

Two new species of *Xiphinema* Cobb, 1913
(Nematoda, Dorylaimida)
from Malawi, East Africa

by D. J. F. BROWN, M. LUC and V. W. SAKA

Abstract. — Descriptions are given of *Xiphinema malawiense* n. sp. and *X. limbeense* n. sp., both from the same location, from the rhizosphere of *Citrus paradisi* Marfad, at the Bvumbwe Agricultural Research Station, Limbe, Malawi. Both species were without males and were morphologically similar to each other and to *X. coxi* Tarjan, 1964. But they may be distinguished from each other and from the latter species by tail length and shape, spear length, and, mainly, by structures of the pseudo Z organ.

Résumé. — Description est donnée de *Xiphinema malawiense* n. sp. et de *X. limbeense* n. sp., provenant l'une et l'autre de la rhizosphère de *Citrus paradisi* Marfad, sur la Station de Recherches Agricoles de Bvumbwe, à Limbe, Malawi. Les deux espèces, dont les mâles n'ont pas été trouvés, sont proches l'une de l'autre, et proches également de *X. coxi* Tarjan, 1964. Elles diffèrent entre elles, et de cette dernière espèce, par la forme et la longueur de la queue, la longueur du stylet et, principalement, par la structure du pseudo-organe Z.

D. J. F. BROWN, *Scottish Crop Research Institute, Invergowrie, Dundee, U.K.*

M. LUC, *Nématologiste de l'ORSTOM : Laboratoire des Vers associé au CNRS, 61, rue Buffon, 75231 Paris cedex 05.*

V. W. SAKA, *Bvumbwe Agricultural Research Station, P. O. Box 5748, Limbe, Malawi.*

During a survey of plant-parasitic nematodes present in Malawi, East Africa, SAKA and SIDDIQI (1979) identified specimens present in several samples as *Xiphinema coxi* Tarjan, 1964, and *X. sahelense* Dalmasso, 1969. In 1980, six of the sites in Malawi, from which these species have been identified previously, were resampled as *X. coxi* and *X. sahelense* have previously only been identified in soils from Europa, Algeria and North America (TARJAN, 1964; DALMASSO, 1969, 1970; MACARA, 1970, 1972; ARIAS & NAVACERRADA, 1973; BROWN, unpubl.). Although longidorid nematodes were found in every sample none were *X. coxi* nor *X. sahelense*. Specimens present in a sample from *Citrus paradisi* Marfad from Limbe represent two undescribed species. Therefore, descriptions of the species *X. malawiense* n. sp. and *X. limbeense* n. sp. are given here.

Specimens, of both species, were heat killed and fixed in formalin and mounted in glycerol using a slow replacement method.

24 SEPT. 1984

2, 8

O. R. S. T. O. M. Fonds Documentaire

N° : 15682, ex 1

Cote : B

Xiphinema malawiense n. sp.

(Fig. 1)

Females

Morphometrics (tab. I) : Holotype : L = 2.44 mm ; a = 53 ; b = 6.4 ; c = 50 ; c' = 1.7 ; V = 43 % ; odontostyle = 117 μ m ; odontophore = 76 μ m ; spear = 193 μ m ; tail length = 49 μ m ; greatest body diameter = 46 μ m ; diameter at anus = 29 μ m ; anterior to oesophago-intestinal junction = 382 μ m ; anterior to vulva = 1.06 mm.

TABLE I. — Morphometrics¹ of females, fourth and third stage juveniles of *Xiphinema malawiense* n. sp.

| | Females | J4 | J3 |
|--|--------------------------------|--------------------------------|------|
| n | 14 | 9 | 1 |
| L (mm) | 2.65 \pm 0.14 (2.44-2.94) | 2.09 \pm 0.17 (1.88-2.31) | 1.44 |
| a | 52 \pm 4.6 (46-64) | 56 \pm 6.6 (45-66) | 45 |
| b | 6.8 \pm 0.47 (6.3-7.9) | 5.4 \pm 0.28 (5-5.8) | 4.9 |
| c | 57 \pm 7.3 (44-67) | 36 \pm 4.3 (29-41) | 29 |
| c' | 1.5 \pm 0.24 (1.21-2.03) | 2.16 \pm 0.44 (1.71-2.81) | 2.04 |
| V | 44 \pm 1.9 (40-46) | — | — |
| Odontostyle (μ m) | 111 \pm 3.3 (103-117) | 92 \pm 5.5 (84-100) | 75 |
| Odontophore (μ m) | 75 \pm 1.6 (72-76) | 64 \pm 3 (60-68) | 51 |
| Spear (μ m) | 186 \pm 4.1 (175-193) | 157 \pm 8.4 (144-167) | 126 |
| Replacement odontostyle (μ m) | — | 113 \pm 4.2 (104-117) | 88 |
| Tail (μ m) | 47 \pm 5.8 (41-63) | 59 \pm 11 (46-73) | 49 |
| Greatest body diameter (μ m) | 51 \pm 5.4 (43-59) | 38 \pm 4.8 (33-44) | 32 |
| Body diameter at anus (μ m) | 32 \pm 2.2 (29-37) | 28 \pm 1.8 (26-31) | 24 |
| Anterior to oesophago-intestinal junction (μ m) | 389 \pm 19 (346-419) | 384 \pm 20 (357-410) | 291 |
| Anterior to vulva (mm) | 1.18 \pm 0.08 (1.06-1.31) | — | — |

1. Mean \pm one standard deviation (n-1) and range.

DESCRIPTION

Body elongate, cylindrical, slightly ventrally curved to open C-shape in which the posterior half of body is more curved than the anterior, when heat relaxed. Cuticle, weakly striated in neck and tail regions, apparently composed of two layers $4.8\ \mu\text{m}$ (3.3-5.5) thick in neck region, $3.5\ \mu\text{m}$ (3-4) at mid-body and $8.3\ \mu\text{m}$ (7.2-9) in the dorsal side of tail. Lateral chord $1/4$ to $1/3$ corresponding body diameter at mid-body. Series of generally indistinct ventral and dorsal pores present of variable number and irregular distance between pores; number of pores in oesophageal region, 10 (5-18) dorsal, 13 (9-17) ventral and a single line of lateral pores becoming a double line posterior to the oesophageal region. Dorsal pores only present in oesophageal region ventral pores present along entire body to anus, 15 (11-19) between oesophageal region and vulva and 17 (14-22) between vulva and anus. Lip region slightly rounded in front $13.6\ \mu\text{m}$ (12.7-14.6) wide, separated from the rest of the body by a weak, smooth constriction. Amphid stirrup shaped, amphidial aperture a large straight, transverse, slit situated anterior to the constriction. Hemizonid flat $6.2\ \mu\text{m}$ (5-8.5) wide, situated $55\ \mu\text{m}$ (34-63) posterior to base of spear; hemizonion lenticular, generally indistinct, $4\ \mu\text{m}$ (3.3-5.5) wide, $49\ \mu\text{m}$ (39-55) posterior to hemizonid. Nerve ring $16\ \mu\text{m}$ (13-19) wide, $62\ \mu\text{m}$ (32-77) posterior to base of spear. Spear (odontostyle + odontophore) conforms to genus; flanges of odontophore $13\ \mu\text{m}$ (14-15) wide, reinforced at their margins. Spear guiding apparatus conforms to genus; basal annule $5\ \mu\text{m}$ (4.5-5.5) wide situated $84\ \mu\text{m}$ (77-95) from anterior end; length of guiding tube variable apparently related to amount of retraction or protraction of spear (5.5 - $32\ \mu\text{m}$). Small triangular, "mucro", $1.9\ \mu\text{m}$ (1.7-2.1) long, situated in oesophageal wall $55\ \mu\text{m}$ (22-94) from spear base, orientation of vertices apparently random ("mucro" absent or inconspicuous in many (50%) specimens). Oesophageal bulb $87\ \mu\text{m}$ (75-98) long, $23\ \mu\text{m}$ (20-30) wide; position of the dorsal oesophageal gland nucleus and of the subventral oesophageal gland nuclei conform to genus. Genital tracts composed of two branches having about the same length and structure. Vagina perpendicular to long body axis, reaching half, or slightly more, the corresponding diameter; sclerotization well developed, composed of two concentric bowl shaped structures; perivaginal muscle (= sphincter) cup-shaped. Ovejector well developed. Uterus composed of a thin walled, cylindrical portion and a long, well developed uterine pouch often divided into two parts, the proximal one having a thinner wall; close to the pouch, a pseudo Z organ is present: it is formed by a dilatation of the uterine wall, without apparent modification in the structure or in the thickness, and containing six to fifteen globular composed bodies; these bodies comprise a central, spherical, very refringent portion, surrounded by a less refringent part, variously lobed or irregular. The uterine pouch has a very irregular lobed wall and is connected to the oviduct pouch by a prominent sphincter; it is followed by the regular straight, thin, part of the uterus, connected with the ovary. No spermatozoa observed. Prerectum $476\ \mu\text{m}$ (347-643) long or about $1/5$ of total body length; rectum $29\ \mu\text{m}$ (22-39) long. Tail conical-rounded, digitate, with dorsal curvature, ventral profile on same line as body profile, peg ventral to body axis, $12.4\ \mu\text{m}$ (10-17) long or $1/4$ of tail length; a blind canal is present; two pairs of caudal pores, one pair of adanal pores present.

Male not found.

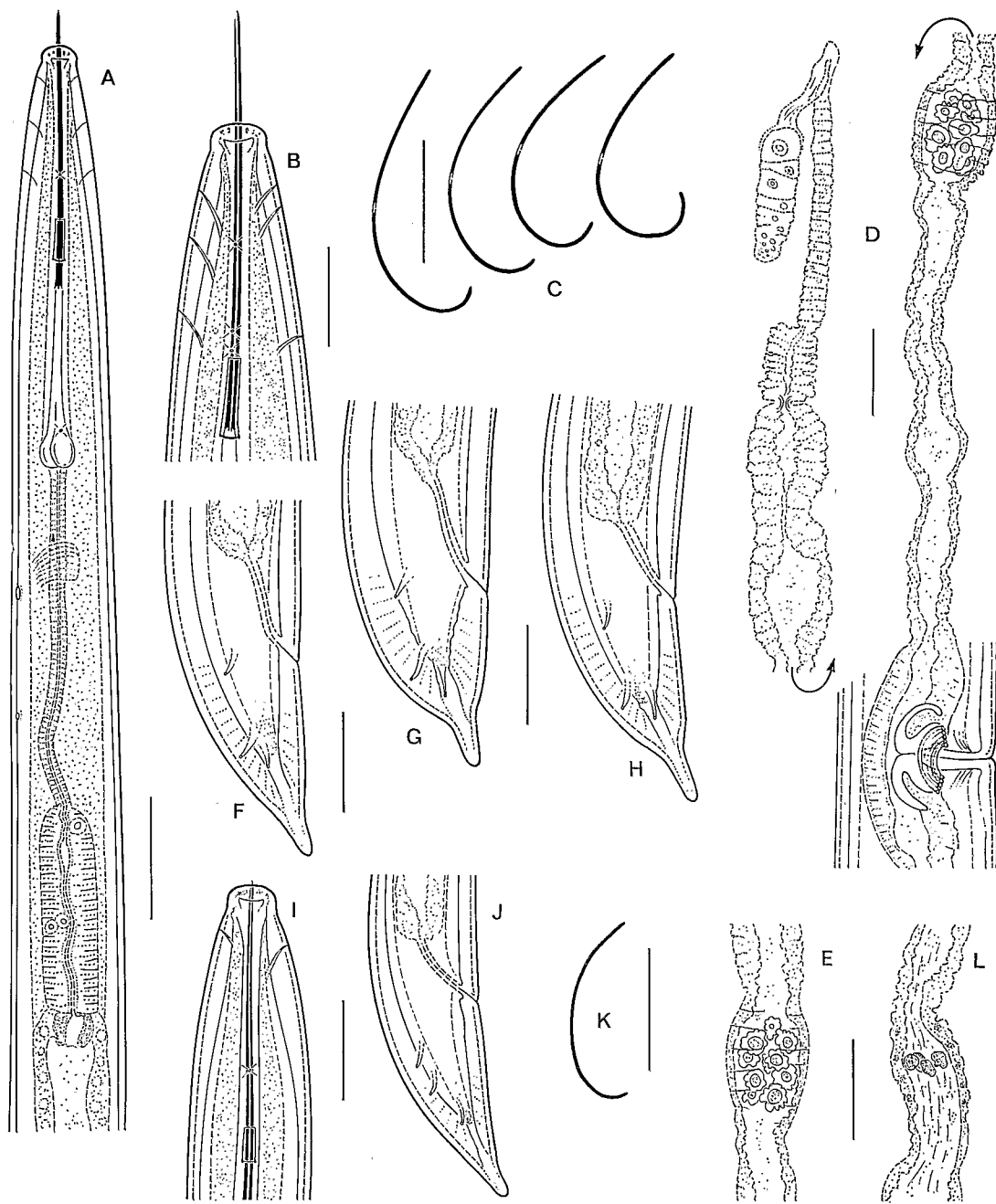


FIG. 1. — *Xiphinema malawiense* n. sp. A-H : Female : A, oesophagus portion ; B, anterior part ; C, body, *in toto* ; D, anterior branch of the genital tract ; E, pseudo Z organ ; F, G, H, tails. I-K : Juvenile, st. IV : I, anterior part ; J, tail ; K, body, *in toto*. — *Xiphinema coxi* Tarjan, 1964 : L, pseudo Z organ. (Each bar represents : A, 50 μ m ; C, K : 1 mm ; others : 25 μ m.)

Juveniles

(Fig. 1; morphometrics tab. I)

Specimens of only fourth stage juveniles and one specimen of a third stage juvenile were observed. Generally, the fourth stage juveniles were similar, although smaller, to the adults. But, the mean value for tail length was larger in the fourth stage juveniles.

HOLOTYPE : Female, slide no. 15323, deposited in Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris.

PARATYPES : Two females deposited in each of the following, Deutschen Nematodensammlung, Münster, Germany DBR; Nematology Department, Rothamsted Experimental Station, Harpenden, England and Rands Afrikaans University, Johannesburg, South Africa. Remaining type material in the Paris Museum collection.

TYPE LOCALITY : Rhizosphere of *Citrus paradisi* Marfad, Bvumbwe Agricultural Research Station, Limbe, Malawi.

DIAGNOSIS : *Xiphinema malawiense* n. sp. is characterized by the female genital tract with two branches having the same structure and about the same length; the presence of a Z pseudo-organ containing numerous composed globules; the tail shape, conical-rounded with a well developed peg; the position of the vulva ($V = 40-46$); and length of the spear (175-193 μm).

RELATIONSHIPS : *Xiphinema malawiense* n. sp. may be differentiated by its tailshape from all species with a pseudo Z organ except *X. basiri* Siddiqi, 1959, *X. coxi* Tarjan, 1964, and *X. parvistilus* Heyns, 1971. From the latter species, *X. malawiense* n. sp. is distinguished by its greater spear length (175-193 *vs.* 118-124 μm). From *X. basiri*, it differs by having more anteriorly situated vulva ($V = 40-46$ *vs.* 48-53) and the structure of the pseudo Z organ which, in *X. basiri* is very weakly differentiated containing only a few simple globular bodies and thus it is often considered as absent (TARJAN, 1973). *X. coxi*, by position of its vulva, tail shape, and general appearance appears to be the species most similar to *X. malawiense* n. sp. but in *X. coxi* the female body is longer (3.06-4.0 *vs.* 2.44-2.94 mm) although one population with shorter females was reported (DALMASSO, 1969). Also in *X. coxi* the structure of the pseudo Z organ is quite different (fig. 1, L): the wall is of similar appearance to adjacent parts of the uterus and contains only 3-4 simple globular bodies.

***Xiphinema limbeense* n. sp.**

(Fig. 2)

Females

Morphometrics (tab. II) : Holotype : L = 2.50 mm; a = 55.5; b = 6.4; c = 41; c' = 2.2; odontostyle = 95 μm ; odontophore = 68 μm ; spear = 163 μm ; tail length = 61 μm ; greatest body diameter = 45 μm ; diameter at anus = 28 μm ; anterior to oesophago-intestinal junction = 390 μm ; anterior to vulva = 1.13 mm.

TABLE II. — Morphometrics¹ of females, fourth and third stage juveniles of *Xiphinema lim-beense* n. sp.

| | Females | J4 | J3 |
|--|----------------------------|--------------------|------------------|
| n | 11 | 3 | 3 |
| L (mm) | 2.56 ± 0.1 (2.44-2.81) | 1.88 | 1.31 |
| a | 58 ± 4.9 (49-68) | 58 (57-59) | 49 (47-50) |
| b | 6.8 ± 0.25 (6.5-7.2) | 5.9 (5.6-6.5) | 4.6 (4.2-5.1) |
| c | 42 ± 2.6 (35-45) | 29.5 (29-30) | 18.5 (18-19) |
| c' | 2.22 ± 0.18 (1.81-2.44) | 2.77 (2.7-2.83) | 4.18 (4-4.35) |
| V | 42 ± 1.3 (41-45) | — | — |
| Odontostyle (μm) | 95 ± 2.4 (90-97) | 78 (75-80) | 61 (51-67) |
| Odontophore (μm) | 69 ± 2.7 (65-74) | 59 (57-62) | 54 (51-61) |
| Spear (μm) | 164 ± 2.5 (160-167) | 137 (132-140) | 115 (112-118) |
| Replacement odontostyle (μm) | — | 94 (90-96) | 78 (74-80) |
| Tail (μm) | 61 ± 4.1 (57-71) | 64 (62-65) | 71 (68-74) |
| Greatest body diameter (μm) | 44 ± 3.9 (36-52) | 32.5 (32-33) | 27 (26-28) |
| Body diameter at anus (μm) | 27 ± 1.9 (26-32) | 24 (23-27) | 17 |
| Anterior to oesophago-intestinal junction (μm) | 374 ± 19 (346-410) | 320 (291-337) | 284 (255-309) |
| Anterior to vulva (mm) | 1.09 ± 0.05 (1.06-1.19) | — | — |

1. Mean ± one standard deviation (n-1) and range.

DESCRIPTION

Body elongate, cylindrical, when heat relaxed is slightly ventrally curved to open C shape in which the posterior half is more curved than the anterior. Cuticle, weakly striated in neck and tail regions, apparently composed of two layers, 2.6 μm (2.2-3.3) thick at mid-body and slightly reinforced in the neck region 3.7 μm (3.3-4.2). Lateral chord 1/4 to 1/3 of diameter at mid-body. Series of ventral and dorsal pores present : ventral pores number 7 to 12 in oesophageal region, 6 to 12 between oesophagus and vulva and 10 to 14 between vulva and anus : dorsal pores, 3-6, only present in oesophageal region.

Lateral pores begin at almost the amphid base and lie in a single row in the oesophageal region behind which they form two rows. Lip region slightly rounded in front, 12 μm (11-12) wide, separated from the rest of the body by a weak, smooth, constriction. Amphid stirrup-shaped, amphidial aperture a large straight, transverse slit, about 2/3 of corresponding body diameter, situated in front of the constriction. Hemizonid flat, 6.5 μm (6-7) wide, situated in region of base of spear; hemizonion lenticular, indistinct 2.1 μm (1.8-2.4) wide, 51 μm (47-55) posterior to hemizonid. Nerve ring 15 μm (12-17) wide situated 64 μm (50-77) posterior to base of spear. Spear (odontophore + odontostyle) conforms to genus; flanges of odontophore 12 μm (12-13) wide, reinforced at their margins. Spear guiding apparatus appearing tubular; basal annule 4.8 μm (4.4-5.5) wide situated 79 μm (70-93) from anterior end; length of "tube" variable, apparently following the spear when it is retracted or protracted (4.4-31 μm). Oesophagus conforms to genus; small, triangular, "mucro" situated in oesophageal wall 1.8 (1.6-2.2) long and 55 μm (33-74) from base of spear, orientation of vertices apparently random; oesophageal bulb 97 μm (88-115) long and 21 μm (18-23) wide; position of the dorsal oesophageal gland nucleus and of the subventral oesophageal gland nuclei conform to genus. Genital tracts composed of two branches having about the same length and structure. Vagina perpendicular to long body axis, reaching about half the corresponding diameter; sclerotization well developed; perivaginal muscle (= sphincter) cup shaped. Ovejector moderately developed. Uterus composed of a thin walled cylindrical, often convoluted portion followed by a long, not well differentiated uterine pouch; close to the pouch a pseudo Z organ is present formed by a dilatation in the uterine wall, the wall being thinner but apparently more muscularized; it contains a few (4-5) bodies, of irregular appearance, composed of a central portion surrounded by lobes, often weakly differentiated; the uterine pouch is connected to the oviduct pouch by a moderately developed sphincter; the uterine pouch is followed by the regular straight, thin part of the uterus, connected with the ovary. No spermatozoa observed. Prerectum 460 μm (357-567) long; rectum 29 μm (24-33) long. Tail conical-rounded digitate, with dorsal curvature, ventral profile on same line as body profile and peg 18 μm (12-21) ventral to body axis; cuticle at tail 7.4 μm (5.5-8) thick on dorsal side; two pairs of caudal pores, one pair of adanal pores present.

Male not found.

Juveniles

Morphometrics : tab. II.

DESCRIPTION

Specimens of only third and fourth stage juveniles observed. Body curvature less pronounced than in adults and in general the two juvenile stages were similar, although progressively smaller than the adults. However, tail length increased in progressively younger stages and the digitation became slightly less conspicuous in the third stage larvae. Replacement odontostyles were present in each juvenile and the length in the third stage juveniles was similar to that of the functional odontostyles in the fourth stage juveniles, whose replacement odontostyles were similar in length to the odontostyles in the adults.

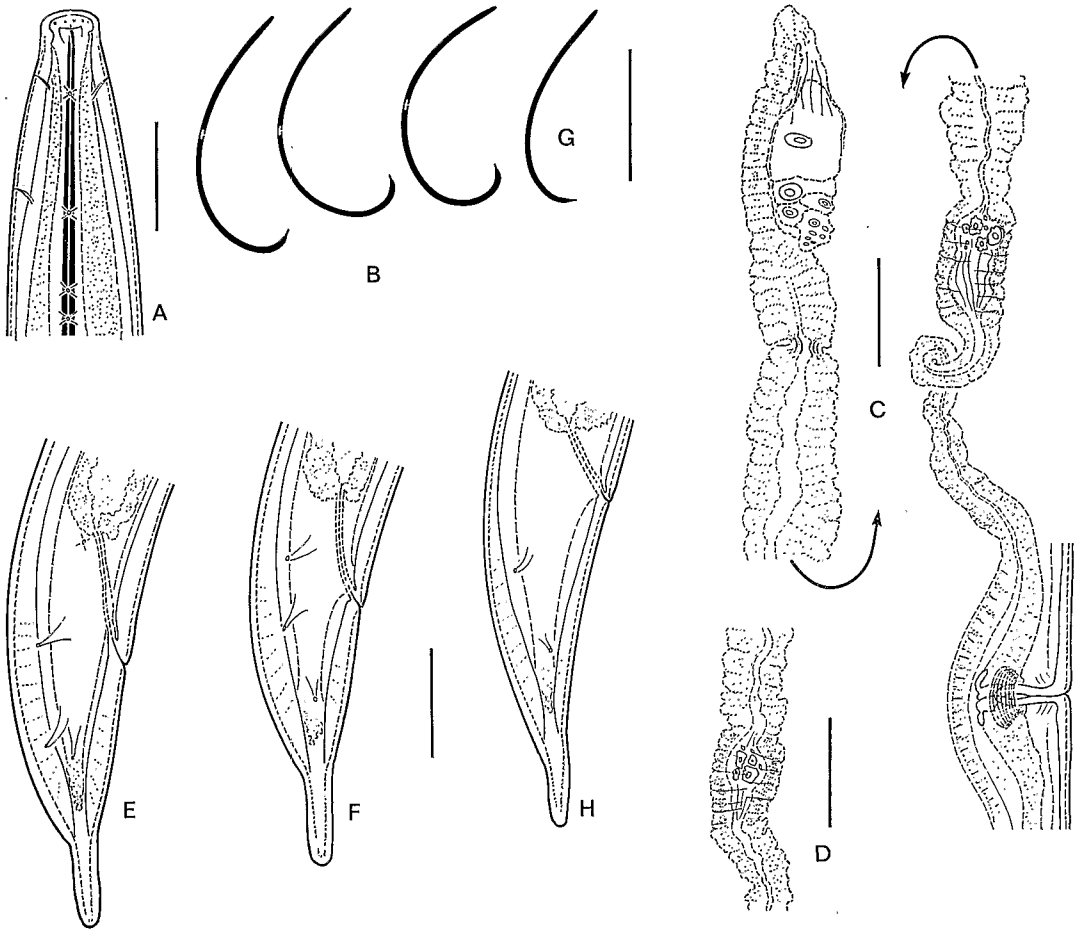


FIG. 2. — *Xiphinema limbeense* n. sp. A-F : Female : A, anterior part ; B, body, *in toto* ; C, anterior branch of genital tract ; D, pseudo Z organ ; E, F, tails. G-H : Juvenile, st. IV : G, body, *in toto* ; H, tail. (Each bar represents : B, G : 1 mm ; others : 25 μ m.)

HOLOTYPE : Female, slide no. 15331, deposited in Muséum national d'Histoire naturelle, Laboratoire des Vers, Paris.

PARATYPES : Two females deposited in each of the following Deutschen Nematodensammlung, Münster, Germany DBR ; Nematology Department, Rothamsted Experimental Station, Harpenden, England, and Rands Afrikaans University, Johannesburg, South Africa. Remaining type material in the Paris Museum collection.

TYPE LOCALITY : Rhizosphere of *Citrus paradisi* Marfad, Bvumbwe Agricultural Research Station, Limbe, Malawi.

DIAGNOSIS AND RELATIONSHIPS : *X. limbeense* n. sp. is similar to *X. malawiense* from which it differs mainly by longer tail, although an overlapping exists, (57-71 μ m *vs.* 41-

63 μm) and the tail is provided with a more differentiated peg. The pseudo Z organ is less differentiated in *X. limbeense* n. sp. than in *X. malawiense* n. sp. and contains fewer globules, of which the composed structure is not so evident. This last character reinforces the resemblance of *X. limbeense* n. sp. to *X. basiri* and *X. coxi* and in particular with the latter species, with the « coconut female » of TARJAN (see fig. 1, J, 1964). But, as stated above, the structure of the pseudo Z organ is more simplified in these latter species.

REMARKS

X. malawiense n. sp. and *X. limbeense* n. sp. are most readily differentiated using mean values for odonstyle and tail lengths. However, the ranges for both these values overlap and examination of further specimens may result in intermediate forms being identified which would cause the validity of separating these two species to be questioned. But the authors consider that at present there appear to be sufficient easily recognisable differences, independent of biotopic differences, which allow these apparently parthenogenetic nematodes to be distinguished and described as separate species. This is to be preferred to attributing these nematodes to an existing species resulting in that species being comprised of diverse populations making a broader species description necessary. However, a taxonomic revision of the group of species comprising *X. basiri*, *X. coxi* and the two new species described here would be useful and the descriptions of *X. malawiense* n. sp. and *X. limbeense* n. sp. given here will be of assistance in such a review.

Acknowledgements : We thank E. CHIKWITA and D. MAKINA for technical assistance.

BIBLIOGRAPHICAL REFERENCES

- ARIAS, M., and G. NAVACERRADA, 1973. — Geographical distribution of *Xiphinema* Cobb in Spanish vineyards. *Nematol. medit.*, **1** : 28-35.
- DALMASSO, A., 1969. — Études anatomique et taxonomique des genres *Xiphinema*, *Longidorus* et *Paralongidorus*. (Nematoda : Dorylaimida). *Mém. Mus. natn. Hist. nat., Paris*, nouv. sér. A, Zool., **61** (2) : 33-82.
- 1970. — Influence directe de quelques facteurs écologiques sur l'activité biologique et la distribution des espèces françaises de la famille des Longidoridae (Nematoda-Dorylaimida) : *Annls Zool. Écol. anim.*, **2** : 163-200.
- LUC, M., and A. DALMASSO, 1974. — Considerations on the genus *Xiphinema* Cobb, 1913 (Nematoda : Longidoridae) and a "lattice" for the identification of species. *Cah. ORSTOM*, sér. Biol., **10** : 303-327.
- MACARA, A. M., 1970. — *Xiphinema amarantum* sp. nov. (Nematoda : Dorylaimidae). *Revta ibér. Parasit.*, **30** : 649-658.
- 1972. — Nematodes and associated fungi found in forest nurseries Act. III^e Congr. Un. fitopat. mediter., Oeiras, Portugal, 22-28 oct. : 321-326.
- SAKA, V. W., and M. R. SIDDIQI, 1979. — Plant-parasitic nematodes associated with plants in Malawi. *Pl. Dis. Repr.*, **63** : 945-948.
- TARJAN, A. C., 1964. — Two new American dagger nematodes (*Xiphinema* : Dorylaimidae) associated with *Citrus*, with comments on the variability of *X. bakeri* Williams, 1961. *Proc. helminth. Soc. Wash.*, **31** : 65-76.
- 1973. — The Dagger Nematodes (*Xiphinema* Cobb) of Florida. *Soil Crop Sci. Soc. Proc.*, **33** : 92-95.