, J) to conoid rounded with a distinct ventral peg (Fig. 4, H, L). All intermediate shapes occur in various other populations and even within the same population (Population 3, Brazil; Population 6, Surinam "cultuurtuin") different tail shapes are present (Fig. 4, E, F, G, H).

The cuticle at the tail-tip also varies. In most specimens (e.g. Fig. 4, A, E, J)

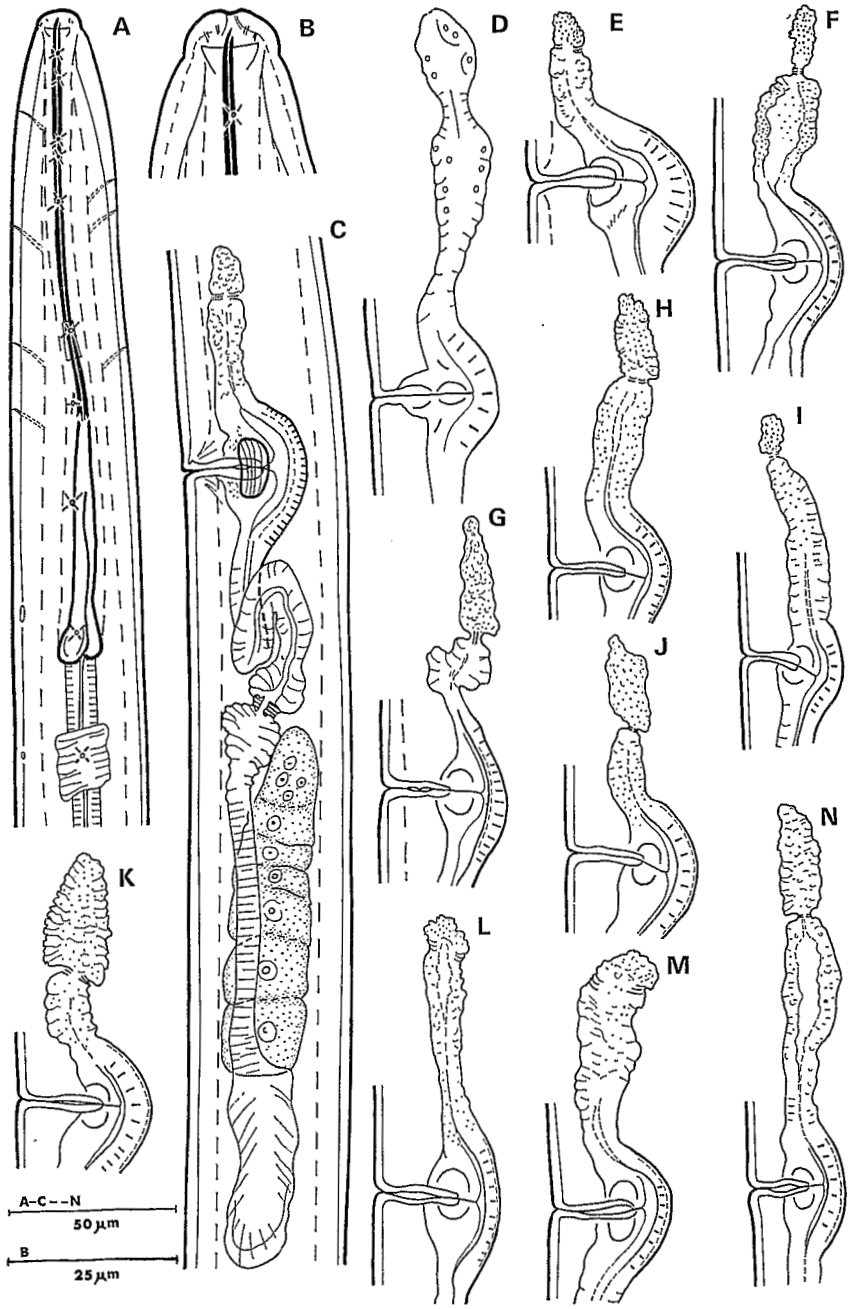

Fig. 3. A-N: *Xiphinema krugi* Lordello, 1955: female: A: anterior end; B: labial region; C: genital tractus (pop. 7, Mauritius); D-N: anterior genital branch: D: type (from Lordello, 1955); E, K: pop. 1 (Sri-Lanka, types of *X. loosi*); F: pop. 2 (Sri-Lanka); G: pop. 4 (Paraguay); H: pop. 5 (Surinam, type of *X. denoudeni*); I: pop. 6 (Surinam, *X. denoudeni*); J: pop. 7 (Mauritius); L: pop. 11 (Florida); M: pop. 12 (Florida); N: pop. 9 (Senegal).

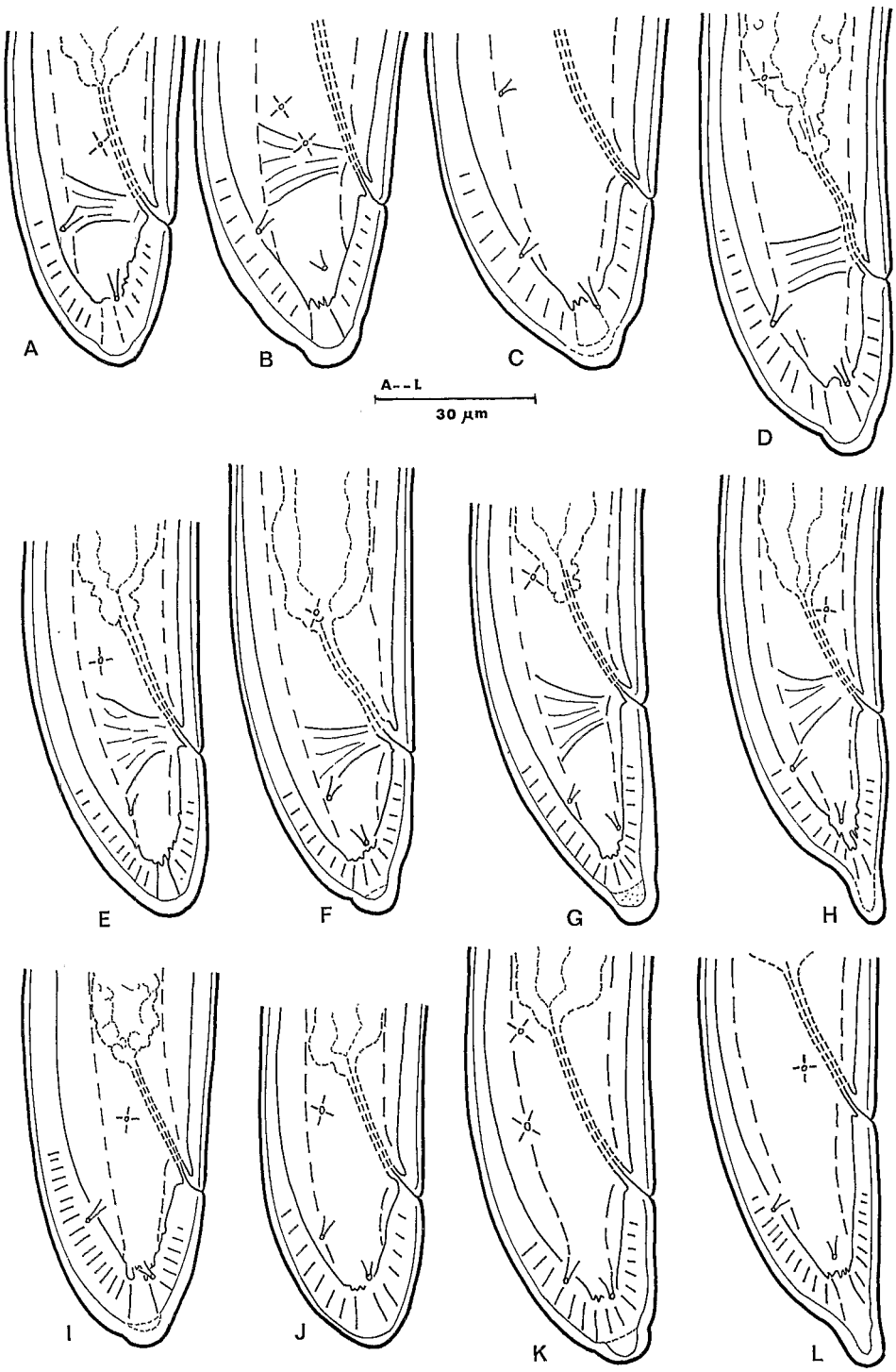

Fig. 4. A-L: *Xiphinema krugi* Lordello, 1955: female tail: A: pop. 2 (Sri-Lanka); B, C: pop. 4 (Paraguay); D: pop. 5 (Surinam, type of *X. denoudeni*); E, F, G, H: pop. 6 (*X. denoudeni*); I: pop. 7 (Mauritius); J, K: pop. 11 (Florida); L: pop. 12 (Florida).

a "blind terminal canal" (see Southey & Luc, 1973) appears as a clear zone in the internal layer(s) of the cuticle along the tail axis. Such a canal is doubtful in some populations (9, Senegal and 10, Alabama) and is definitely absent in some specimens of populations 3 (Brazil), 6 (Surinam "Cultuurtuin") and 11 (Florida, *Bauhinia*) (see Fig. 4, F, G, J, K, Fig. 5, B, C). The outermost cuticle layer is often disjointed at the tail extremity (Fig. 4, C, G, K; Fig. 5, B).

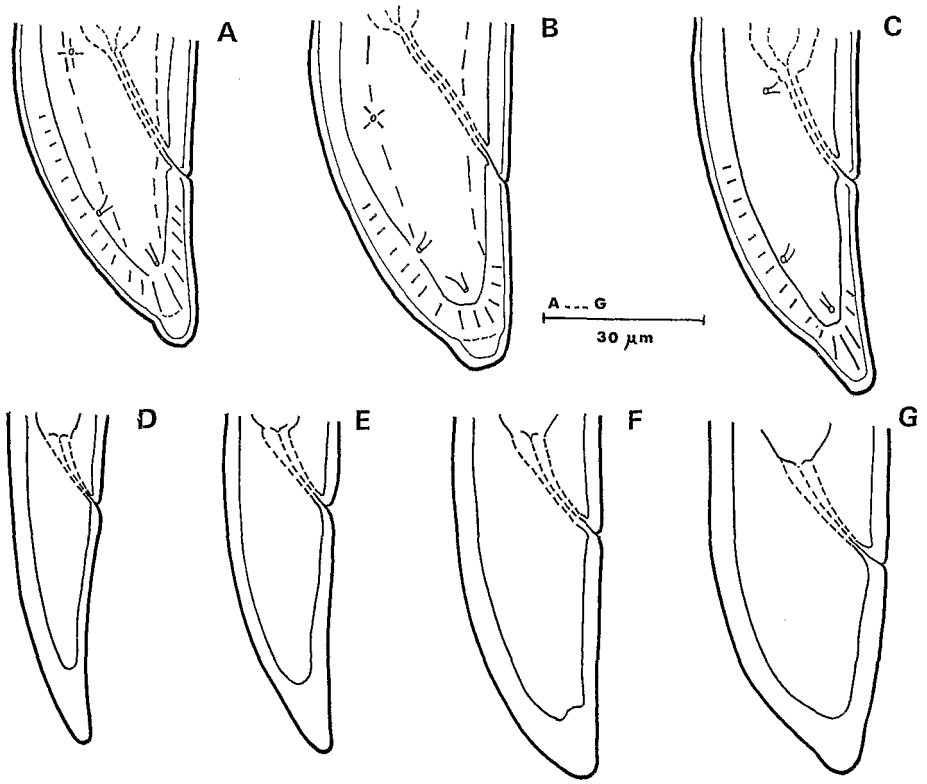

Fig. 5. A-G: *Xiphinema krugi* Lordello, 1955, population 3 (Brazil): A, B, C: female tail; populateion 4 (Paraguay): D: tail, J 1; E: tail, J 2; F: tail, J 3; G: tail, J 4.

The tail varies more in *X. krugi* than generally in the genus *Xiphinema* where tail length, shape and structure remain some of the best characters to differentiate species. The tail varies in other species of the genus, but mainly in length, e.g. *X. cavenessi* Luc, 1973 and *X. malagasi* Luc, 1973, where length varies but shape is constant. This is more pronounced in some South African species (Heyns, 1976). Marked differences in tail shape are rare: in *X. rotundatum* Schuurmans Stekhoven & Teunissen, 1938, Luc & Tarjan (1963) observed tails from perfectly hemispherical to conical. In *X. imitator* Heyns, 1965, as in *X. krugi*, the tail can be perfectly rounded at the tip or provided with a "small digitate non-protoplasmic process"; both shapes exist in the same population. Moreover a blind terminal

canal, although not noted in the description, is clearly visible on the drawings of the tail in both sexes.

Juveniles

Juveniles from population 4 (Paraguay) resembled the adult females, except for the tail which is long in the J I and becomes more hemispheroid with each moult (Fig. 5, D-G). Numerical data are in Table IV (columns 1 to 4).

TABLE IV

Xiphinema krugi *Lordello, 1955: Numerical data on juveniles*

	J 1	J 2	J 3	J 4	Nº 1	Nº 2	Nº 3	Nº 4
n	5	5	7	5	—	—	—	—
L (mm)	0.74 0.72-0.74	0.96 0.93-0.99	1.30 1.13-1.44	1.67 1.57-1.75	0.84	0.94	1.41	1.47
a	32.6 32.2-33.4	35.2 33.9-37.7	38.4 34.2-40.8	41.4 38.0-43.5	38.0*	33.6*	35.3*	45.9*
b	3.2 3.0-3.3	3.3 3.0-3.6	3.7 3.2-4.0	3.9 3.7-4.2	3.6*	3.6*	3.9*	4.9*
Tail length (µm)	46 44-49	46 44-49	45 39-53	39 37-40	24	36	36	40
c	16.0 15.0-16.4	21.0 20.2-21.5	29.0 25.7-32.7	42.9 39.4-45.9	34.8*	26.2*	39.2*	36.7*
c'	2.9 2.7-2.9	2.3 2.3-2.4	1.7 1.5-1.9	1.2 1.2-1.3	—	—	—	—
Od. style (µm)	51 49-54	62 61-65	80 75-84	103 98-110	48	64	84	72
Od. phore (µm)	41 40-42	49 47-51	57 53-60	67 65-68	38*	44*	60*	54*
Total spear L. (µm)	92 89-96	111 108-115	138 131-142	170 165-176	86	108	144	126
Replacement Od. style (µm)	61 58-63	80 77-82	101 95-105	118 114-121	66	84	112	90

* *calculated on data*

Numerical data on four juveniles were given in the original description of *X. krugi* (Lordello, 1955) and are repeated in Table IV (columns 5 to 8). Discrepancies exist between these data and ours but Lordello's nematodes could be attributed to the different juvenile stages: Juv. No. 1: J1: Juv. No. 2: J2; Juv. No. 3 and 4: J3. The main difference is in tail length which is noticeably shorter in Lordello's J1 and J2. This could be attributed to difficulty in locating the anus in early juvenile stages.

Male

Only one male was described, by Loos (1949); it has the following characters: L = 1.87 mm; a = 37; b = 4.6; c = 62; c′ = 0.8. Spicules massive, arcuate; adanal papillae and three ventral supplements. Tail hemispheroid with three pairs of caudal pores.

Redefinition of the species

The above data, from many populations, allow *X. krugi* to be more accurately defined. An objection could be made as the type specimens were not examined, but this cannot be sustained because the original description and drawings of Lordello (1955) are perfectly clear and subsequent drawings and data given for the syntypes (Frederick & Tarjan, 1974) complement the original ones. Only two doubts remained: the structure of the anterior genital branch and that of the tail, and these have now been resolved, although the detailed structure of the tail, and especially of its tip, remains unknown for the type population.

Synonyms of *Xiphinema krugi* Lordello, 1955 are: *X. denoudeni* Loof & Maas, 1972; *X. loosi* Southey & Luc, 1973; *X. ensiculiferum* apud Loos, 1949; *X. ensiculiferum* apud Williams, 1959; *X. mammillatum* apud Den Ouden, 1965; *X. brasiliense* apud Maas, 1970.

Diagnosis:

Female: Length varies from 1.55 to 2.6 mm. Labial region offset by a slight constriction. Spear length: 154-207 μm. Vulva at 29-36%. Anterior genital branch without ovary, with reduced uterus, sphincter, and vestigial oviduct. Posterior genital branch normal, without Z differentiation. Tail short (24-45 μm), rounded or with a more or less developed ventral bulge or peg; c′ varying from 0.6 to 1.7.

Juveniles: Same general appearance as female. Tail conoid-elongate in early stages becoming stouter and more rounded (c′ of J1 to J4 varying from 2.9 to 1.2).

Male: described above.

Among the 75 species that constitute the genus *Xiphinema, X. krugi* is easily recognised by the structure of the reduced, but differentiated anterior genital branch. Only three other species show such a structure. Two of them, *X. filicaudatum* Loof & Maas, 1972 and *X. longicaudatum* Luc, 1961 are distinguished by their long tails: respectively 363-545 μm (c′ = 10-15) and 154-241 μm (c′ = 6.0-8.1). *X. surinamense* Loof & Maas, 1972 most resembles *X. krugi* and also has a hemispheroid tail, but the female has a much longer anterior genital branch (on original drawing: 240 μm or 4.8 vulval diameters). Although its oviduct may be much reduced and the ovary absent, the anterior uterus in *X. surinamense* is as long and apparently of the same structure as the posterior one (the same is true of *X. filicaudatum*). This results in a more posterior vulva in *X. surinamense* than in *X. krugi* (V = 36-42 vs 29-36). There are other differences as well e.g. the abundance of males in *X. surinamense*.

Another species resembling *X. krugi* is *X. costaricense* Lamberti & Tarjan, 1974.

Measurements, ratios and tail-shape are very similar in both species. In *X. costaricense* the anterior female genital branch is said to be short (45-52 μm or about one vulval diameter) and undifferentiated. This last point needs confirmation because the authors' original drawings suggest differentiation. However, *X. krugi* and *X. costaricense* differ markedly in the tail-shape of the juvenile stages.

Following the "lattice" established by Luc & Dalmasso (1975), *X. krugi* has now to be quoted:

A: 2; B: 4; C: 1 (2); D: 3/5/6; E: 3/4/5; F: 2 (3); G: 2 (3); H: 3; I: 2; J: 4; K: 2; L: 1.

Geographical variations

X. krugi appears to be a tropical and subtropical species of wide distribution. The only two numerical characters that vary appreciably in the thirteen populations

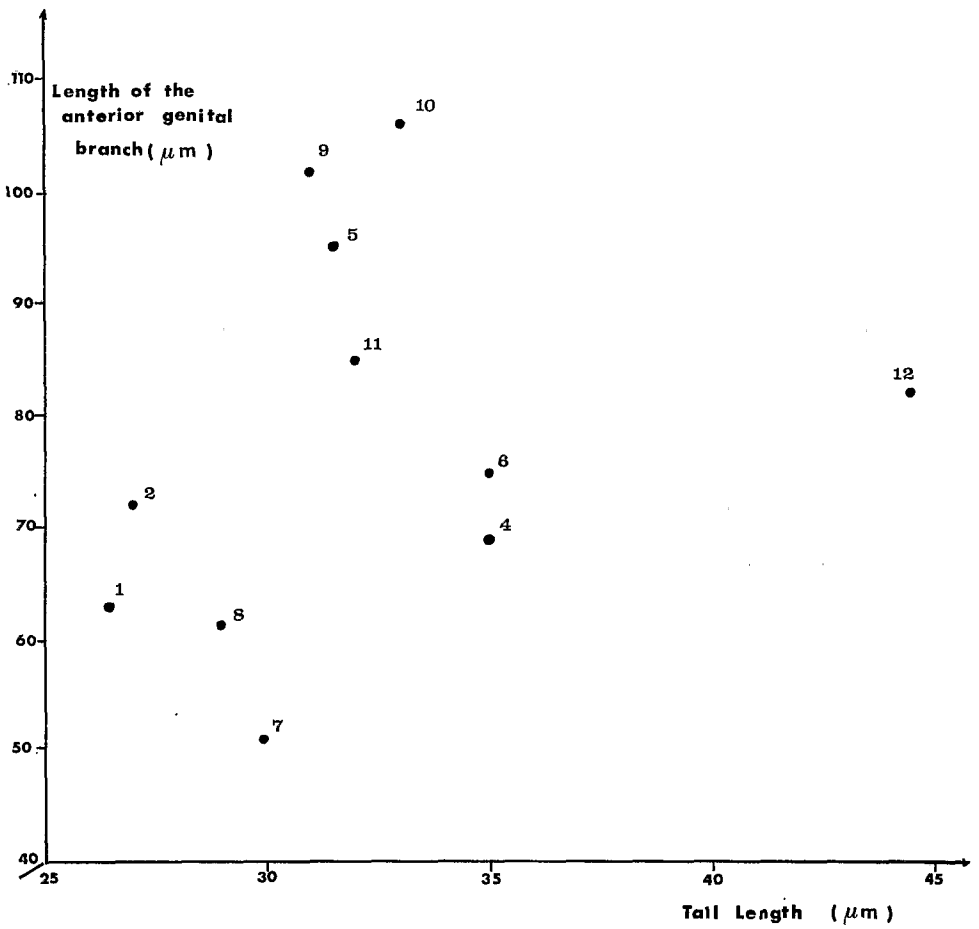

Fig. 6. *Xiphinema krugi* Lordello, 1955. Co-variation between length of the anterior genital branch and tail length. Mean values of different populations referred to by their code number (see p. 7).

examined are the length of the tail (reflecting differences in shape) and the length of the anterior female genital branch. Fig. 6 suggests that if these two characters are unrelated, populations from Sri-Lanka (1 and 2) and from Mauritius (7 and 8) could form a separate group combining short tail length (hemispheroid) and short anterior genital branch. Note that these populations were previously considered a distinct species (*X. loosi*). Population 12 (Florida) appears to be separated from all the others (including other populations from Florida) by the greater length of its tail. However, the present data are not enough to allow conclusions to be drawn about geographical races; more populations and specimens need to be examined to establish whether they exist.

Addendum

After the manuscript was submitted, Mr. P. A. A. Loof kindly sent to one of us (M.L.) a specimen of *Xiphinema krugi* found near rooots of *Ficus* sp. at Dala (Fiji Islands). This population had the following measurements:

Females (n = 10): L = 1.91 mm (1.84-1.96); a = 41 (38-44); b = 5.1 (4.3-6.9); tail length = 34 μm (33-37); c = 57 (54-63); c′ = 1.1 (0.9-1.2); V = 34 (33-36); odontostyle = 118 μm (114-120); odontophore = 73 μm (70-75); total spear length = 191 μum (188-195); length of the ant. gen. br. 55 μm (47-74); length ant. gen. br./vulval diam. = 1.2 (1.1-1.5).

The shape of the tail is constant and similar to that found in the Sri-Lanka (Fig. 4, A) and Mauritius (Fig. 4, I) populations. This characteristic as well as relatively short anterior genital branch support the idea of two groups in the species, depending on geographical distribution.

We thank Dr. A. C. Tarjan who kindly sent slides of *X. krugi* as well as original data and drawings of syntypes; Mr. P. A. A. Loof, who loaned slides of *X. denoudeni*; and the late Dr. S. A. Sher who sent specimens of various populations of *X. krugi*.

RÉSUMÉ

Redescription de Xiphinema longicaudatum *Luc, 1961 et observations concernant* Xiphinema krugi *Lordello, 1955* (Nematoda: Longidoridae)

Les auteurs donnent une redescription de *Xiphinema longicaudatum* Luc, 1961 fondée sur l'étude de 29 femelles provenant de différents points d'Afrique de l'ouest. Cette espèce n'était jusqu'à présent connue que par une seule femelle. Une attention particulière est portée à la structure de la branche génitale antérieure femelle, atrophiée. *Xiphinema krugi* Lordello, 1955 est étudié sur treize populations d'Afrique, d'Asie et d'Amérique du Sud et du Nord. La structure de la branche génitale antérieure femelle, réduite et composée, comme chez *X. longicaudatum*, de trois parties (utérus réduit, sphincter et reste dégénéré de l'oviducte) est conforme à la description originale. Des variations sont notées concernant la longueur, la forme et la structure de l'extrémité de la queue entre populations ou à l'intérieur même de certaines d'entre elles. Se fondant principalement sur ces deux points les auteurs confirment en l'établissant sur des bases plus fermes, la synonymisation de *X. denoudeni* Loof & Maas, 1972 et de *X. loosi* Southey & Luc, 1973 avec *X. krugi*.

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