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DESCRIPTIONS OF SIX NEW SPECIES OF *XIPHINEMA* (NEMATODA, DORYLAIMIDA) FROM THE MEDITERRANEAN REGION

by

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Summary. Six new species of *Xiphinema* from the mediterranean region are described. Five of them, namely *X. sphaerocephalum* from Spain, *X. nuragicum* from Italy, *X. adenobystherum* from Algeria, *X. cobni* from Israel and *X. macrogastrum* from Turkey, were previously considered as *X. turcicum* Luc et Dalmasso, but all differ from it in not having any Z differentiation in the female genital tract (*X. turcicum* possesses a rudimentary Z pseudo-organ) and in having large spines in the uterus (never observed in *X. turcicum*). *X. hispanum* sp. n. from Spain resembles *X. aceri*, from which it differs by its longer body and differently shaped lip region, and *X. diannae* from which it differs by its longer body, posterior vulva and wider tail.

Xiphinema turcicum was originally described from Turkey (Luc and Dalmasso, 1963) and then reported throughout the Mediterranean region: Israel (Cohn, 1968), Algeria (Dalmasso, 1969), Italy (Prota *et al.*, 1971; Roca and Lamberti, 1978), Spain (Arias, 1979), Malta (Lamberti *et al.*, 1982) and Bulgaria (Lamberti *et al.*, 1983).

Detailed comparative morphological studies of some Mediterranean populations previously identified as *X. turcicum*, revealed consistent differences with respect to paratypes of this species. In our opinion they represent five undescribed species, all without any "Z" differentiation (Grimaldi De Zio *et al.*, 1979), which are described here together with another new species of *Xiphinema* found in Spain.

Materials and methods

Nematodes were extracted from soil by the Cobb wet sieve technique, killed and fixed in hot 5% formalin and mounted in anhydrous glycerin.

Specimens were measured and drawn with the aid of a camera lucida.

Descriptions

XIPHINEMA SPHAEROCEPHALUM sp. n. (Figs. 1-3; Table I)

Holotype female: L = 3.8 mm; a = 52; b = 7.6; c = 106; c' = 0.7; V = 50; odontostyle = 144 µm; odontophore = 92 µm; oral aperture to guiding ring = 133 µm; tail length = 36

µm; J (hyaline portion of tail) = 10.5 µm; body diameter at lip region = 15 µm; body diameter at guiding ring = 50 µm; body diameter at base of oesophagus = 65 µm; body diameter at vulva = 72 µm; body diameter at anus = 50 µm; body diameter at beginning of J = 30 µm.

Allotype male: L = 3.8 mm; a = 66; b = 7.2; c = 85; c' = 0.9; odontostyle = 145 µm; odontophore = 89 µm; oral aperture to guiding ring = 127 µm; tail length = 45 µm; J = 10.5 µm; body diameter at lip region = 15 µm; body diameter at guiding ring = 46.5 µm; body diameter at base of oesophagus = 56.5 µm; body diameter at mid body = 59 µm; body diameter at anus = 47.5 µm; body diameter at beginning of J = 31 µm; spicules = 89.5 µm; lateral guiding pieces = 21 µm.

Female *habitus* as an open C when killed; body cylindrical, tapering very gradually towards the extremities; cuticle smooth, 2-3.5 µm thick along the body. Lip region 8-9 µm high, hemi-elliptical, well rounded frontally, offset from the rest of the body by a slight depression. Amphids large, stirrup shaped, with aperture as a wide arcuate transverse slit. Odontostyle 2-3 µm in diameter at its base; odontophore well flanged at the base, 14-14.5 µm wide. Guiding tube with the two guiding rings well evident, 9-14 µm apart. Oesophagus dorylaimoid with the basal enlarged portion occupying 1/3 to 1/4 of its total length and measuring 118-140 µm long and 22-24 µm wide; oesophageal intestinal valve amorphous. Reproductive system amphidelphic, with equally developed branches; vulva slit-like, slightly anterior to mid body; vagina extending almost 1/2 in the body diameter; uteri very long (395-423 µm), containing large lanceolate spines in the tubular portion, but not seen in the distal *pars dilatata*; no "Z" differentiation nor spermatheca are evident; oviduct consisting of a large pouch and a tubular portion; ovaries reflexed. Preectum

well evident 650-700 μm long. Rectum extending more or less the body width at anus. Tail rounded with a slight mammillate projection of terminus, bearing four caudal pores on each side.

Male generally similar to female with posterior part of the body more curved. Testis well developed full of sperms. Spicules very strong, curved; guiding pieces cuneiform. The adanal pair of papillae is preceded by five 6-8 ventromedian single supplements.

Type habitat and locality: rhizosphere of *Quercus faginea* Lam. at the Coto Rios, Sierra de Cazorla, Jaén, Spain.

Type material: Holotype, allotype, three paratype females and two paratype males in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two female and one male paratypes in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two female and one male paratypes in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema sphaerocephalum* sp. n. is characterized by body length of about 4 mm, odontostyle length about 150 μm , slightly anterior vulva, equally developed female genital branches, large uterine spines, offset lip region and round tail with small mammillate projection.

It is similar to *X. ingens* Luc et Dalmaso, 1963, *X. turcicum* Luc et Dalmaso, 1963; *X. dentatum* Sturhan, 1978; *X. melitense* Lamberti, Bleve-Zacheo et Arias, 1982; *X. majus* Bos et Loof, 1984, *X. hardingi* Joubert, Kruger et Heyns, 1987 and *X. macroacanthum* Lamberti, Roca et Agostinelli, 1989, but differs from all of these in not having any "Z" differentiation in the female genital tract (Z-organ occurs in *X. hardingi*, *X. majus* and *X. dentatum* and Z-pseudo organ in *X. melitense*, *X. ingens*, *X. macroacanthum* and *X. turcicum*). Moreover, it differs from *X. ingens* by its smaller size (L = 3.9 vs 5.7 mm) and from *X. turcicum* (which has only a rudimentary Z-pseudo organ) in having large spines in the uteri (not observed in *X. turcicum*), shorter odontostyle (150 vs 157 μm) and lower values of "a" and "c" ratios (58 and 109 vs 68 and 118 respectively).

X. sphaerocephalum also resembles *X. nuragicum* sp. n., *X. adenobysterum* sp. n., *X. cobni* sp. n. and *X. macrogastrum* sp. n.

Compared to *X. nuragicum*, *X. sphaerocephalum* has anterior vulva (V = 48 vs 50), posterior guiding ring (140 vs 129 μm from anterior extremity), thicker anterior and thinner posterior profiles of the body, offset lip region (almost continuous with the rest of the body in *X. nuragicum*) and slightly bulging tail terminus (bluntly rounded in *X. nuragicum*).

Compared to *X. adenobysterum*, *X. sphaerocephalum* has shorter body (3.9 vs 4.4 mm), lower value of "a"

and "c" ratios (58 and 109 vs 69 and 136 respectively), anterior vulva (V = 48 vs 52) slightly bulging tail terminus (bluntly rounded in *X. adenobysterum*) and no glandular structure in the uterine walls (evident in *X. adenobysterum*).

Compared to *X. cobni*, *X. sphaerocephalum* has higher "c" ratio value (109 vs 96), lower c' value (0.8 vs 0.9), shorter odontostyle (150 vs 164 μm), shorter tail (36 vs 43 μm) and slightly bulging tail terminus (widely conoid with rounded terminus in *X. cobni*).

Compared to *X. macrogastrum*, *X. sphaerocephalum* has shorter body (3.9 vs 4.6 mm), shorter odontostyle (150 vs 160 μm), shorter tail (36 vs 42 μm), thinner body profile, less expanded lip region and slightly bulging tail terminus (bluntly rounded in *X. macrogastrum*) and no glandular structures in the uterine walls (evident in *X. macrogastrum*).

Finally, compared to *X. nuragicum* sp. n., *X. adenobysterum* sp. n., *X. cobni* sp. n. and *X. macrogastrum* sp. n., *X. sphaerocephalum* is the only species for which males were found. However, it cannot be considered to be an amphigonous species as no sperms, which were plentiful in the testis, were ever observed in the female genital tract.

***XIPHINEMA NURAGICUM* sp. n. syn. *X. turcicum* sensu Prota et al., 1971 (Figs. 1, 3 and 4; Table I)**

Holotype female: L = 4.2 mm; a = 69; b = 8.4; c = 110; c' = 0.8; V = 50; odontostyle = 145 μm ; odontophore = 78 μm ; oral aperture to guiding ring = 130 μm ; tail length = 38 μm ; J = 11 μm ; body diameter at lip region = 13 μm ; body diameter at guiding ring = 42 μm ; body diameter at base of oesophagus = 49 μm ; body diameter at vulva = 61 μm ; body diameter at anus = 48 μm ; body diameter at beginning of J = 33 μm .

Female *habitus* as an open C when killed; body cylindrical tapering very gradually towards the extremities; cuticle smooth, 2-3.5 μm thick along the body. Lip region 7-7.5 μm high, more or less rounded frontally, continuous or very slightly offset from the rest of the body by a depression. Amphids stirrup shaped with aperture as a straight slit. Odontostyle 2-2.5 μm in diameter at its base; odontophore well flanged at the base 13.5-15 μm wide. Guiding tube with the two guiding rings well evident, 11-13.5 μm apart. Oesophagus dorylaimoid with the basal enlarged portion occupying about 1/3 of its total length and measuring 103-120 μm long and 19-26 μm wide. Oesophagus intestinal valve amorphous. Reproductive system amphidelphic, with equally developed branches; vulva slit-like, situated more or less at mid body; vagina extending from 1/2 to 1/3 in the body diameter, uteri 341-370 μm long, containing large spines in the tubular portion but not seen

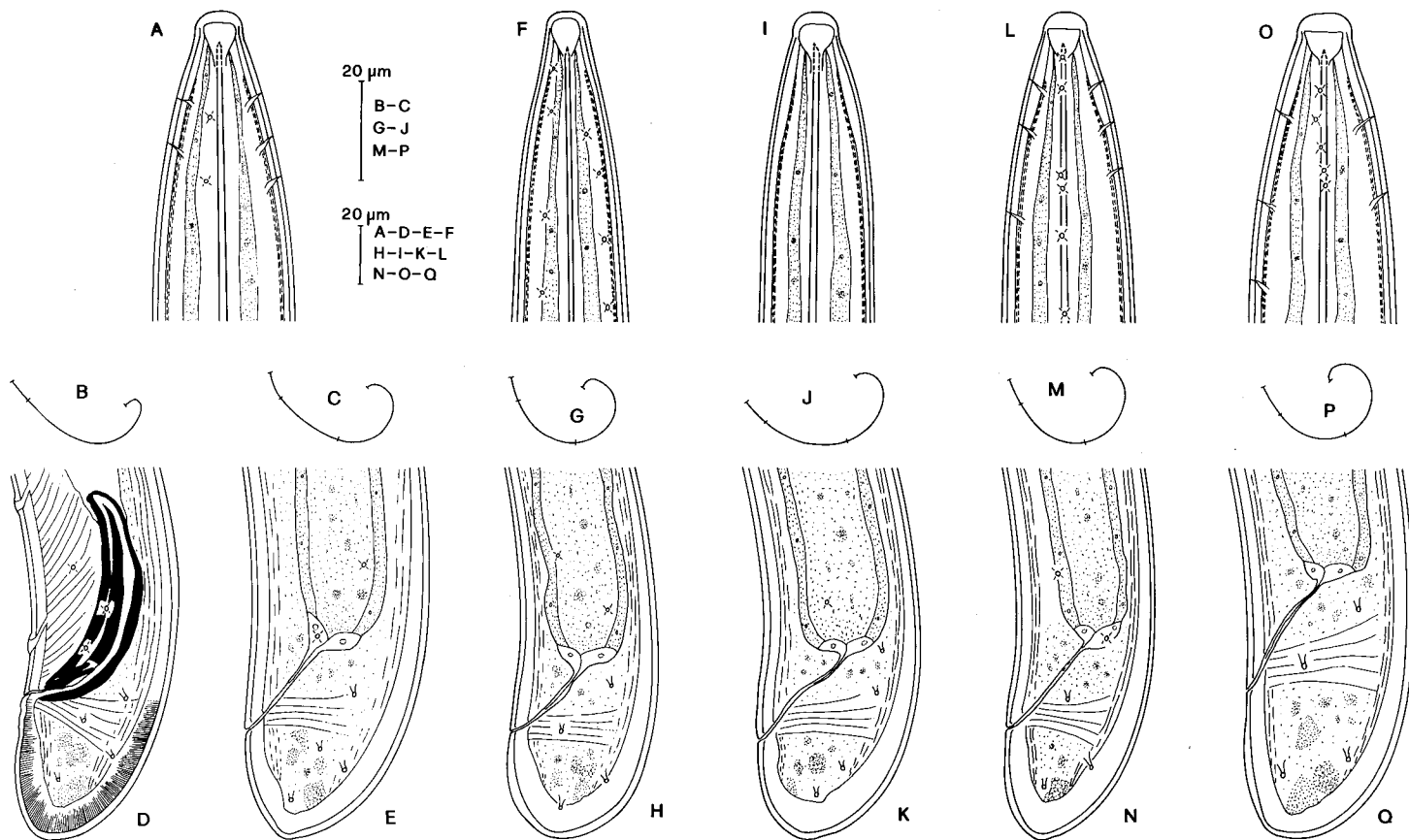


Fig. 1 - *Xiphinema sphaerocephalum* sp. n.; A, female anterior region; B, male *habitus*; C, female *habitus*; D, male posterior region; E, female posterior region. *X. nuragicum* sp. n. female: F, anterior region; G, *habitus*; H, posterior region. *X. adenobystherum* sp. n. female: I, anterior region; J, *habitus*; K, posterior region. *X. cobni* sp. n. female: L, anterior region; M, *habitus*; N, posterior region. *X. macrogastrum* sp. n. female: O, anterior region; P, *habitus*; Q, posterior region.

in the distal *pars dilatata*; no Z differentiation or spermatheca evident; ovaries reflexed. Prerectum well evident 560-650 µm long. Rectum extending from 2/3 to 1 body width at anus. Tail bluntly rounded with four caudal pores on each side.

Male not found.

Type habitat and locality: rhizosphere of *Vitis* sp. at Guspini, Cagliari, Italy.

Type material: holotype and 14 paratype females in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two paratype females in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema nuragicum* sp. n. is characterized by body length of about 4 mm, odontostyle

length about 144 µm, mid body vulva, equally developed female genital branches, large uterine spines, continuous or very slightly offset lip region and bluntly rounded tail.

It is similar to *X. ingens* Luc *et* Dalmasso, 1963; *X. turcicum* Luc *et* Dalmasso, 1963; *X. dentatum* Sturhan, 1978, *X. melitense* Lamberti, Blevé-Zacheo *et* Arias, 1982; *X. majus* Bos *et* Loof, 1984, *X. hardingi* Joubert, Kruger *et* Heyns, 1987 and *X. macroacanthum* Lamberti, Roca *et* Agostinelli, 1989, but differs from all these in the absence of any "Z" differentiation in the female genital tract (Z-organ occurs in *X. hardingi*, *X. majus* and *X. dentatum* and Z-pseudo organ in *X. melitense*, *X. ingens*, *X. macroacanthum* and *X. turcicum*). Moreover it differs from *X. ingens* in its smaller size ($L = 4$ vs 5.7 mm) and from *X. turcicum*, (which has only a rudimentary Z-pseudo organ) in having large spines in the uteri (not observed in *X. turcicum*), shorter odontostyle (144 vs 157 µm) and lower value of "c" ratio (104 vs 118).

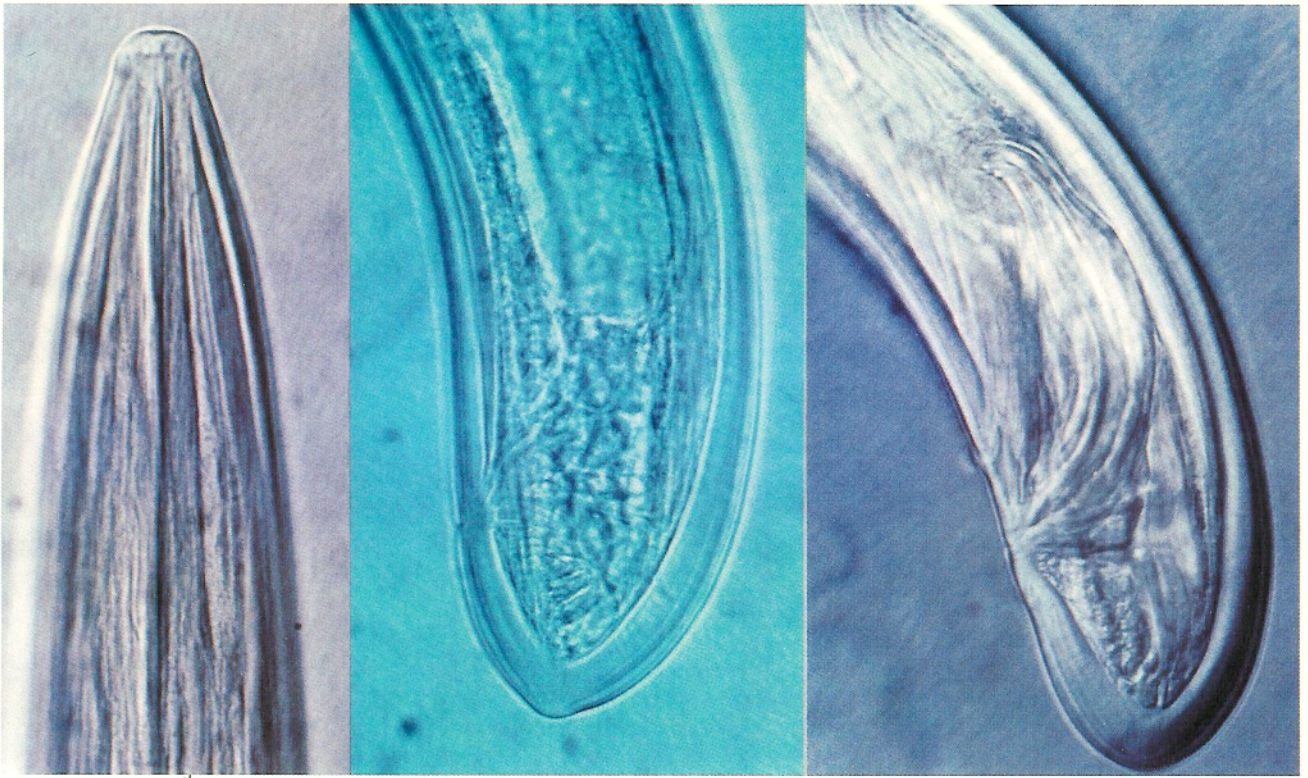


Fig. 2 - *X. sphaerocephalum* sp. n.; female anterior region (left); female posterior region (middle); male posterior region (right).

X. nuragicum also resembles *X. sphaerocephalum* sp. n., *X. adenohystherum* sp. n., *X. cobni* sp. n. and *X. macrogastrum* sp. n.

Compared to *X. sphaerocephalum*, *X. nuragicum* has posterior vulva ($V = 50$ vs 48), anterior guiding ring (129 vs 140 μm from the anterior extremity), thinner anterior and thicker posterior profile of the body continuous or very slightly offset lip region (clearly offset from the rest of the body in *X. sphaerocephalum*) and bluntly rounded tail (bulging tail terminus in *X. sphaerocephalum*).

Compared to *X. adenohystherum*, *X. nuragicum* has slightly shorter body (4 vs 4.4 mm), anterior vulva ($V = 50$ vs 52), longer tail (38 vs 32 μm) and absence of glandular structures in the uterine walls (very clear in *X. adenohystherum*).

Compared to *X. cobni*, *X. nuragicum* has shorter odontostyle (144 vs 164 μm), anterior guiding ring (129 vs 149 μm from the anterior extremity), more rounded tail (widely conoid in *X. cobni*) and no glandular structures in the uterine walls (evident in *X. cobni*).

Compared to *X. macrogastrum*, *X. nuragicum* has shorter body (4 vs 4.6 mm), shorter odontostyle (144 vs 160

μm), more anterior guiding ring (129 vs 150 μm from the anterior extremity), less expanded lip region and no glandular structures in the uterine walls (evident in *X. macrogastrum*).

***XIPHINEMA ADENOHYSTERUM* sp. n. (Figs. 1, 3 and 5; Table I)**

Holotype female: $L = 4.3$ mm; $a = 71$; $b = 7.7$; $c = 128$; $c' = 0.8$; $V = 51$; odontostyle = 150 μm ; odontophore = 83 μm ; oral aperture to guiding ring = 135 μm ; tail length = 33.5 μm ; $J = 13$ μm ; body diameter at lip region = 15 μm ; body diameter at guiding ring = 42 μm ; body diameter at base of oesophagus = 52 μm ; body diameter at vulva = 60.5 μm ; body diameter at anus = 44 μm ; body diameter at beginning of $J = 34$ μm .

Female *habitus* as an open C when killed; body cylindrical, tapering gradually towards the extremities; cuticle smooth, 1.5 - 2.5 μm thick along the body. Lip region 9 - 9.5 μm high, hemispherical, offset from the rest of the body by a depression. Amphids large, stirrup shaped with aperture

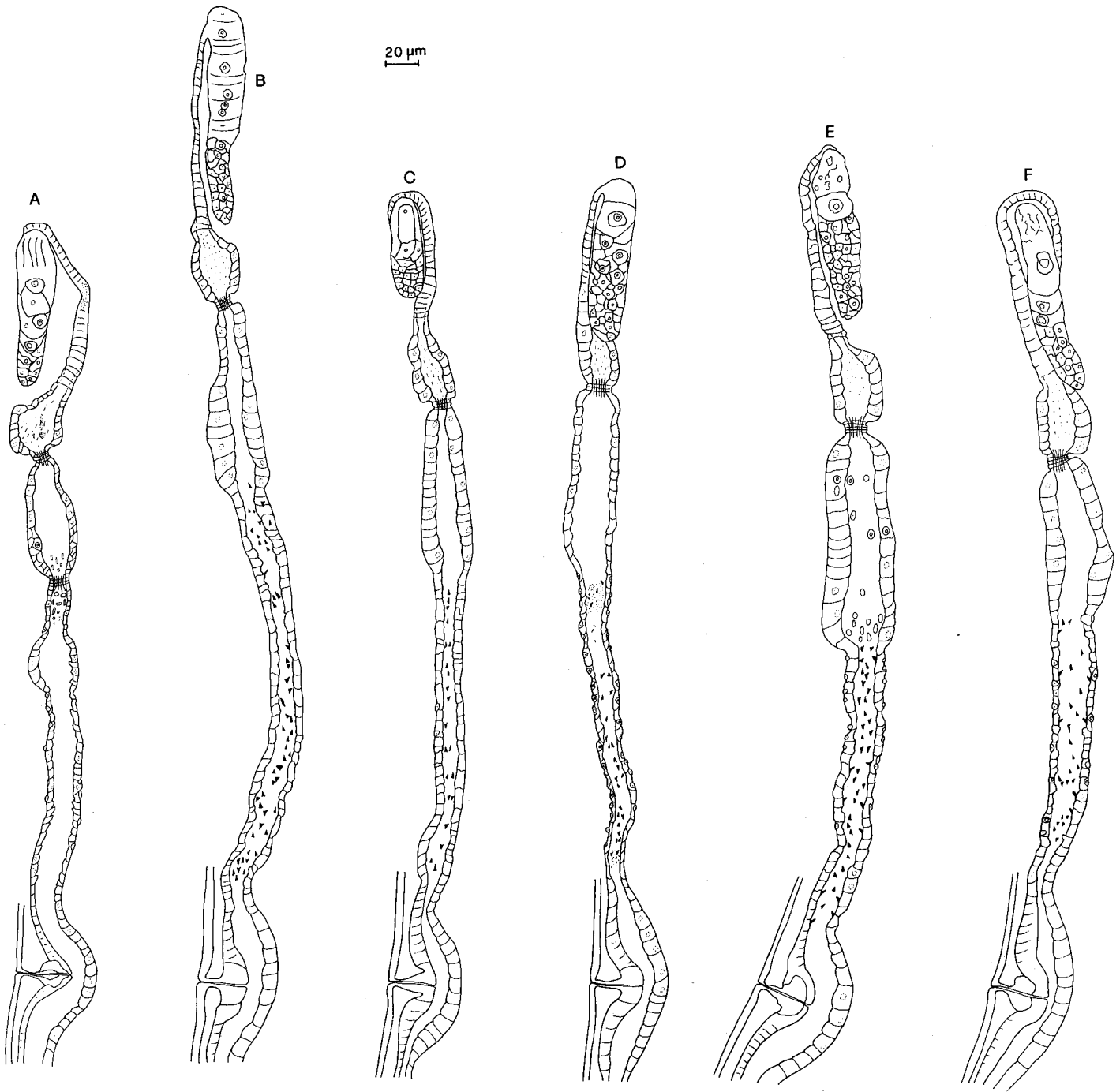


Fig. 3 - Female anterior genital tracts of: A, *X. turcicum*; B, *X. sphaerocephalum* sp. n.; C, *X. nuragicum* sp. n.; D, *X. adeno-hysterum* sp. n.; E, *X. cobni* sp. n.; F, *X. macrogastrum* sp. n.

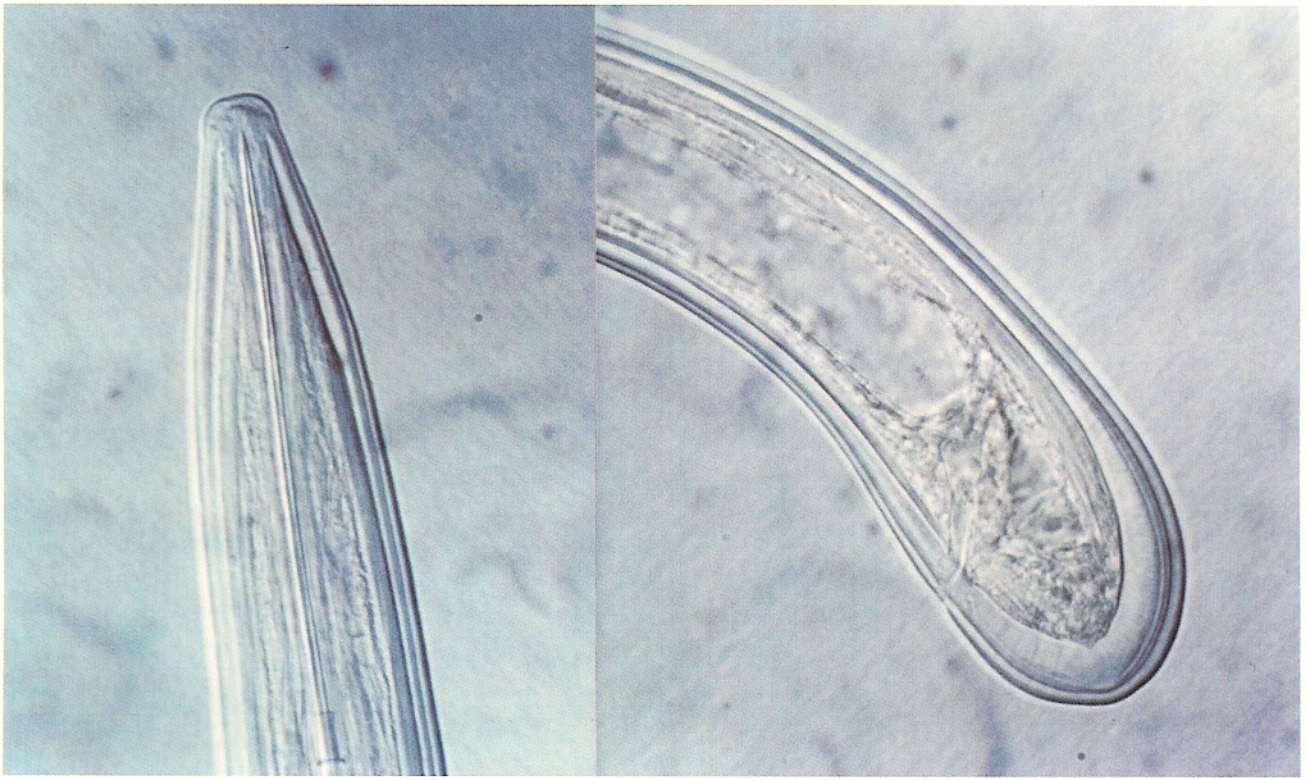


Fig. 4 - Female anterior (left) and posterior regions of *X. nuragicum* sp. n.

as an arcuate slit. Odontostyle 2-2.5 μm diameter at its base; odontophore well flanged at the base, 15-16.5 μm wide. Guiding tube with the two guiding rings well evident, 14-16.5 μm apart. Oesophagus dorylaimoid with the basal enlarged portion occupying 1/4 of its total length and measuring 150-160 μm long and 25-29 μm wide. Oesophagus-intestinal valve amorphous. Reproductive system amphidelphic with equally developed branches; vulva slit-like, situated more or less at mid body; vagina extending to 2/3 of the body diameter; uteri 365-382 μm long, containing large spines in the tubular portion but not seen in the distal *pars dilatata*; several glandular structures are evident in the walls of the uterine tubular portion; no Z differentiation or spermatheca evident; ovaries reflexed. Prerectum very long (460-600 μm). Rectum extending from 2/3 - 1 body width at anus. Tail bluntly rounded with four caudal pores on each side.

Male not found.

Type habitat and locality: rhizosphere of unidentified trees at the Setif Experimental Station, Costantine, Algeria.

Type material: holotype and three paratype females in the collection of the Istituto di Nematologia Agraria del

Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two paratype females in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema adenohysterum* sp. n. is characterized by body length of about 4.4 mm, odontostyle length about 150 μm , slightly posterior vulva, equally developed female genital branches, large uterine spines, glandular structure in the uterine walls, offset lip region and bluntly rounded tail.

It is similar to *X. ingens* Luc et Dalmasso, 1963, *X. turcicum* Luc et Dalmasso, 1963, *X. dentatum* Sturhan, 1978, *X. melitense* Lamberti, Blevé-Zacheo et Arias, 1982, *X. majus* Bos et Loof, 1984, *X. bardingi* Joubert, Kruger et Heyns, 1987 and *X. macroacanthum* Lamberti, Roca et Agostinelli, 1989, but differs from all of these in not having any "Z" differentiation in the female genital tract (Z-organ occurs in *X. bardingi*, *X. majus* and *X. dentatum* and Z-pseudo organ in *X. melitense*, *X. ingens*, *X. macroacanthum* and *X. turcicum*). Moreover, it differs from *X. ingens* in its smaller size (L = 4.4 vs 5.7 mm) and from *X. turcicum* (which has only

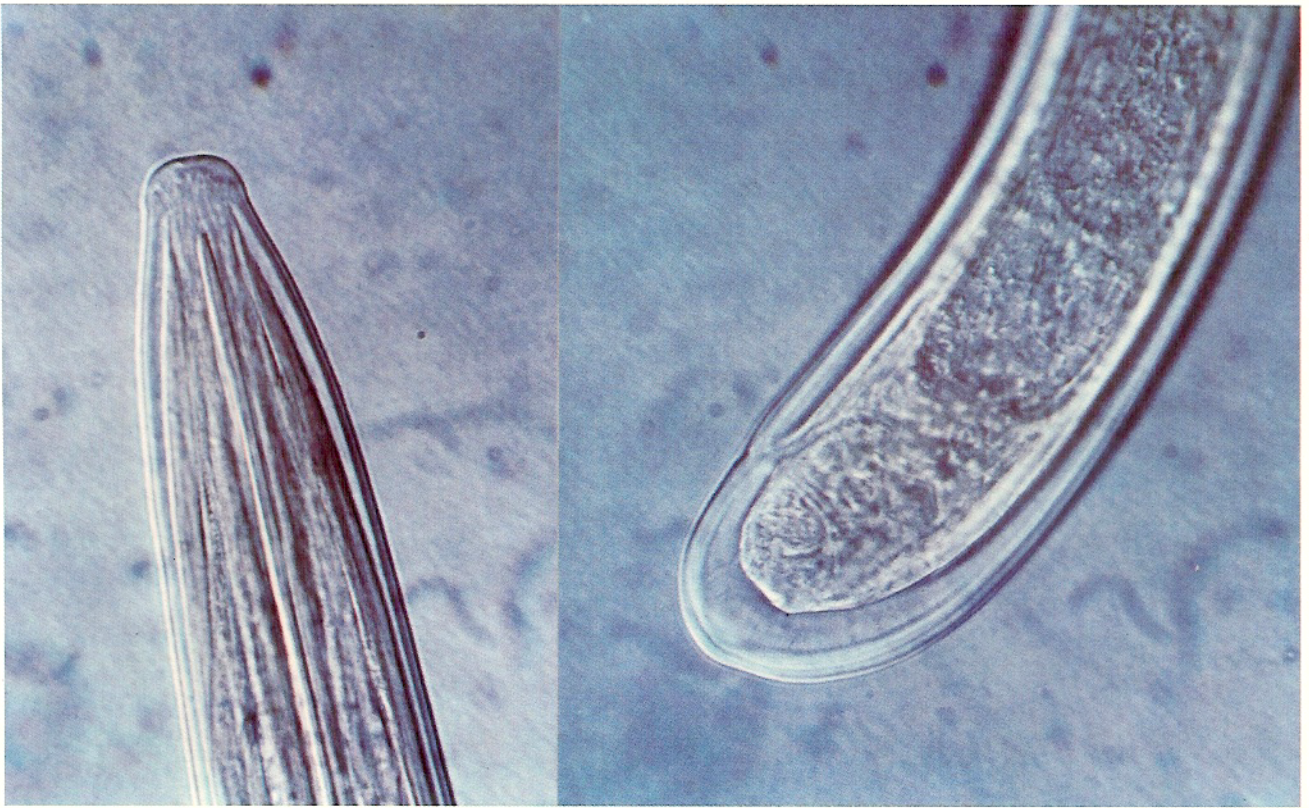


Fig. 5 - Female anterior (left) and posterior regions of *X. adenohystberum* sp. n.

a rudimentary Z-pseudo organ) in having large spines in the uterus and glandular structures in the uterine walls (neither observed in *X. turcicum*), higher value of “c” ratio (136 vs 118) and posterior vulva ($V = 52$ vs 48).

X. adenohystberum also resembles *X. sphaerocephalum* sp. n., *X. nuragicum* sp. n., *X. cobni* sp. n. and *X. macrogastrum* sp. n.

Compared to *X. sphaerocephalum*, *X. adenohystberum* has longer body (4.4 vs 3.9 mm), higher value of “a” and “c” ratios (69 and 136 vs 58 and 109 respectively), posterior vulva ($V = 52$ vs 48), bluntly rounded tail (slightly bulging in *X. sphaerocephalum*) and glandular structures in the uterine walls (not observed in *X. sphaerocephalum*).

Compared to *X. nuragicum*, *X. adenohystberum* has longer body (4.4 vs 4 mm), posterior vulva ($V = 52$ vs 50) shorter tail (32 vs μm) and glandular structures in the uterine walls (not observed in *X. nuragicum*).

Compared to *X. cobni*, *X. adenohystberum* has longer body (4.4 vs 4.1 mm), higher value of “a” and “c” ratios (69 and 136 vs 59 and 96 respectively), posterior vulva ($V = 52$ vs 49), lower c' value (0.7 vs 0.9), shorter odontostyle (149

vs 164 μm), shorter tail (32 vs 43 μm) and more bluntly rounded tail (widely conoid in *X. cobni*).

Compared to *X. macrogastrum*, *X. adenohystberum* has higher value of “c” ratio (136 vs 111), posterior vulva ($V = 52$ vs 47), shorter odontostyle (149 vs 160 μm), anterior guiding ring (135 vs 150 μm from the anterior extremity) shorter tail (32 vs 42 μm) and less expanded lip region.

***XIPHINEMA COHNI* sp. n. syn. *X. turcicum sensu* Cohn, 1968 (Figs. 1, 3 and 6; Table I)**

Holotype female: $L = 4.1$ mm; $a = 58$; $b = 7.3$; $c = 118$; $c' = 0.8$; $V = 49$; odontostyle = 156 μm ; odontophore = 88 μm ; oral aperture to guiding ring = 138 μm ; tail length = 35 μm ; $J = 13.5$ μm ; body diameter at lip region = 15 μm ; body diameter at guiding ring = 47 μm ; body diameter at base of oesophagus = 59 μm ; body diameter at vulva = 71 μm ; body diameter at anus = 46.5 μm ; body diameter at beginning of $J = 33$ μm .

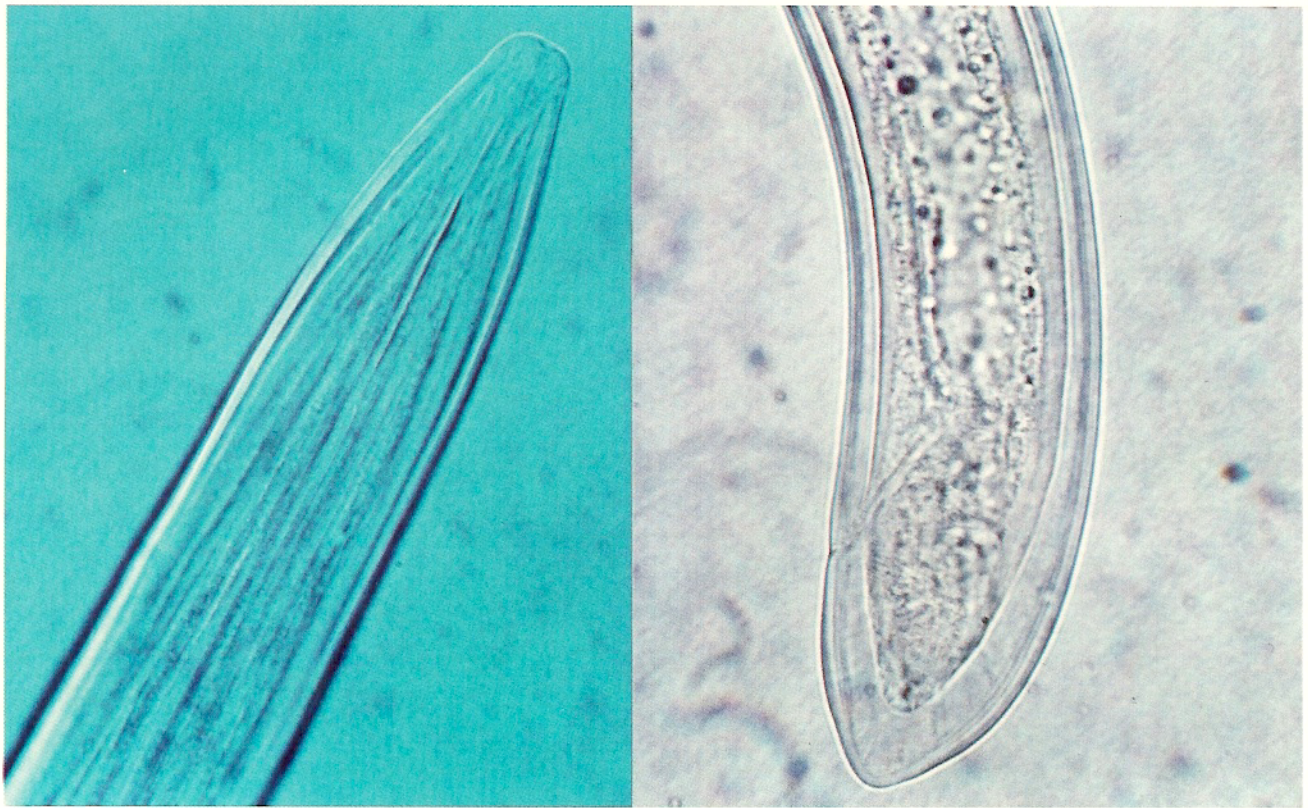


Fig. 6 - Female anterior (left) and posterior regions of *X. cobni* sp. n.

Female *habitus* as an open C when killed; body cylindrical, tapering gradually towards the extremities; cuticle smooth 2-3 μm thick along the body. Lip region 7.5-8 μm high hemispherical, well rounded frontally, very slightly offset from the rest of the body by depression. Amphids large stirrup shaped, with aperture as a wide, straight transverse slit. Odontostyle 2-3 μm diameter at its base; odontophore well flanged at the base, 13.5-15 μm wide. Guiding tube with the two guiding rings well evident, 12-19.5 μm apart. Oesophagus dorylaimoid, containing a mucro in the anterior tubular part, 36-65 μm behind the odontophore base and with the basal enlarged portion occupying from 1/3 to 1/4 of its total length, measuring 115-122 μm long and 25-29 μm wide. Oesophageal-intestinal valve amorphous. Reproductive system amphidelphic with equally developed branches; vulva slit-like, slightly anterior to mid body; vagina extending slightly less than 1/2 the body diameter; uteri 318-335 μm long, containing large spines in the tubular portion, but not seen in the distal *pars dilatata*; glandular structures evident in the walls of the

uterine tubular portion; no "Z" differentiation or spermatheca evident; oviduct consisting of a pouch and a tubular portion; ovaries reflexed. Prerectum 560-618 μm long; rectum extending a little over one body width at anus. Tail widely conoid with rounded terminus and four caudal pores on each side.

Male not found.

Type habitat and locality: rhizosphere of *Quercus* sp., Meron Mountain, Galilee, Israel.

Type material: holotype and eight paratype females in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two paratype females in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema cobni* sp. n. is characterized by body length of about 4 mm, odontostyle length around 164 μm , almost mid body vulva, equally

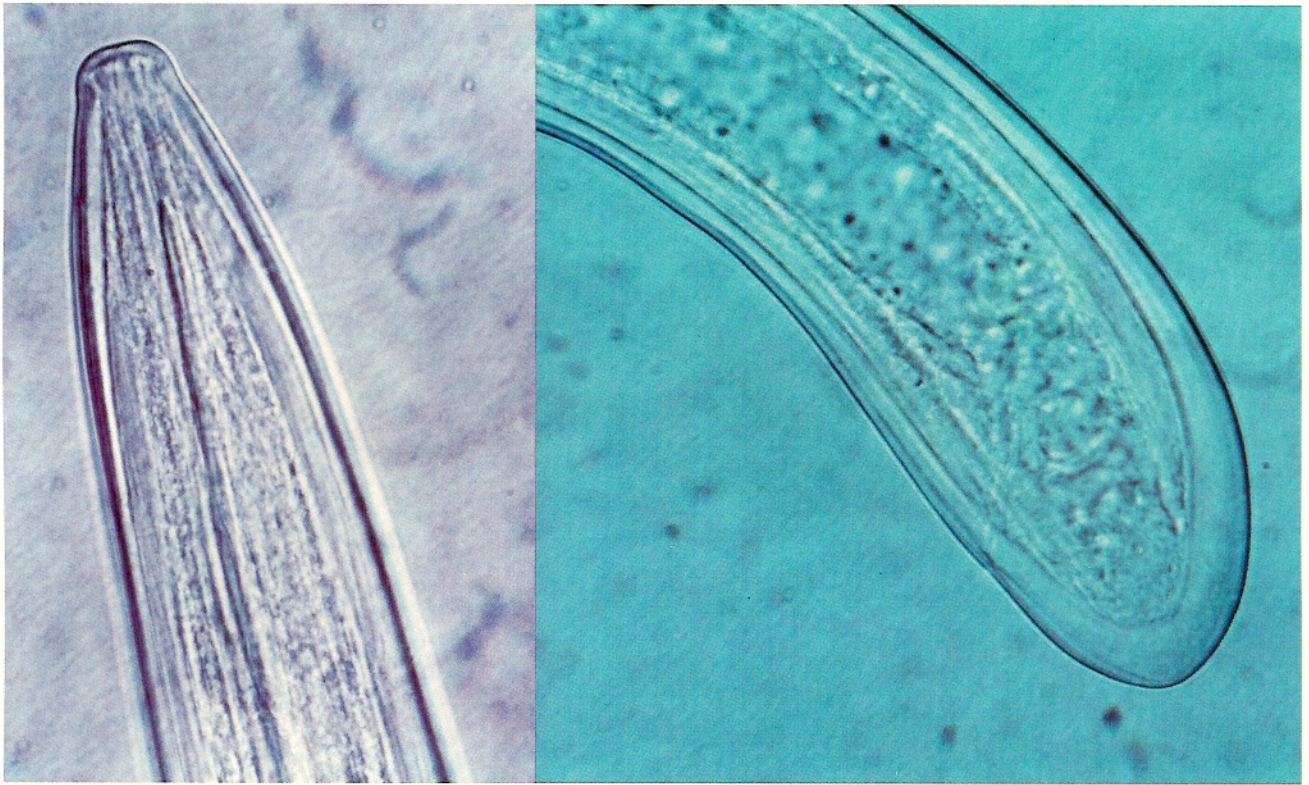


Fig. 7 - Female anterior (left) and posterior regions of *X. macrogastrum* sp. n.

developed female genital branches, large uterine spines, glandular structure in the uterine walls, slightly offset lip region and widely conoid tail with rounded terminus.

It is similar to *X. ingens* Luc *et* Dalmaso, 1963, *X. turcicum* Luc *et* Dalmaso, 1963; *X. dentarum* Sturhan, 1978; *X. melitense* Lamberti, Blevé-Zacheo *et* Arias, 1982; *X. majus* Bos *et* Loof, 1984, *X. bardingi* Joubert, Kruger *et* Heyns, 1987 and *X. macroacanthum* Lamberti, Roca *et* Agostinelli, 1989, but differs from all of these in not having any "Z" differentiation in the female genital tract (Z-organ occurs in *X. bardingi*, *X. majus* and *X. dentatum* and Z-pseudo organ in *X. melitense*, *X. ingens*, *X. macroacanthum* and *X. turcicum*). Moreover, it differs from *X. ingens* in its smaller size (L = 4.1 vs 5.7 mm) and from *X. turcicum*, which has only a rudimentary Z-pseudo organ, in having large spines in the uterus and glandular structures in the uterine walls (neither observed in *X. turcicum*) and lower value of 'a' and 'c' ratios (59 and 96 vs 68 and 118).

X. cobni also resembles *X. sphaerocephalum* sp. n., *X. nuragicum* sp. n., *X. adenobystherum* sp. n. and

X. macrogastrum sp. n. Compared to *X. sphaerocephalum*, *X. cobni* has lower 'c' ratio value (96 vs 109), higher 'c' value (0.9 vs 0.8), longer odontostyle (164 vs 150 μ m), longer tail (43 vs 36 μ m) and widely conoid with rounded terminus tail (slightly bulging in *X. sphaerocephalum*).

Compared to *X. nuragicum*, *X. cobni* has longer odontostyle (164 vs 144 μ m), posterior guiding ring (149 vs 129 μ m from the anterior extremity), widely conoid tail, (bluntly rounded in *X. nuragicum*) and glandular structures in the uterine walls (not evident in *X. nuragicum*).

Compared to *X. adenobystherum*, *X. cobni* has shorter body (4.1 vs 4.4 mm), lower value of 'a' and 'c' ratios (59 and 96 vs 69 and 136 respectively), anterior vulva (V = 49 vs 52), higher 'c' value (0.9 vs 0.7), longer odontostyle (164 vs 149 μ m), longer tail (43 vs 32 μ m) and widely conoid tail (bluntly rounded in *X. adenobystherum*).

Compared to *X. macrogastrum*, *X. cobni* has shorter body (4.1 vs 4.6 mm), lower value of 'c' ratio (96 vs 111), less offset lip region, thinner body profile and narrower tail.

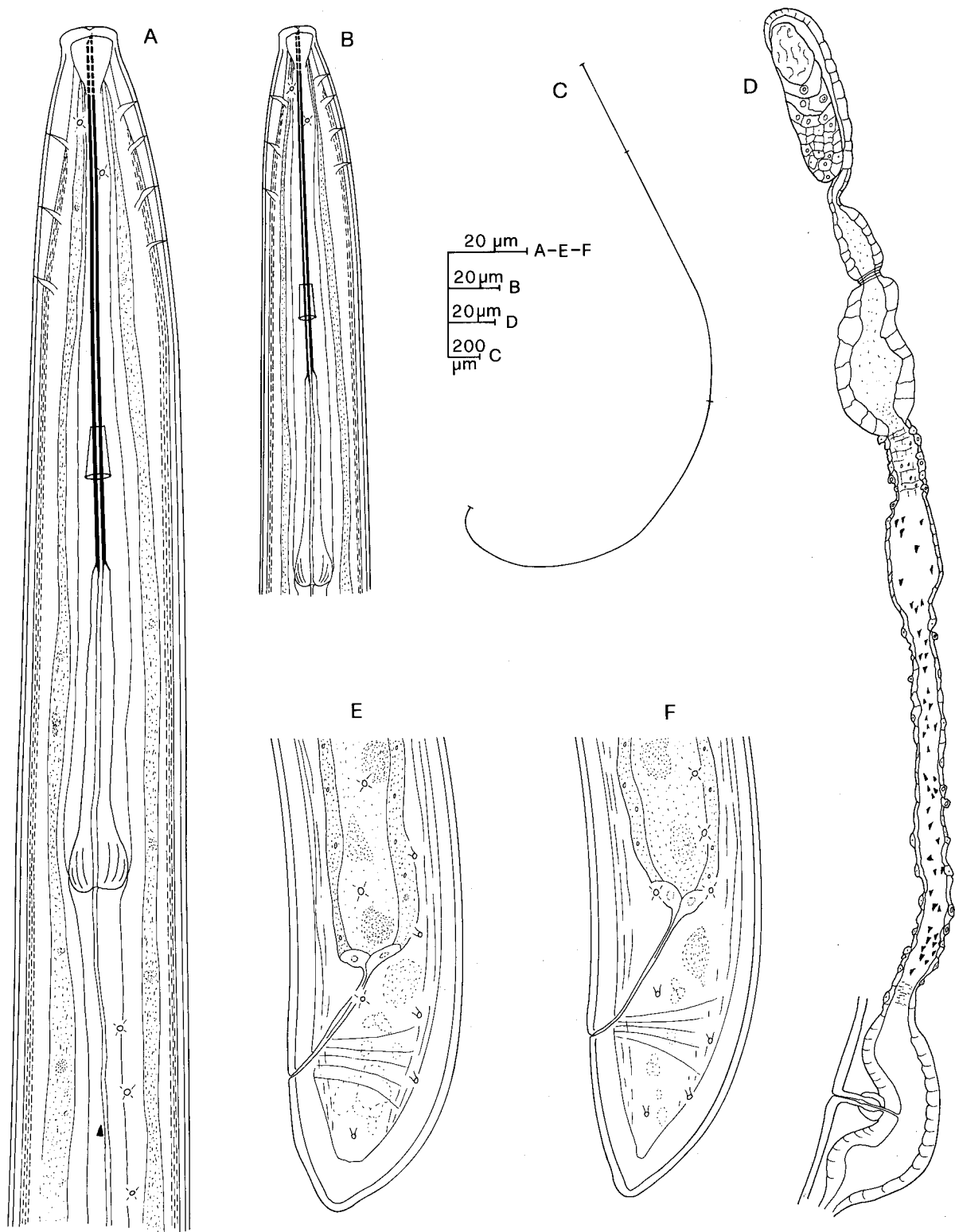


Fig. 8 - Female of *X. hispanum* sp. n. A and B, anterior region; C, habitus; D, anterior genital tract; E and F posterior regions.

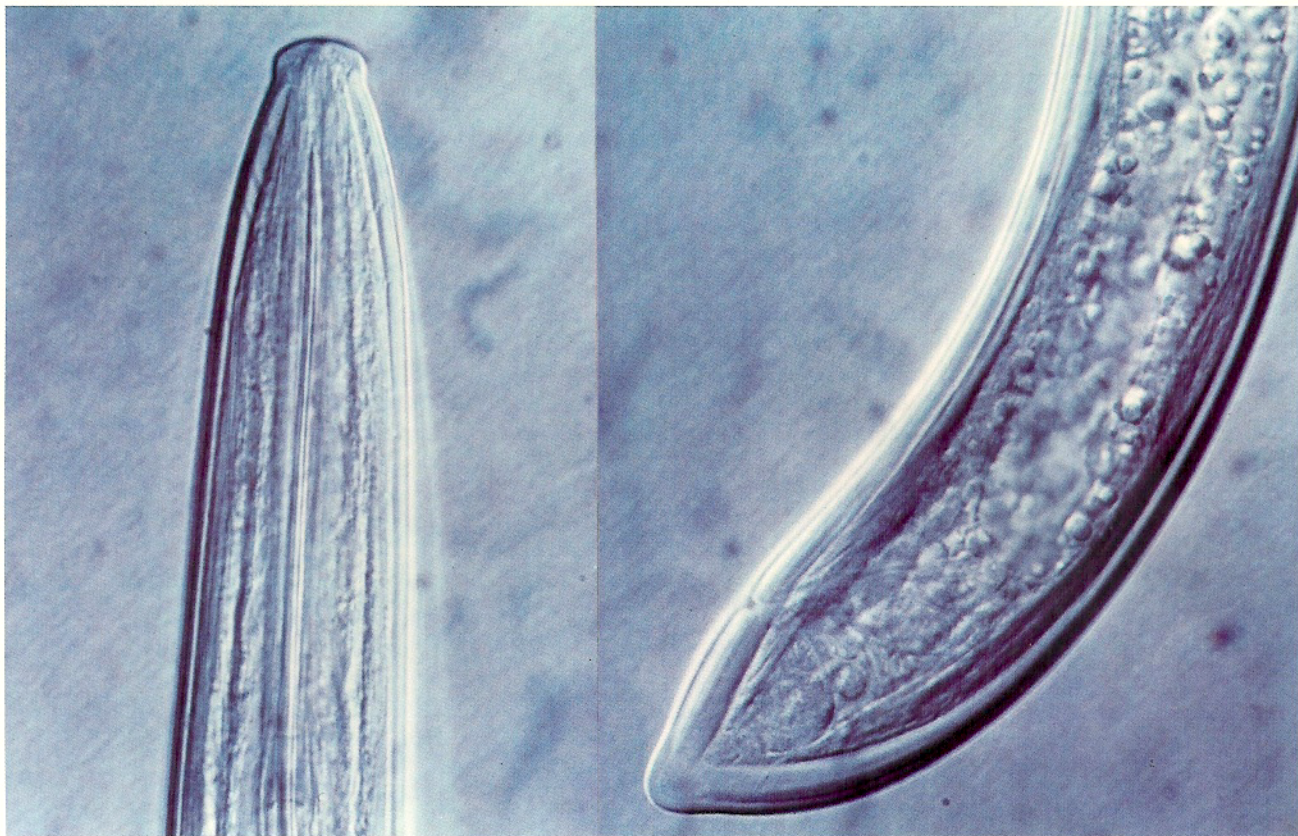


Fig. 9 - Female anterior (left) and posterior regions of *X. hispanum* sp. n.

***XIPHINEMA MACROGASTRUM* sp. n.**

(Figs. 1, 3 and 7; Table 1)

Holotype female: L = 4.6 mm; a = 66; b = 6.9; c = 117; c' = 0.8; V = 48; odontostyle = 165 μ m; odontophore = 101 μ m; oral aperture to guiding ring = 153 μ m; tail length = 39.5 μ m; J = 10.5 μ m; body diameter at lip region = 17.5 μ m; body diameter at guiding ring = 53.5 μ m; body diameter at base of oesophagus = 63.5 μ m; body diameter at vulva = 70 μ m; body diameter at anus = 52 μ m; body diameter at beginning of J = 36 μ m.

Female *habitus* as a closed C when killed; body cylindrical, tapering towards the extremities; body cuticle smooth 2.5-4 μ m. Lip region 8-9.5 μ m high, cylindrical, frontally flattened and laterally rounded, offset from the rest of the body by depression. Amphids large, stirrup shaped with aperture as a wide straight transverse slit. Odontostyle robust 3 μ m in diameter at its base; odontophore well flanged at the base, 16-19 μ m wide. Guiding tube with the two

guiding rings well evident, 18-19.5 μ m apart. Oesophagus dorylaimoid containing a mucro in the tubular part, about 100 μ m behind the base of the odontophore; basal enlarged portion of the oesophagus very large, occupying from 1/3 to 1/4 of the total oesophagus length, 162-187 μ m long and 32-37 μ m wide. Oesophageal intestinal valve amorphous. Reproductive system amphidelphic with equally developed branches; vulva slit-like, slightly anterior to mid body; vagina extending almost 1/2 in the body diameter; uteri 353-385 μ m long, formed by a tubular part, containing spines in the lumen and glandular structure in the walls, and a large *pars dilatata*; no Z differentiation or spermatheca visible; oviduct consisting of a well evident pouch and a tabular portion; ovaries reflexed. Prerectum 700-765 μ m long. Rectum extending to more or less the body width at anus. Tail bluntly rounded sometimes with an inconspicuous bulge projecting slightly ventrally, bearing four caudal pores on each side.

Male not found.

Type habitat and locality: rhizosphere of almond trees (*Prunus amygdalus* Batsch), Besni, Gaziantep, Turkey.

Type material: holotype and two paratype females in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two paratype females in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema macrogastrum* sp. n. is characterized by body length of about 4.5 mm, odontostyle length about 160 µm, slightly anterior vulva, equally developed female genital branches, uterine spines, glandular structures in the uterine walls, cylindrical offset lip region and bluntly rounded tail.

It is similar to *X. ingens* Luc et Dalmasso, 1963, *X. turci-*

cum Luc et Dalmasso, 1963; *X. dentatum* Sturhan, 1978; *X. melitense* Lamberti, Bleve-Zacheo et Arias, 1982; *X. majus* Bos et Loof, 1984, *X. hardingi* Joubert, Kruger et Heyns, 1987 and *X. macroacanthum* Lamberti, Roca et Agostinelli, 1989, but differs from all of these in not having any "Z" differentiation in the female genital tract (Z-organ occurs in *X. hardingi*, *X. majus* and *X. dentatum* and Z-pseudo organ in *X. melitense*, *X. ingens*, *X. macroacanthum* and *X. turcicum*). Moreover, it differs from *X. ingens* in its smaller size (L = 4.6 vs 5.7 mm) and from *X. turcicum*, (which has only a rudimentary Z-pseudo organ), in having spines in the uterus and glandular structures in the uterine walls (neither observed in *X. turcicum*), more expanded and frontally flattened lip region (hemispherical in *X. turcicum*) and wider tail.

X. macrogastrum also resembles *X. sphaerocephalum* sp. n., *X. nuragicum* sp. n., *X. adenobystherum* sp. n. and *X. cobni* sp. n.

TABLE I - *Morphometrics of paratypes of species of Xiphinema*

	<i>X. turcicum</i> (after Luc and Dalmasso, 1963)		<i>X. sphaerocephalum</i>			
	n	6 ♀♀	7 ♀♀	7 ♀♀	4 ♂♂	
L (mm)		4.02 (3.64-4.24)	3.3-4.3	(3.9 ± 0.30)	3.7-4	(3.8 ± 0.09)
a		67.6 (63.1-70.0)	54.3-65.0	(57.9 ± 5.92)	63.5-66.9	(65.5 ± 4.55)
b		7.2 (6.4-7.6)	6.1-8.3	(7.3 ± 0.78)	6.8-7.0	(6.9 ± 0.17)
c		117.7 (102-125.3)	94.0-125.4	(109.1 ± 12.6)	88.5-99.5	(94.5 ± 4.34)
c'		0.8 (0.7-0.85)	0.7-0.9	(0.8 ± 0.08)	0.8-0.9	(0.85 ± 0.05)
V		48.4 (46.7-49.6)	47.0-50.0	(48 ± 0.98)	-	-
Odontostyle (µm)		157 (152-160.5)	143.5-168.2	(149.9 ± 10.19)	141.8-151.2	(146.3 ± 6.66)
Odontophore (µm)		93.5 (85.5-98.5)	84.7-97.6	(89.9 ± 4.19)	79.4-94.1	(88 ± 5.51)
Oral aperture to guiding ring (µm)		144 (132-157)	125.9-161.8	(140.4 ± 3.10)	126.5-135.3	(132.6 ± 4.37)
Tail length (µm)		30-39	32.4-44.7	(35.9 ± 4.41)	38.2-44.7	(40.4 ± 2.65)
J (hyaline portion of tail) (µm)		-	11.2-12.19	(11.8 ± 0.98)	8.8-10.6	(9.6 ± 0.89)
Body diam. at lip region (µm)		14-16.5	14.8-16.5	(15.4 ± 0.63)	13.8-16.8	(15.8 ± 1.24)
Body diam. at guiding ring (µm)		-	44.8-50.6	(49.0 ± 3.10)	45.9-46.8	(46.2 ± 0.39)
Body diam. at base of oesophagus (µm)		-	51.7-65.9	(60.2 ± 5.50)	55.3-60.0	(57.2 ± 1.77)
Body diam. at vulva or mid body (µm)		-	58.8-70.0	(66.2 ± 6.44)	55.3-62.4	(58.2 ± 4.12)
Body diam. at anus (µm)		44-51	44.7-49.4	(46.9 ± 1.74)	45.9-50.0	(48.0 ± 1.79)
Body diam. at beginning of J (µm)		-	30.0-35.3	(32.8 ± 2.26)	28.2-34.6	(30.6 ± 2.61)
Spicules (µm)		-	-	-	84.7-91.2	(86.9 ± 3.13)
Guiding pieces (µm)		-	-	-	18.8-23.5	(20.9 ± 1.90)

Compared to *X. sphaerocephalum*, *X. macrogastrum* has longer body (4.6 vs 3.9 mm), longer odontostyle (160 vs 150 μm), longer tail (42 vs 36 μm), thicker body profile, more expanded lip region, bluntly rounded tail (slightly bulging in *X. sphaerocephalum*) and glandular structures in the uterine walls (not evident in *X. sphaerocephalum*).

Compared to *X. nuragicum*, *X. macrogastrum* has longer body (4.6 vs 4 mm), longer odontostyle (160 vs 144 μm), posterior guiding ring (150 vs 129 μm from the anterior extremity), more expanded lip region and glandular structures in the uterine walls (not evident in *X. nuragicum*).

Compared to *X. adenohysterum*, *X. macrogastrum* has lower value of 'c' ratio (111 vs 136), anterior vulva (V = 47 vs 52), longer odontostyle (160 vs 149 μm), posterior guiding ring (150 vs 135 μm from the anterior extremity), longer tail (42 vs 32 μm) and more expanded lip region.

Compared to *X. cobni*, *X. macrogastrum* has longer body (4.6 vs 4.1 mm), higher value of 'c' ratio (111 vs 96), more offset lip region, thicker body profile and wider tail.

Summarising, *X. turcicum* differs from all these species, once considered populations of *X. turcicum* because of having a rudimentary Z-pseudo organ (never observed in the five new species above described) and no uterine spines (very evident in all five new species above described). Moreover, it differs from *X. sphaerocephalum* sp. n. in having longer odontostyle (157 vs 150 μm) and higher values of 'a' and 'c' ratios (68 and 118 vs 58 and 109 respectively), from *X. nuragicum* sp. n. in having longer odontostyle (157 vs 144 μm) and higher value of 'c' ratio (118 vs 104), from *X. adenohysterum* sp. n. in having lower value of 'c' ratio (118 vs 136) and anterior vulva (V = 48 vs 52), from *X. cobni* sp. n. in having higher value of 'a' and 'c' ratios (68 and 118 vs 59 and 96) and from *X.*

<i>X. nuragicum</i> range (means \pm SD)		<i>X. adenohysterum</i>		<i>X. cobni</i>		<i>C. macrogastrum</i>	
18 ♀♀		7 ♀♀		12 ♀♀		6 ♀♀	
3.3-4.5	4.0 \pm 0.37)	3.9-4.7	(4.4 \pm 0.31)	3.6-4.6	(4.1 \pm 0.33)	4.4-4.9	(4.6 \pm 0.18)
55.1-76.1	(65.6 \pm 6.18)	65.2-73.3	(68.5 \pm 3.15)	51.0-68.3	(59.0 \pm 5.70)	58.9-65.5	(61.8 \pm 2.67)
6.7-8.9	(7.7 \pm 0.63)	6.9-8.2	(7.6 \pm 0.39)	6.2-8.3	(7.1 \pm 0.53)	6.7-7.4	(6.9 \pm 0.26)
79.1-123.4	(104.4 \pm 13.05)	126.8-149.6	(136.1 \pm 10.76)	82.6-115.2	(95.7 \pm 11.95)	91.1-118.3	(111.2 \pm 10.57)
0.7-0.9	(0.8 \pm 0.06)	0.7-0.8	(0.75 \pm 0.06)	0.8-1.1	(0.9 \pm 0.11)	0.7-1.0	(0.8 \pm 0.09)
47.0-53	(50.0 \pm 1.44)	49-53	(52 \pm 1.66)	47.0-51	(49 \pm 1.54)	46.0-48.5	(47 \pm 0.78)
137.1-150.0	(143.8 \pm 3.28)	143.3-151.8	(149.1 \pm 2.83)	149.4-174.1	(164.2 \pm 8.56)	155.3-165.3	(160.2 \pm 3.53)
77.1-87.1	(81.7 \pm 2.47)	79.4-88.2	(84.5 \pm 2.85)	81.2-101.0	(93.4 \pm 7.43)	93.5-102.5	(99.2 \pm 3.51)
124.1-135.3	(129.2 \pm 2.89)	127.1-140.6	(135.4 \pm 3.98)	137.6-161.2	(148.7 \pm 7.34)	147.1-155.9	(150.2 \pm 3.52)
32.3-42.2	(38.3 \pm 2.78)	29.4-35.3	(31.9 \pm 2.52)	36.5-48.2	(42.8 \pm 4.24)	37.6-54.1	(42.1 \pm 5.91)
9.4-14.1	(10.9 \pm 1.32)	10.0-12.9	(11.8 \pm 1.22)	11.8-14.7	(13.1 \pm 1.01)	8.8-10.6	(10.0 \pm 0.68)
12.9-14.7	(13.7 \pm 0.55)	13.2-15.2	(15.0 \pm 0.89)	14.7-15.9	(15.2 \pm 0.59)	17.6-18.2	(18.1 \pm 0.29)
38.2-48.2	(41.9 \pm 2.61)	41.2-44.7	(43.2 \pm 1.44)	42.9-54.7	(48.2 \pm 3.41)	51.2-55.3	(52.9 \pm 1.48)
47.0-55.9	(51.5 \pm 3.61)	48.8-58.8	(54.2 \pm 2.88)	54.1-72.3	(61.1 \pm 5.52)	63.5-68.2	(66.3 \pm 1.58)
52.3-67.6	(60.7 \pm 5.08)	57.1-70.6	(64.1 \pm 4.76)	58.8-83.5	(69.3 \pm 7.45)	70.0-81.2	(75.2 \pm 3.98)
44.1-55.9	(49.7 \pm 3.49)	38.8-47.1	(45.1 \pm 2.98)	42.9-50.0	(46.3 \pm 2.63)	50.6-55.9	(53.01 \pm 1.96)
30.6-41.2	(34.6 \pm 3.18)	27.1-37.1	(33.1 \pm 3.25)	25.9-34.7	(30.9 \pm 2.71)	29.4-37.6	(34.4 \pm 2.80)
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

macrogastrum sp. n. in having less expanded and hemispherical lip region (frontally flattened in *X. macrogastrum*) and narrower tail.

***XIPHINEMA HISPANUM* sp. n. (Figs. 8 and 9)**

Holotype female: L = 4.7 mm; a = 82; b = 9.5; c = 137; c' = 0.9; V = 49; odontostyle = 141 μ m; odontophore = 76.5 μ m; oral aperture to guiding ring = 126.5 μ m; tail length = 34 μ m; J = 12 μ m; body diameter at lip region = 15 μ m; body diameter at guiding ring = 39 μ m; body diameter at base of oesophagus = 48 μ m; body diameter at vulva = 57.5 μ m; body diameter at anus = 38 μ m; body diameter at beginning of J = 20.5 μ m.

Paratype females (n = 14): L = 4.4 \pm 0.30 (4.2-5.1) mm; a = 78.6 \pm 5.69 (73.1-83.9); b = 9.1 \pm 1.0 (7.8-9.7); c = 118.5 \pm 8.49 (101.7-137.2); c' = 0.9 \pm 0.08 (0.8-1.1); V = 50 \pm 1.60 (49-51); odontostyle = 137.0 \pm 3.85 (131.2-142.3) μ m; odontophore = 79.3 \pm 1.88 (76.5-82.9) μ m; oral aperture to guiding ring = 117.3 \pm 4.57 (110.6-126.5) μ m; tail length = 37.1 \pm 3.64 (32.3-41.2) μ m; J = 12.3 \pm 2.02 (10.0-14.7) μ m; body diameter at lip region = 15.2 \pm 0.46 (14.1-15.9) μ m; body diameter at guiding ring = 39.3 \pm 0.71 (38.2-40.6) μ m; body diameter at base of oesophagus = 48.2 \pm 1.46 (45.9-50.6) μ m; body diameter at vulva = 55.6 \pm 3.34 (51.2-61.8) μ m; body diameter at anus = 40.2 \pm 1.84 (37.6-42.3) μ m; body diameter at beginning of J = 23.9 \pm 2.36 (20.0-28.2) μ m.

Female *habitus* as a very open C when killed; body cylindrical, tapering very gradually towards the extremities; body cuticle smooth, 2-2.5 μ m thick. Hypodermal cords with granular structures along all of the body length. Lip region 6-7.5 μ m high, offset from the rest of the body by depression, frontally rounded. Amphids large, stirrup shaped, with aperture as a wide arcuate transverse slit. Odontostyle 2.5 μ m in diameter at the base; odontophore well flanged at the base, 14-17 μ m wide. Guiding tube with the two guiding rings 12-17 μ m apart. Oesophagus dorylaimoid, containing a refrigent mucro, about 65 μ m behind the base of the odontophore, in the anterior tubular part; basal enlarged portion of the oesophagus 130-140 μ m long and 20-22.5 μ m wide occupying 1/3 of the total oesophagus length. Oesophageal-intestinal valve elliptical. Reproductive system amphidelphic, with equally developed branches; vulva slit-like, at mid body; vagina extending to almost 1/2 body diameter; uteri 360-370 μ m long, consisting of a tubular portion with spines in its lumen and glandular bodies in its walls and an inconspicuous *pars dilatata* also containing spines; spermatheca present (but devoid of sperms), preceded by a Z constriction (Grimaldi-De Zio et al., 1979); oviduct consisting of a small pouch and a tubular portion; ovaries reflexed. Prerectum evident, 650-700 μ m long. Rectum slightly more than one body width of

anus. Tail widely conical with rounded terminus, bearing four caudal pores on each side.

Male not found.

Type habitat and locality: rhizosphere of *Cistus albidus* L. near Las Viñas, Sierra Morena, Andujar, Jaén, Spain.

Type material: Holotype and 10 paratype females in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in the Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; two paratype females in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Differential diagnosis: *Xiphinema hispanum* sp. n. is characterized by body length of about 4.5 mm, odontostyle length about 137 μ m, mid body vulva, equally developed female genital branches, uterine spines, lip region well offset and widely conical, with rounded terminus tail.

It resembles *X. aceri* Chizhov, Tiev et Turkina, 1986 and *X. diannae* Kruger et Heyns, 1987, but differs from *X. aceri* in its longer body (4.4 vs 3.8 mm), higher value of 'c' ratio (118 vs 101) and differently shaped (frontally rounded vs flattened) and more expanded lip region; from *X. diannae*, *X. hispanum* differs in having longer body (4.4 vs 3 mm), longer odontostyle (137 vs 91 μ m), posterior vulva (V = 50 vs 46) and shorter (37 vs 55 μ m) and wider tail (subdigitate in *X. diannae*).

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