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THE *XIPHINEMA AMERICANUM*-GROUP IN PORTUGAL WITH DESCRIPTIONS OF FOUR NEW SPECIES (NEMATODA, DORYLAIMIDA)

by

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Summary. A study of the specific composition of the *Xiphinema americanum*-group in Portugal, including Madeira and Azores, indicated the occurrence of twelve species, seven known species (*X. diffusum*, *X. duriense*, *X. madeirense*, *X. pachtaicum*, *X. rivesi*, *X. santos* and *X. pachydermum*) and five undescribed species, four of which are described as new and are named: *X. brevisicum*, *X. longistilum*, *X. mesostilum* and *X. microstilum*. The fifth is not named because of the scarcity of material. *X. pachydermum*, *X. brevisicum*, *X. longistilum*, *X. mesostilum* and *X. microstilum* which all have common or abundant males constitute a new sub-group within the *X. americanum*-group. *X. diffusum* and *X. rivesi* are reported for the first time from Portugal. Comments are made on the geographical distribution of all these species in Portugal. A dichotomous key is proposed for the identification of the named species within the *X. americanum*-group occurring in Portugal.

A survey of longidorid nematodes carried out in the vineyards of the Dão and Douro regions in Portugal has revealed the occurrence of five species belonging to the *Xiphinema americanum*-group (Lamberti *et al.*, 1993).

The investigation was extended to the whole country, including the Atlantic islands of Madeira and Azores and the results are reported here.

Materials and methods

Soil samples were collected from the rhizosphere of plants in cultivated or natural habitats. Nematodes were extracted by means of Cobb's wet sieving technique, killed and fixed in hot 5% formalin and processed to anhydrous glycerol. Measurements were taken with the aid of a camera lucida.

Results and discussion

Twelve species that can be attributed to the *Xiphinema americanum*-group were found. *X. duriense* Lamberti *et al.*, *X. madeirense* Brown *et al.*, *X. pachtaicum* (Tulaganov) Kirjanova, *X. pachydermum* Sturhan and *X. santos* Lamberti *et al.*, have originally been described or have already been reported from Portugal. *X. diffusum* Lamberti *et* Bleve Zacheo, and *X. rivesi* Dalmasso, to the best of our knowledge, are reported for the first time from Portugal. *X. bre-*

visicum, *X. longistilum*, *X. mesostilum*, and *X. microstilum* are described as new species. Finally, a single population, constituted by three females only, was found in the rhizosphere of maize at Ponte de Sôr. Its morphometric characters do not fit with any of the described species but because of scarcity of material we report it as *Xiphinema* sp.

According to Lamberti and Ciancio (1993) the splitting of the *X. americanum*-group into subgroups puts *X. diffusum* and *X. rivesi* and probably *X. santos*, as indicated by Lamberti *et al.* (1993), into the *X. americanum* sub-group and *X. madeirense*, *X. pachtaicum*, *X. pachydermum* and probably *X. duriense*, as indicated by Lamberti *et al.* (1993), into the *X. pachtaicum* sub-group, confirming that the *X. americanum*-group putative species occurring in Portugal belong to two sub-groups only. However, Loof and Luc (1990) excluded *X. pachydermum* from the *X. americanum*-group because it is a bisexual species, with numerous males which would be the only one within the group, as well as having other characters not typical of the group. Lamberti and Carone (1991) and Lamberti and Ciancio (1993) retained this species within the *X. americanum*-group considering to be inconsistent the arguments proposed for its exclusion by Loof and Luc, (1990). However, with the four new species described here, all with numerous males and with morphometric characters falling in the range of the *X. americanum*-group, we propose *Xiphinema pachydermum* sub-group which includes *X. pachydermum*, *X. brevisicum* sp.n., *X. longistilum* sp.n., *X. mesostilum* sp.n., and *X. microstilum* sp.n.

The survey indicates certain aspects of the occurrence and geographical distribution of the species:

– *Xiphinema diffusum* was found in Madeira in the rhizosphere of grapevines at Santana and Câmara de Lobos, in the eastern part of the island (Fig. 1) and only once in continental Portugal in the rhizosphere of citrus at Quinta do Hilário, Setúbal (Fig. 1). Its occurrence in Madeira was anticipated, while its presence in Europe, although only occasional, represents a new record.

– *Xiphinema duriense* was found only in continental Portugal, but was present throughout the country (Fig. 1), except in the extreme south. It was found in nine localities (Table I) mainly in the rhizosphere of grapevines or in fallow soil which had hosted grapevines. There was one record from a tobacco field.

– *Xiphinema madeirense* was found in six localities in continental Portugal (Table II), mainly in the northern region but in two instances in central Portugal (Fig. 1). It occurred also at Santana in Madeira (Fig. 1) and at Vinha da Canáda, Mistério, in Terceira island of Azores (Fig. 1). It was predominantly present in the rhizosphere of grapevines. There were single records from fallow soil, the rhizosphere of peach or the rhizosphere of hop.

Xiphinema pachtaicum was the most frequently occurring species. It was present in continental Portugal as well as in Madeira and Terceira (Table III). However, in mainland Portugal it was concentrated on the north and central regions (Fig. 1). A nematode survey carried out in the past (M. A. Bravo, unpublished) in the “Região Vitivinícola do Oeste” revealed the presence of *X. pachtaicum* in 71% of

TABLE I - Localities and plants in the rhizosphere of which *Xiphinema duriense* occurred.

Locality	Host
Barrocalvo, Carvalhal, Bombarral	Grapevine
Casal do Torneiro, Moita de Ferreiros, Lourinhã	Grapevine
Monte Meão, Pocinho, Vila Nova de Foscôa	Fallow
Painho, Cadaval	Grapevine
Quinta da Adúa, Montemor-o-Novo	Fallow
Quinta da Várzea, Lagoeiro, Idanha-a-Nova	Tobacco
Quinta de Côto, Cidadelhe, Mesão Frio	Grapevine
Vale do Sabor, Moncorvo	Grapevine
Quinta Nova, Montemor-o-Novo	Fallow

TABLE II Localities and plants in the rhizosphere of which *X. madeirense* occurred.

Locality	Host
Continental Portugal:	
Azervadinha, Coruche	Peach
Monte Meão, Pocinho, Vila Nova de Foscôa	Fallow
Quinta da Calçada, Provesende, Sabrosa	Grapevine
Quinta da Noruega, Póvoa Cadaval	Grapevine
Quinta de Linhares, Pico dos Regalados, Vila Verde	Hop
Quinta do Paço, Peso da Régua	Grapevine
Madeira:	
Santana	Grapevine
Azores:	
Vinha da Canáda, Mistério, Terceira Isl.	Grapevine

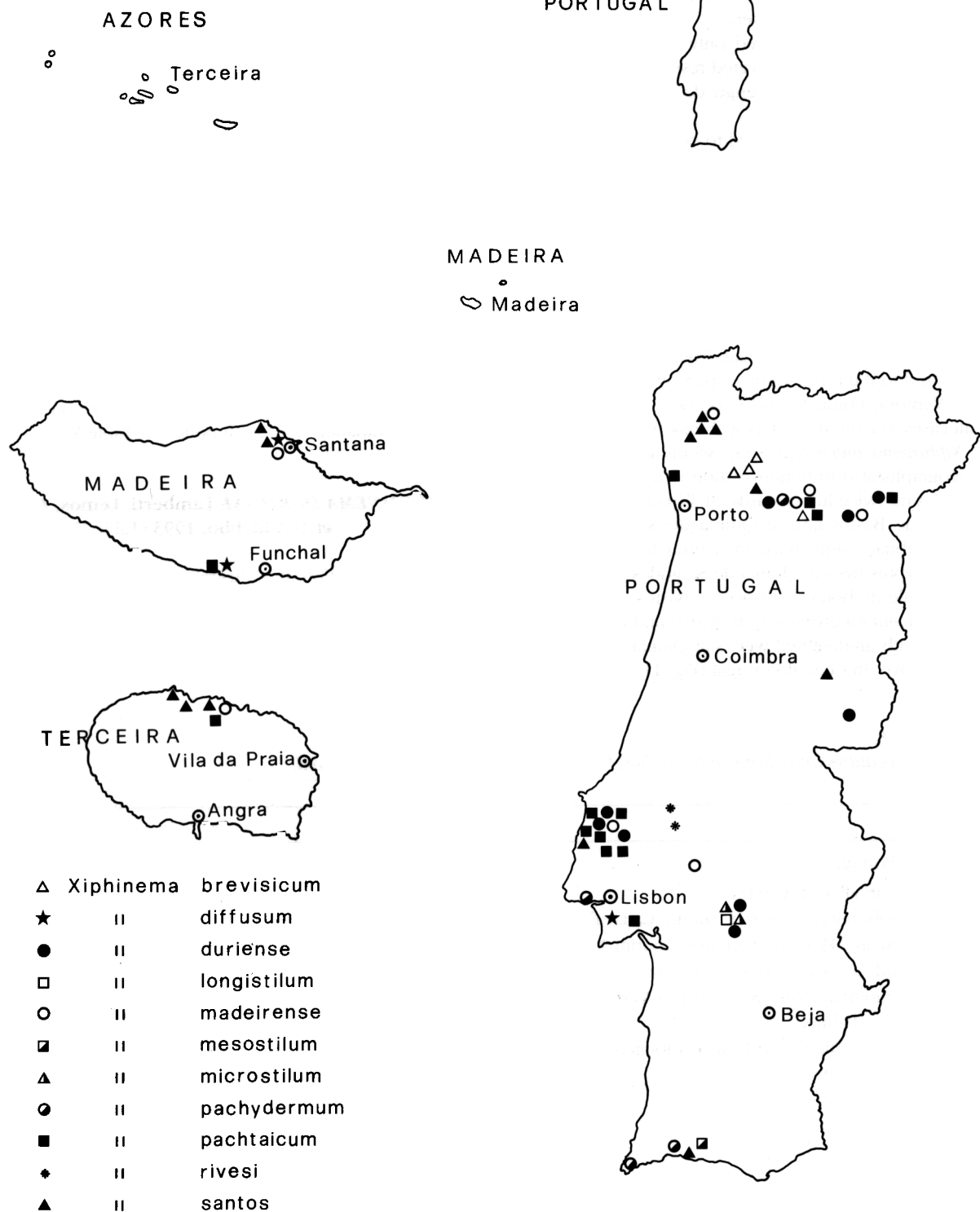


Fig. Distribution of *Xiphinema americanum*-group species in Portugal.

608 vineyards sampled in the localities of Torres Vedras, Bombarral, Cadaval, Sobral de Montagraço, Lourinhã, Arruda dos Vinhos and Alenquer.

Xiphinema rivesi occurred only in central continental Portugal in two vineyards located respectively at Quinta da Alorna, Almeirim and Reguengo do Alviela, Pombalinho, Santarém (Fig. 1).

Xiphinema santos appeared to be the most widespread species. It was found throughout continental Portugal (Fig. 1) as well as in the islands of Madeira (Fig. 1) and Terceira (Fig. 1). It was associated with many kinds of plants (Table IV).

Xiphinema pachydermum occurred only in continental Portugal (Fig. 1) and only once it was found in association with grapevine at Quinta de Santa Bárbara, Peso da Régua in the northern region of the country. The other three records were in central Portugal, from Quinta do Marquês, Oeiras and to the most southern part of the country, Quinta da Ventosa, Portimão and Cabo de S. Vicente, Sagres, in all cases in natural habitats with oak trees.

Xiphinema brevisicum sp.n. seems to be restricted in its geographical distribution to northern Portugal (Fig. 1). It was found twice in vineyards, at Tapada, Vale de Bouro, Celorico de Bastos and at Quinta do Seixo, Valença do Douro, Tabuaço and twice in natural habitats with pine and eucalyptus trees at Quinta de Sergudes, Felgueiras and at Mata, Vale de Bouro, Celorico de Bastos.

Xiphinema longistilum sp.n. was found in two cultivated fields with unidentified weeds at Quinta da Adúa, Montemor-o-Novo, in Central Portugal (Fig. 1).

Xiphinema mesostilum sp.n. occurred in the rhizosphere of olive trees only at Quinta da Lameira, Silves, in southern Portugal (Fig. 1).

Xiphinema microstilum sp.n. was also found only in central Portugal, in two fields with unidentified weeds at Quinta da Adúa and Quinta Nova, both near Montemor-o-Novo (Fig. 1).

Descriptions

XIPHINEMA DIFFUSUM Lamberti et Bleve-Zacheo, 1979 (Table V)

Descriptions and illustrations of *X. diffusum* are reported in Lamberti and Bleve-Zacheo, 1979 and Lamberti *et al.*, 1991. However, the Portuguese specimens of this species seem to be larger than those reported from other localities; as a contribution to the knowledge on its morphometric variation they are reported in Table V.

XIPHINEMA DURIENSE Lamberti, Lemos, Agostinelli et D'Addabbo, 1993 (Table VI)

A description and illustrations are given in Lamberti *et al.*, 1993. Some specimens were of smaller size, with a shorter odontostyle and a posterior vulva, compared to the original description. Ranges in the morphometrics are reported in Table VI.

TABLE III Localities and plants in the rizhosphere of which *X. pachtaicum* occurred.

Locality	Host
Continental Portugal:	
Barrocalvo, Carvalhal, Bombarral	Grapevine
Casal das Aboboreiras, Dagorda-Painho, Cadaval	Grapevine
Casal do Torneiro, Moita de Ferreiros, Lourinhã	Grapevine
Lugar de Tondela, Godim, Peso da Régua	Grapevine
Quinta da Almoinha, Dois Portos, Torres Vedras	Grapevine
Quinta do Anjo, Palmela	Peach
Quinta do Seixo, Valença do Douro, Tabuaço	Grapevine
Vairão, Vila do Conde	Raspberry
Vale do Sabor, Moncorvo	Grapevine
Madeira:	
Câmara de Lobos	Grapevine
Azores:	
Vinha da Canada, Mistério, Terceira Isl.	Grapevine

***XIPHINEMA MADEIRENSE* Brown, Faria, Lamberti,
Halbrendt, Agostinelli *et* Jones, 1992**
(Table VII; Figs. 2 and 3)

Descriptions and illustrations of *X. madeirense* are in Brown *et al.*, 1992 and Lamberti *et al.*, 1993. However, some populations have minor variations in their morphometrics, compared to the original population, such as body and odontostyle length (sometimes longer and sometimes shorter), *c'* (sometimes higher) and vulva (either slightly anterior or posterior) position. These are reported in Table VII, which also includes data on a population from Terceira Azores. The population from Quinta de Linhares, Pico dos Regalados, Vila Verde contained a male, hitherto unknown.

The male is similar to the female but more coiled in the posterior region. Spicules and guiding piece are faintly

sclerotized. The adanal pair of supplements is preceded by a row of 5 ventromedian ones. Tail ventrally curved bearing two pairs of caudal pores.

***XIPHINEMA PACHTAICUM* (Tulaganov, 1938)
Kirjanova, 1951** (Table VIII; Fig. 4)

X. pachtaicum has been thoroughly described and illustrated by Lamberti and Martelli, 1971 and Lamberti and Bleve-Zacheo, 1979. Some Portuguese populations of this species have a longer body and odontostyle and an anterior vulva, compared to those from other Mediterranean localities. Some of them, including one from Vairão, Vila do Conde, in northern Portugal, which contains two males (Fig. 4), are reported in Table VIII.

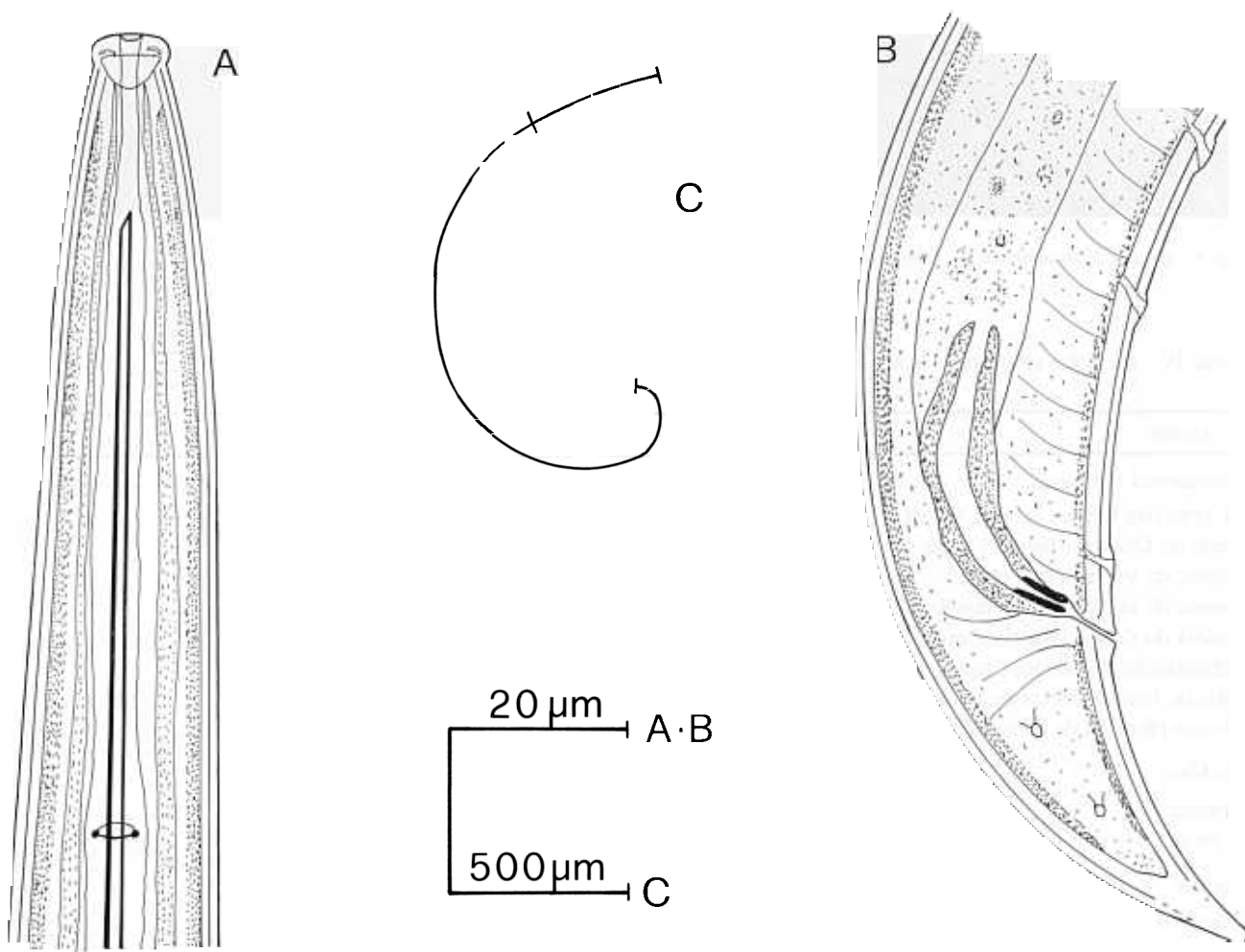


Fig. 2 - Male of *Xiphinema madeirense*, A, anterior region; B, posterior region; C, habitus.



Fig. 3 - Male of *X. madeirense*: A, anterior region; B, posterior region.

TABLE IV - *Localities and plants in the rizhosphere of which X. santos occurred.*

Locality	Host
Continental Portugal:	
Beirado das Burras, Zebras, Fundão	Peach
Casal do Chafariz, Torres Vedras	Grapevine
Quinta da Veiga, Vila Verde	Hop
Quinta de Linhares, Pico dos Regalados, Vila Verde	Hop
Quinta do Corgo, Adaúfe, Braga	Grapevine
Urbanização do Serrão, Lagoa	Peach
Vilar de Frades, Areias de Vilar, Barcelos	Hop
Viveiro Florestal de Amarante, Amarante	Pine
Madeira:	
Santana	Grapevine
S. Jorge	Grapevine
Azores:	
Biscoitos, Terceira Isl.	Grapevine
Canada das Vinhas, Terceira Isl.	Grapevine
Vinha da Canada, Mistério, Terceira Isl.	Grapevine

TABLE V - *Morphometrics of Portuguese populations of X. diffusum.*

Locality	Quinta do Hilário, Setúbal	Santana, Madeira	Câmara de Lobos, Madeira
Host	Citrus	Grapevine	Grapevine
n	5 ♀♀	2 ♀♀	3 ♀♀
L mm	2.0 (2.0-2.2)	2.0-1.9	1.85 (1.7-2.0)
a	49 (46-53)	48.5-45	46 (43-47)
b	6.6 (6.2-7.2)	5.0-6.0	6.6 (5.5-7.9)
c	70 (67-75)	79-77	68 (64-71)
c'	1.0 (1.0-1.0)	1.0-1.0	1.0 (1.0-1.0)
V	50 (50-50)	50-47	51 (50-54)
Odontostyle µm	92 (90-93)	95-96	89.5 (83-96.5)
Odontophore µm	55 (53.5-56)	52-52	52 (51-53)
Oral aperture to guiding ring µm	76 (73-78)	79-81	75 (67-79)
Tail µm	29 (28-30)	25-25	27 (26.5-28)
J (hyalin portion of tail) µm	10 (9-12)	11-11	8 (8-9)
Body diameter at lip region µm	13.5 (13-13.5)	12-12	12 (12-12)
Body diameter at guiding ring µm	29 (28-30)	30-31	27.5 (26.5-28)
Body diameter at base of oesophagus µm	37 (35-39)	38-38	36 (33.5-37)
Body diameter at vulva µm	41 (40-43.5)	41-42	41 (36-43.5)
Body diameter at anus µm	29 (28-31)	26.5-26	27 (26.5-27)
Body diameter at beginning of J µm	18 (16.5-20)	15-14	15 (15-15)

TABLE VI - *Morphometrics of Portuguese populations of X. duriense.*

Locality	Monte Meão, Pocinho, Vila Nova de Foscôa	Quinta Nova, Montemor-o-Novo	Vale do Sabor, Moncorvo	Quinta do Côto, Cidadelhe, Mesão
Host	Unidentified weeds	Unidentified weeds	Grapevine	Grapevine
n	10 ♀♀	10 ♀♀	5 ♀♀	5 ♀♀
L mm	1.6 (1.5-1.8)	1.8 (1.6-1.9)	1.9 (1.8-2.0)	1.8 (1.7-1.85)
a	73.5 (70-81)	72 (68-75)	80 (76-85)	79 (75-81)
b	5.9 (5.2-6.5)	7.0 (6.1-8.7)	7.2 (6.7-7.5)	6.8 (6.4-7.1)
c	52.5 (47-59)	65 (58-70)	57 (53-61)	53 (51-55)
c'	2.35 (2.2-2.5)	1.8 (1.6-2.1)	2.4 (2.2-2.5)	2.4 (2.3-2.6)
V	61 (59-65)	64 (63-67)	62 (60-63)	63 (61-65)
Odontostyle µm	68 (62-71)	67.5 (59-72)	66 (65-68)	66 (64-68)
Odontophore µm	37 (35-38)	38.5 (37-40)	39 (38-41)	37 (36-38)
Oral aperture to guiding ring µm	57 (53-62)	57.5 (53-61)	53 (50-56)	53 (50-54)
Tail µm	31 (29-33.5)	28 (24-31)	33 (29-34)	34 (33.5-34)
J (hyalin portion of tail) µm	7.5 (6.5-8)	7.5 (6.5-9)	9 (8-10)	9 (8-9)
Body diameter at lip region µm	8 (8-8)	8 (8-9)	8 (8-8)	8 (8-8)
Body diameter at guiding ring µm	16 (15-16.5)	18 (16.5-19)	16.5 (16.5-16.5)	16 (15-16)
Body diameter at base of oesophagus µm	20 (19-21)	22.5 (21-23)	21 (21-21)	21 (20-21)
Body diameter at vulva µm	22 (21-23)	25 (23-26.5)	24 (23.5-25)	23 (21-24)
Body diameter at anus µm	13.5 (13-15)	16 (15-18)	14 (13.5-15)	14 (13-14)
Body diameter at beginning of J µm	5.5 (5-7)	7.5 (6.5-8)	6 (6-7)	6 (6-6.5)

Morphometrics of populations, including one from Madeira, one from Terceira, Azores and another, with two males, from Braga, northern Portugal, all differ in some characters such as a slightly longer or shorter body, anterior vulva, shorter odontostyle or lower value of *c'*, from the original description. These are reported in Table X.

Two males occurred in the population from Braga. As the paratype (Lamberti *et al.*, 1993) they both bear eight ventromedian supplements preceeding the adanal pair.

XIPHINEMA PACHYDERMUM Sturhan, 1983

(Table XI; Figs. 7 and 8)

Populations examined in the present work vary in one or more morphometric characters from the type populations (Sturhan, 1983). For example, compared to the type population, the Portimão, the Peso da Régua and the Sagres populations all have a longer body; the Portimão, the Oeiras and the Sagres populations have a shorter odontostyle, but the Peso da Régua population has a longer odontostyle and the Sagres population an anterior vulva, whereas the other three populations have a slightly posterior vulva, compared to the paratypes. Moreover the four new species, namely *X. brevisicum*, *X. longistilum*, *X. mesostilum* and *X. microstilum* are all bisexual and closely related to *X. pachydermum*. Therefore measurements and illustrations are provided of the populations of *X. pachydermum* that were found in order to have available a quick and easy comparison.

XIPHINEMA BREVISICUM sp.n.

(Table XII; Figs. 9 and 10)

Holotype female: L = 2.2 mm; a = 85; b = 7.5; c = 53; *c'* = 2.5; V = 55; odontostyle = 61 µm; odontophore = 43 µm; oral aperture to guiding ring = 53 µm; tail = 42 µm; J (hyalin portion of tail) = 9 µm; body diameter at lip region = 9 µm; body diameter at guiding ring = 19 µm; body diameter at base of oesophagus = 23 µm; body diameter at vulva = 26 µm; body diameter at anus = 16.5 µm; body diameter at beginning of J = 6 µm.

Female *habitus* coiled in a more or less open C when killed. Body tapering very gradually towards the extremities; cuticle smooth, 1.5-2 µm thick at mid-body. Lip region 3-3.5 µm high, almost elliptical, expanded, offset from the rest of the body by a distinct depression. Am-



Fig. 4 - Posterior region of male of *X. pachytaicum*.

XIPHINEMA RIVESI Dalmasso, 1969

(Table IX; Fig. 5 and 6)

Female *habitus* at closed C when killed; body cylindrical, tapering very gradually towards the extremities, lip region almost continuous with the rest of body, sometimes with a very shallow depression; odontostyle strong with heavily sclerotized flanges; basal enlarged part of the oesophagus containing three nuclei; vulva slightly posterior to midbody; vagina occupying about 1/3 of corresponding body width; uteri strongly muscled; no spermatheca, nor "Z" differentiation visible in the gonad, ovaries reflexed; tail conoid with rounded terminus, bearing two caudal pores on each side.

The morphometrics of two populations found in central Portugal are reported in Table IX. They differ slightly from the type population (Dalmasso, 1969) for the longer body and in one of them the shorter odontostyle and from the American populations (Lamberti and Bleve-Zacheo, 1979) for the longer body and odontostyle.

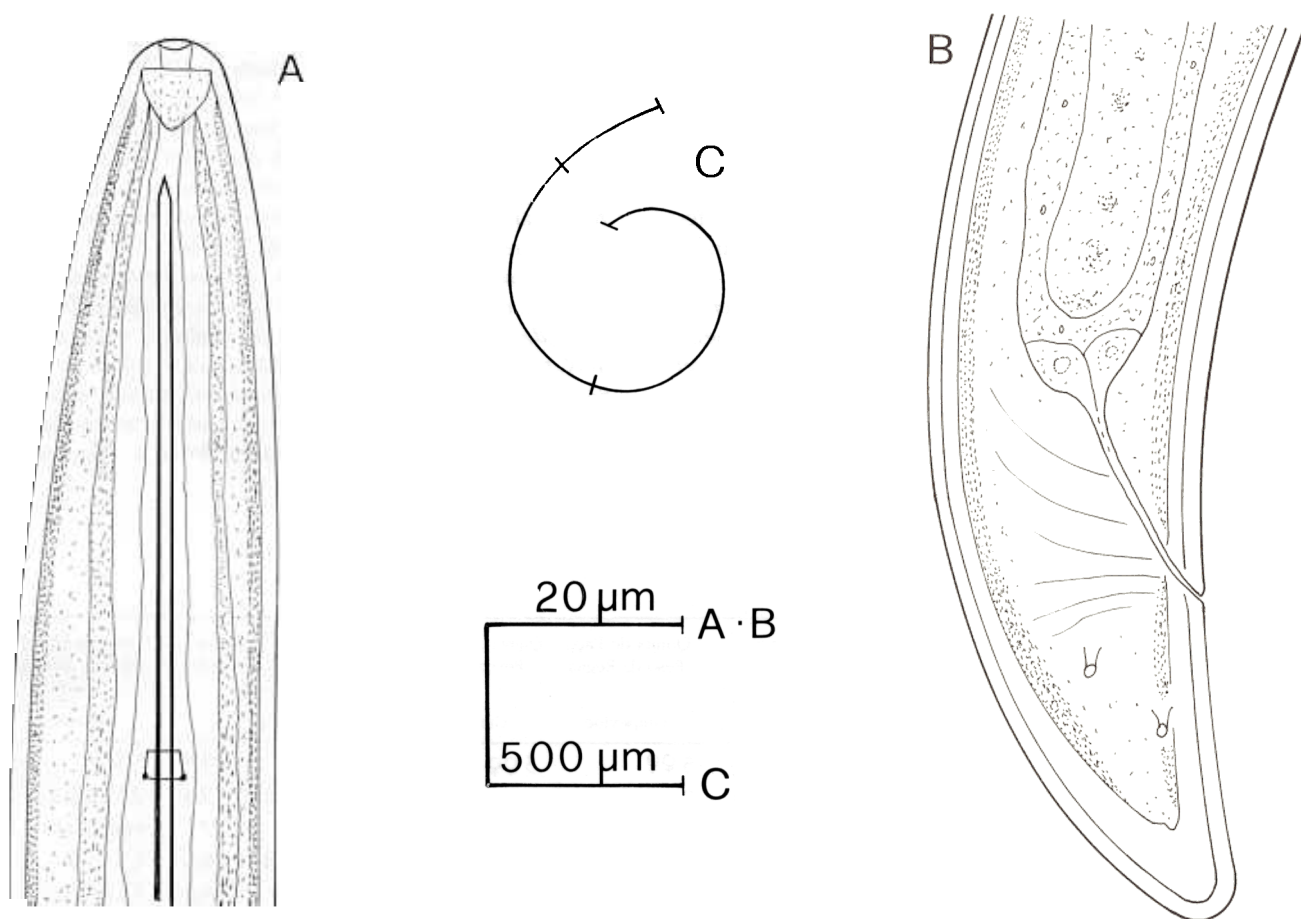


Fig. 5 - Female of *X. rivesi*: A, anterior region; B, posterior region; C, *habitus*.

phids stirrup-shaped. Odontostyle thin 1 μm in diameter at its base, odontophore flanged. Guiding sheath with only the basal ring readily visible. Oesophagus basal portion enlarged occupying about 1/3 of the total oesophagus length, measuring 85-94 μm long and 12 μm wide, containing three nuclei; in the tubular region of the oesophagus a mucro is often visible, 26-60 μm behind the odontophore base. Oesophageal intestinal valve heart-shaped. Reproductive system amphidelphic with equally developed branches; vulva slit-like, posterior to midbody; vagina occupying 1/2 corresponding body width; uteri containing sperms, separated from the oviduct by a sphincter; no spermatheca nor any "Z" differentiation visible; ovaries reflexed. Prerectum 68-80 μm long; rectum slightly longer than body diameter at anus. Tail elongated, slightly curved ventrally, bearing on each side two caudal pores.

Males in numbers almost equal to females, more coiled than females in the posterior region, bearing 4 or 5 ventro-median supplements preceding the adanal pair. Spicules arcuate. Tail elongated, curved ventrally with two pores on each side.

Type locality

Tapada, Vale de Bouro, Celorico de Bastos, Portugal in rhizosphere of grapevines, *Vitis* sp.

Populations of *X. brevisicum* were also found at Mata, Vale de Bouro, Quinta de Sergudes, Felgueiras and Quinta do Seixo, Valença do Douro (Fig. 1). The females of all these populations had a longer body than the type population and that from Quinta de Sergudes also had a slightly longer odontostyle (Table XII).

Diagnosis and relationships

Xiphinema brevisicum sp.n. is a bisexual species, characterized by body length of about 2.0 to 2.5 mm, almost elliptical lip region, offset by depression from the rest of body, odontostyle length of 57-65 μm , vulva at 53-58%, amphidelphic with equally developed branches of the female reproductive system and elongate slightly ventrally curved tail.

Xiphinema brevisicum is similar to *X. opisthobysterum* Siddiqi, 1961, *X. simile* Lamberti, Choleva *et* Agostinelli, 1983 and *X. duriense* Lamberti, Lemos, Agostinelli *et* D'Addabbo, 1993. However, it differs from them in the presence of abundant males, in the longer body (less than 2 mm in average for the three species) and shorter on-

odontostyle (more than 65 μm in average for the three species). Moreover, it differs from *X. opisthobysterum* and *X. duriense* in the anterior vulva ($V = 56-61$ in *X. opisthobysterum* and $V = 60$ in *X. duriense*) longer tail (30-36 μm in *X. opisthobysterum* and 31 μm in *X. duriense*) and higher value of c' (1.9-2 in *X. opisthobysterum* and 2.1 in *X. duriense*) and from *X. simile* in the posterior vulva and higher c' value ($V = 53$ and $c' = 1.6$ in *X. simile*).

Compared to the other four bisexual species included in the *X. americanum*-group, *X. brevisicum* differs from *X. pachydermum* Sturhan, 1983 in the higher a value (63-76 in *X. pachydermum*), lower c and higher c' values ($c = 70-83$ and $c' = 1.2-1.6$ in *X. pachydermum*), shorter odontostyle (77-91 μm in *X. pachydermum*) and more elongated tail (26-35 μm in *X. pachydermum*); from *X. longistilum*

TABLE VII Morphometrics of Portuguese populations of *X. madeirensis*

Locality	Monte Meão, Pocinho, Vila Nova de Foscôa	Azervadinha, Coruche	Quinta do Paço, Peso da Régua	Quinta da Noruega, Póvoa Cadaval	Quinta de Linhares, Pico dos Regalados, Vila Verde	Vinha da Canada, Mistério, Terceira, Azores
Host	Unidentified weeds	Peach	Grapevine	Grapevine	Hop	Grapevine
n	5 ♀♀	5 ♀♀	5 ♀♀	5 ♀♀	5 ♀♀	1 ♂ 5 ♀♀
Lmm	2.0 (1.9-2.1)	2.1 (2.1-2.3)	2.1 (1.9-2.1)	2.2 (2.2-2.4)	2.2 (2.1-2.4)	2.1 2.1 (2.1-2.2)
a	69 (68-69)	72 (69-76)	74 (70-77)	68 (64-75)	72 (67-75)	71 66 (62-69)
b	6.2 (5.8-6.5)	6.3 (5.6-7.1)	6.0 (5.4-6.9)	6.6 (5.9-7.5)	6.2 (5.5-7.4)	6.0 6.4 (5.9-7.2)
c	55 (51.5-62)	54 (48-58)	59 (55-67)	62 (58.5-65)	55 (49-59)	52.5 53 (47-56)
c'	2.0 (1.8-2.2)	2.2 (2.1-2.5)	2.0 (1.9-2.1)	1.9 (1.8-2.0)	2.2 (2.1-2.3)	2.1 2.1 (2.0-2.4)
V	55 (53-58)	55 (52-57)	57 (57-58)	54 (54-54.5)	56 (54-57)	— 54 (52-57)
Odontostyle μm	102 (99-104)	101.5 (99-104)	103 (101-105)	108 (104-109)	103 (101-104)	105 102 (101-103)
Odontophore μm	48.5 (47-52)	52 (50-53.5)	50 (47-53)	52 (51-52)	53 (51-55)	51 50 (49-53)
Oral aperture to guiding ring μm	84.5 (83-86.5)	89.5 (88-92)	89 (83-94)	92 (86.5-95)	87 (84-88)	89 83 (80-86.5)
Tail μm	36 (34-39)	40 (37-44)	35 (31-38)	36 (34-38)	41 (39-44)	40 40 (38-47)
J (hyalin portion of tail) μm	10 (9-12)	10 (9-11)	9 (9-10)	9 (8-10)	13 (11-13)	12 10 (9-11)
Body diameter at lip region μm	8 (8-9)	8 (8-9)	9 (9-9)	9 (9-9)	8 (8-9)	9 8.5 (9-11)
Body diameter at guiding ring μm	22 (22-23)	22 (22-23.5)	23 (22-26)	24 (23.5-25)	22.5 (22-23.5)	22 22 (22-23)
Body diameter at base of oesophagus μm	26.5 (25-28)	27 (25-29)	25 (24-26.5)	28 (27-31)	29 (28-29)	26 28 (27-28)
Body diameter at midbody or vulva μm	29 (28-31)	30 (28-32)	28 (26.5-30)	32 (29-37)	31 (29-33)	29 31 (27-34)
Body diameter at anus μm	18 (17-19)	18 (17-19)	18 (16.5-19)	19 (19-19)	19 (18-19)	19 19 (18-19)
Body diameter at beginning of J μm	7 (6-8)	7 (6-7)	7 (6-8)	7 (6-7)	7 (6-9)	8 (6.5-8)
Spicules μm	—	—	—	—	—	38 —

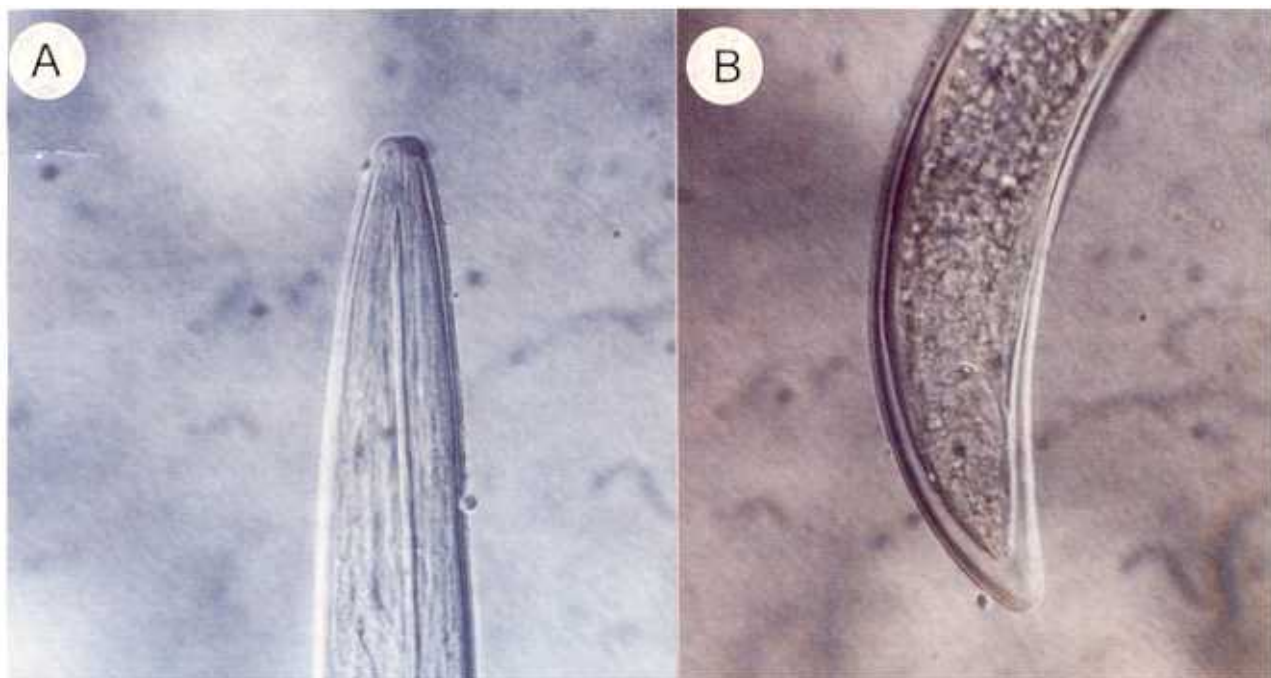


Fig. 6 - Female of *X. rivi*: A, anterior region; B, posterior region.

sp.n. in the almost elliptical lip region (hemielliptical in *X. longistilum*), shorter odontostyle (112 μm in *X. longistilum*), lower *c* value (80 in *X. longistilum*), higher *c'* value (1.5 in *X. longistilum*), anterior guiding ring (104 μm from oral aperture in *X. longistilum*) and more elongated tail and less robust and shorter spicules in the male (49 μm in *X. longistilum*); from *X. mesostilum* sp.n. for having lower *c* value (98 in *X. mesostilum*), higher *c'* value (1.5 in *X. mesostilum*), shorter odontostyle (93 μm in *X. mesostilum*), anterior guiding ring (80 μm in *X. mesostilum*) and more elongated and longer tail (26 μm in *X. mesostilum*); finally *X. brevisicum* differs from *X. microstilum* sp.n. in its shorter body (2.6 mm in *X. microstilum*), lower *c* value (74 in *X. microstilum*), higher *c'* value (1.7-1.8 in *X. microstilum*), shorter odontostyle (74 μm in *X. microstilum*) and more elongated tail (conoid in *X. microstilum*).

Type material

Holotype female, six paratype females and six paratype males in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari Italy; two paratype females and one paratype male in each of the following collections: Entomology and Nematology

Department, Rothamsted Experimental Station, Harpenden, United Kingdom; Plant Nematology Laboratory, United States Department of Agriculture, Beltsville, United States of America, and Estação Agronómica Nacional I.N.I.A., Oeiras, Portugal.

***XIPHINEMA LONGISTILUM* sp.n.**

(Table XIII; Figs. 11 and 12)

Holotype female: L = 2.8 mm; a = 77; b = 7.9; c = 78; *c'* = 1.5; V = 55; odontostyle = 112 μm ; odontophore = 55 μm ; oral aperture to guiding ring = 101 μm ; tail = 36.5 μm ; J (hyalin portion of tail) = 11 μm ; body diameter at lip region = 9 μm ; body diameter at guiding ring = 26 μm ; body diameter at base of oesophagus = 32 μm ; body diameter at vulva = 36.5 μm ; body diameter at anus = 23.5 μm ; body diameter at beginning of J = 11 μm .

Female *habitus* coiled in a more or less closed C when killed. Body tapering gradually towards the extremities, but abruptly in the extreme anterior region; cuticle smooth 2-2.5 μm thick at midbody. Lip region 4 μm high, hemielliptical, offset from the rest of the body by a depression. Amphids large stirrup shaped. Odontostyle 2 μm in diameter at its base; odontophore strongly flanged. Guiding

sheath with the two rings about 10 µm apart. Oesophagus with the basal enlarged portion occupying about 1/3 of the total oesophageal length, measuring 90-94 µm long and 15-16 µm wide, containing three nuclei. A mucro in the tubular portion of the oesophagus lays 35-70 µm behind the odontophore base. Oesophageal intestinal valve large, amorphous. Reproductive system amphidelphic with equally developed branches; vulva slit-like, posterior to midbody; vagina occupying almost 1/2 the corresponding body width; uteri full of sperms, separated from the oviduct by a sphincter; no spermatheca nor any "Z" differentiation visible; ovaries reflexed. Prerectum obscure; rectum slightly longer than body diameter at anus. Tail conoid with subacute terminus, bearing two pores on each side.

Males as numerous as females, more coiled in the posterior region, bearing 6 or 7 ventromedian supplements preceding the adanal pair. Spicules robust arcuate. Tail conoid, slightly curved ventrally, with pointed terminus and two pores on each side.

Type locality

Quinta da Adúia, Montemor-o-Novo, Portugal in rhizosphere of unidentified weeds.

Diagnosis and relationships

Xiphinema longistilum sp.n. is a bisexual species, characterized by 2.8 mm body length, hemielliptical lip region, offset from the rest of body by depression, odontostyle length of 112 µm, vulva at 56%, amphidelphic with equally developed branches of the female reproductive system and conoid with subacute terminus tail.

Xiphinema longistilum is similar to *X. fortuitum* Roca, Lamberti *et* Agostinelli, 1987, *X. madeirense*, Brown, Faria, Lamberti, Halbrendt, Agostinelli *et* Jones, 1992, and *X. du-riense* Lamberti, Lemos, Agostinelli *et* D'Addabbo, 1993. However, it differs from *X. fortuitum*, in having a longer

TABLE VIII - *Morphometrics of Portuguese populations of X. pachtaicum.*

Locality	Câmara de Lobos, Madeira	Vinha da Canada, Mistério, Terceira, Azores	Quinta do Seixo, Valença do Douro, Tabuaço	Vairão, Vila do Conde	
Host	Grapevine	Grapevine	Grapevine	Raspberry	
n	5 ♀♀	5 ♀♀	5 ♀♀	5 ♀♀	2 ♂♂
L mm	1.9 (1.8-2.0)	1.9 (1.8-2.0)	2.2 (2.1-2.3)	2.1 (2.0-2.2)	2.0-2.1
a	66 (60-69)	64 (62-66)	80 (74.5-87)	71 (64-76)	76-76
b	6.0 (5.8-6.4)	6.6 (6.0-7.3)	6.8 (6.6-7.0)	6.4 (6.1-6.7)	6.1-6.5
c	60 (58-64)	63 (57-68)	64 (60-71)	63 (58-66)	60-60
c'	1.7 (1.6-1.8)	1.8 (1.7-1.9)	2.0 (1.9-2.1)	2.0 (1.8-2.1)	1.9-2.0
V	56 (55-58)	56 (55.5-58)	55 (52-57)	53 (52-55)	—
Odontostyle µm	88 (87-91)	86 (84-88)	90 (89-92)	84 (82-89)	84-77
Odontophore µm	49 (47-51)	48 (46-50)	46 (43-49)	48 (46-51)	44-47
Oral aperture to guiding ring µm	79 (78-81)	73 (69-77)	77 (74-78)	70 (63-75)	72-69
Tail µm	32 (31-35)	30 (29-31)	34 (32-35)	33 (32-36)	33.5-35
J (hyalin portion of tail) µm	9 (8-11)	12 (10-12)	9 (8-11)	10 (9-11)	9-9
Body diameter at lip region µm	9 (8-9)	8 (8-9)	8 (8-9)	9 (9-9)	9-9
Body diameter at guiding ring µm	21 (21-22)	21 (21-22)	20.5 (20-21)	21 (21-22)	19-20
Body diameter at base of oesophagus µm	26 (25-26.5)	26 (23.5-28)	24 (23.5-24)	26 (25-29)	23.5-25
Body diameter at midbody or vulva µm	29 (28-30)	30 (28-32)	27 (26.5-28)	29 (27-31)	26.5-28
Body diameter at anus µm	18 (18-19)	17 (16-18)	17 (16.5-18)	17 (16.5-18)	18-18
Body diameter at beginning of J µm	8 (8-9)	9 (9-10)	8 (8-8)	8 (8-9)	8-8
Spicules µm	—	—	—	—	41-44

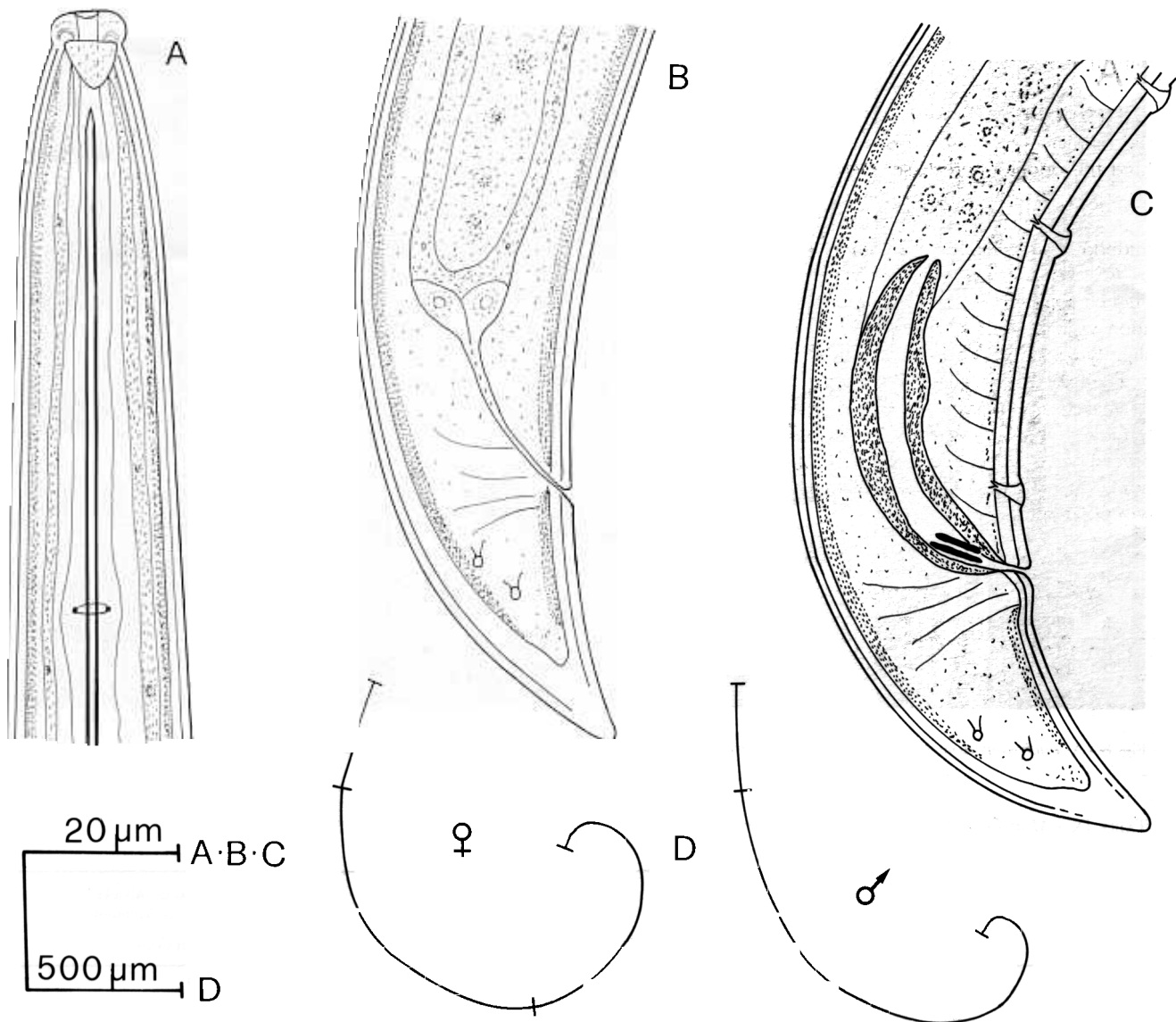


Fig. *X. pachydermum*: A, anterior region of female; B, posterior region of female; C, posterior region of male; D, *habitus*.

odontostyle (102 μm in *X. fortuitum*), slightly posterior vulva ($V = 54$ in *X. fortuitum*), posterior guiding ring (83 μm from oral aperture in *X. fortuitum*) lower c' value (1.9 in *X. fortuitum*) and more pointed tail; from *X. madeirense* for its longer body (2.2 mm in *X. madeirense*), higher c value (59 in *X. madeirense*), lower c' value (1.9 in *X. madeirense*), longer odontostyle (105 μm in *X. madeirense*) and broader tail; and from *X. duriense* in its longer body (1.8 mm in *X. duriense*), higher c value (58 in *X. duriense*), lower c' value (2.1 in *X. duriense*), anterior vulva ($V = 60$ in *X. duriense*), longer odontostyle (70 μm in *X.*

duriense), posterior guiding ring (61 μm from the oral aperture in *X. duriense*) and more pointed tail.

Compared to the other four bisexual species included in the *X. americanum*-group, *X. longistilum* differs from *X. pachydermum* Sturhan, 1983 in its longer body (2.1-2.4 mm in *X. pachydermum*), longer odontostyle (77-91 μm in *X. pachydermum*) and posterior guiding ring (64-76 μm from the oral aperture in *X. pachydermum*); from *X. brevisicum* sp.n. in having an hemielliptical lip region (almost elliptical in *X. brevisicum*), longer odontostyle (60-63 μm in *X. brevisicum*), higher c value (58-60 in *X. brevisicum*),

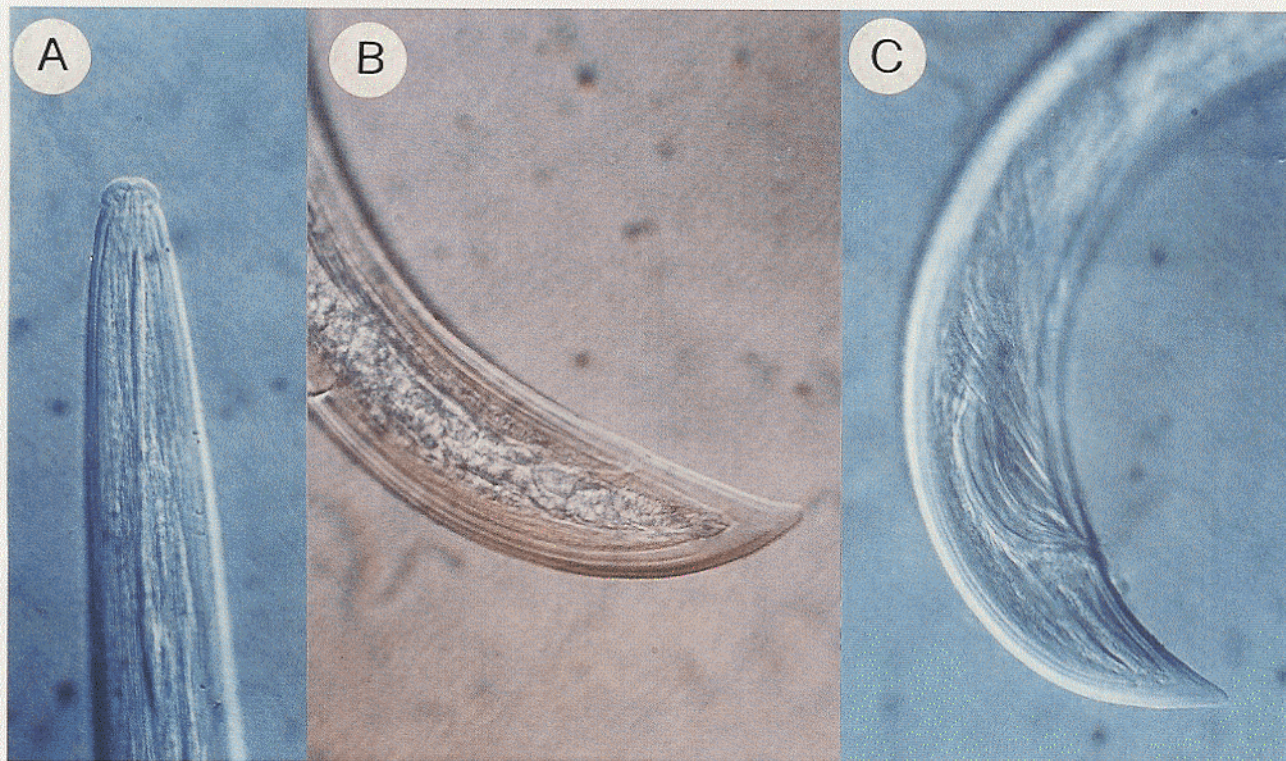


Fig. 8 - *X. pachydermum*: A, anterior region of female; B, posterior region of female; C, posterior region of male.

TABLE IX - *Morphometrics of two Portuguese populations of X. rivesi.*

Locality	Quinta da Alorna, Almeirim	Reguengo do Alviela, Pombalinho, Santarém
Host	Grapevine	Grapevine
n	5 ♀♀	5 ♀♀
L mm	2.0 (1.9-2.0)	2.1 (2.1-2.2)
a	53 (50-55)	55 (53-58)
b	7.0 (6.5-7.0)	6.8 (6.2-7.1)
c	61 (59-63)	61 (59.5-64.5)
c'	1.5 (1.4-1.6)	1.4 (1.3-1.5)
V	52 (50-55)	52 (50-54.5)
Odontostyle μm	91 (88-95)	96 (94-98)
Odontophore μm	50 (47-53)	52 (51-53.5)
Oral aperture to guiding ring μm	73 (72-73.5)	77 (74-79)
Tail μm	33 (31-34)	35 (34-36)
J (hyalin portion of tail) μm	9 (8-10)	9 (8-11)
Body diameter at lip region μm	9 (9-9)	10 (10-11)
Body diameter at guiding ring μm	26.5 (26-26.5)	28 (27-28)
Body diameter at base of oesophagus μm	34 (32-35)	35 (34-36.5)
Body diameter at vulva μm	37 (36-40)	39 (38-41)
Body diameter at anus μm	22.5 (21-24)	25 (22-26.5)
Body diameter at beginning of J μm	12 (11-14)	13 (12-15)

TABLE X - *Morphometrics of Portuguese populations of X. santos.*

Locality	Canada das Vinhas, Terceira, Azores	Santana, Madeira	Quinta do Corgo, Adáufo, Braga	
Host	Grapevine	Grapevine	Grapevine	
n	5 ♀♀	5 ♀♀	5 ♀♀	2 ♂♂
L mm	1.8 (1.7-1.8)	1.9 (1.8-2.0)	1.7 (1.7-1.8)	1.7-1.8
a	47 (45-49)	44 (41-47)	45 (41-47)	51-54
b	5.9 (5.8-6.0)	6.4 (5.9-7.5)	6.0 (5.7-6.5)	6.0-6.1
c	58 (55-62)	54 (51-59)	56 (54.5-60)	48-49
c'	1.4 (1.3-1.6)	1.5 (1.4-1.7)	1.5 (1.5-1.6)	1.5-1.5
V	50 (47-53)	49 (47-50)	51 (50-53)	—
Odontostyle µm	80 (79-82)	86.5 (85-88)	81 (79-83.5)	82-78
Odontophore µm	50 (48-52)	50 (46-52)	48 (46-52)	45-46
Oral aperture to guiding ring µm	64 (62-65)	66 (65-70)	63 (60-66)	65-63.5
Tail µm	31 (28-33)	35 (34-38)	31 (30-31)	35-32
J (hyalin portion of tail) µm	10 (9-11)	8 (7-9)	11 (11-12)	9-9
Body diameter at lip region µm	11 (11-11)	11 (11-11)	10 (10-11)	11-11
Body diameter at guiding ring µm	26 (25-26.5)	29 (27-32)	25 (25-26)	25-25
Body diameter at base of oesophagus µm	34 (32-36.5)	37 (34-42)	34.5 (32-38)	31-31
Body diameter at midbody or vulva µm	38 (35-40)	43 (40-45)	38.5 (36.5-42)	33.5-33.5
Body diameter at anus µm	21 (21-22)	23 (23-23.5)	20 (19-21)	23-25
Body diameter at beginning of J µm	11 (9-13)	10 (9-10)	11 (10-11)	9-9
Spicules µm	—	—	—	50-50

lower c' value (2.4-2.9 in *X. brevisicum*), posterior guiding ring (53-54 µm from oral aperture in *X. brevisicum*), less elongated tail and more robust and longer spicules in the male (35-41 µm in *X. brevisicum*); from *X. mesostilum* sp.n. in its lower a value (91 in *X. mesostilum*), lower c value (98 in *X. mesostilum*), longer odontostyle (93 µm in *X. mesostilum*), posterior guiding ring (80 µm from oral aperture in *X. mesostilum*), longer tail (26 µm in *X. mesostilum*) and longer spicules in the male (40 µm in *X. mesostilum*); finally it differs from *X. microstilum* sp.n. in its longer body (2.4-2.6 mm in *X. microstilum*), longer odontostyle (74 µm in *X. microstilum*), posterior guiding ring (62-63 µm from oral aperture in *X. microstilum*) and more elongated tail.

Type material

Holotype female, eight paratype females and seven paratypes males in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females and one paratype male in each of the following collections: Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden,

United Kingdom; Plant Nematology Laboratory, United States Department of Agriculture, Beltsville, United States of America, and Estação Agronómica Nacional, I.N.I.A., Oeiras, Portugal.

XIPHINEMA MESOSTILUM sp.n.

(Table XIV; Figs 13 and 14)

Holotype female: L = 2.6 mm; a = 98; b = 8.5; c = 98; c' = 1.6; V = 58; odontostyle = 94 µm; odontophore = 48 µm; oral aperture to guiding ring = 78 µm; tail = 26.5 µm; J (hyalin portion of tail) = 9 µm; body diameter at lip region = 8 µm; body diameter at guiding ring = 21 µm; body diameter at base of oesophagus = 25 µm; body diameter at vulva = 26.5 µm; body diameter at anus = 16.5 µm; body diameter at beginning of J = 9 µm.

Female *habitus* coiled in a more or less open C when killed. Body tapering very gradually towards the extremities. Cuticle smooth 1-2 µm thick at midbody. Lip region hemielliptical, 3.5-4 µm high, offset from the rest of the body by a depression. Amphids large, stirrup shaped. Odontostyle 1.5-2 µm in diameter at its base; odontophore

weakly flanged. Guiding sheath with only the basal ring readily visible. Oesophagus with the enlarged basal portion 71-76 μm long and 12-14 μm wide, occupying approximately 1/3 of the total oesophagus length and containing three nuclei. A mucro is present in the tubular portion of the oesophagus 28-38 μm behind the odontophore base. Oesophageal-intestinal valve heart shaped. Reproductive system amphidelphic with equally developed branches; vulva slit-like, posterior to midbody; vagina occupying about 1/2 corresponding body width, uteri short full of sperms, separated by a sphincter from a structure, which has the appearance of a very long spermatheca, but not containing sperms, devoid of any "Z" differentiation; another sphincter separates the spermatheca from the oviduct which starts with a chamber, unusual in specimens of the *X. americanum*-group; ovaries reflexed. Prerectum not readily visible; rectum slightly longer than body diameter at anus. Tail conoid with two pores on each side.

Males as numerous as females, more coiled in the posterior region, with 6-8 ventromedian supplements preceding the adanal pair. Spicules slightly arcuate. Tail rounded dorsally, bearing two pores on each side.

Type locality

Quinta da Lameira, Silves, Portugal in rhizosphere of olive, *Olea europaea* L.

Diagnosis and relationships

Xiphinema mesostilum sp.n. is a bisexual species characterized by 2.5 mm body length, hemielliptical lip region, offset from the rest of the body by depression, odontostyle length of 93 μm , vulva at 57%, amphidelphic with equally developed branches of the female reproductive system, which comprises a spermatheca, and conoid tail.

Because of the presence of a spermatheca in the female genital tract *Xiphinema mesostilum* differs from all the species included in the *X. americanum*-group. However, it is similar to *X. fortuitum* Roca, Lamberti *et* Agostinelli, 1987, *Xiphinema madeirense* Brown, Faria, Lamberti, Halbrendt, Agostinelli *et* Jones, 1992 and *X. duriense* Lamberti, Lemos, Agostinelli *et* D'Addabbo, 1993. It differs from *X. fortuitum* in having higher c value (76 in *X. for-*

TABLE XI - *Morphometrics of Portuguese populations of X. pachydermum.*

Locality	Quinta da Ventosa, Portimão		Quinta do Marquês, Oeiras		Quinta de St. Bárbara, Peso da Régua		Cabo de S. Vicente, Sagres	
Host	Natural vegetation		Natural vegetation		Grapevine		Natural vegetation	
n	5 ♀♀	5 ♂♂	5 ♀♀	5 ♂♂	4 ♀♀	1 ♂	5 ♀♀	5 ♂♂
L mm	2.4 (2.2-2.5)	2.3 (2.1-2.4)	2.1 (1.9-2.2)	2.1 (2.0-2.2)	2.4 (2.3-2.5)	2.1	2.4 (2.3-2.4)	2.2 (2.1-2.3)
a	72 (69-74)	79 (76-83)	76 (73-80)	81 (75.5-85)	63 (62-66)	65	75 (72-78)	81 (75-85)
b	7.4 (6.8-8.5)	7.5 (6.8-8.1)	6.8 (5.4-7.4)	7.3 (6.7-8.9)	7.1 (6.7-7.4)	6.3	8.3 (7.4-9.1)	7.9 (7.1-8.9)
c	79.5 (75-87)	73 (70.5-78)	79 (71-89)	78 (69-85)	70 (67-77)	50	83 (78-91)	82 (77.5-89)
c'	1.4 (1.4-1.5)	1.5 (1.4-1.6)	1.6 (1.5-1.7)	1.5 (1.4-1.6)	1.5 (1.4-1.6)	1.6	1.5 (1.4-1.6)	1.4 (1.3-1.5)
V	60 (58-62.5)	—	61 (60-63)	—	59.5 (56-62)	—	55 (54-56.5)	—
Odontostyle μm	80 (75-85)	76 (75-79)	79 (71-85)	79 (76.5-82)	91 (86-95)	88	77 (75-79)	78 (75-81)
Odontophore μm	48 (45-53)	46 (45-47)	43 (41-45)	41 (39-42)	49 (48-50)	47	48 (46-50)	45 (42-48)
Oral aperture								
to guiding ring μm	68 (65-71)	65 (63-67)	64 (62-66.5)	66 (63.5-69)	76.5 (75-78)	78	66 (64-68)	67 (66-68)
Tail μm	30 (28-32)	31.5 (30-33.5)	26 (25-29)	27 (24-29)	35 (32-37)	42	29 (28-31)	27 (26-28)
J (hyalin portion of tail) μm	11 (10-12)	10 (9-12)	8 (8-9)	8 (6-8)	11 (9-12)	11	9 (8-9)	8 (7-9)
Body diameter at lip region μm	9 (9-9)	9 (9-9)	8 (8-8)	8 (8-8)	10 (9-11)	9	9 (9-9)	9 (9-9)
Body diameter at guiding ring μm	22 (21-22)	21 (20-21)	19 (18-19)	18 (17-18)	25 (25-26)	23.5	21 (21-21)	20 (19-21)
Body diameter at base of oesophagus μm	29 (27-30)	26 (25-28)	23 (23-24)	23 (21-26)	32 (29-35)	29	27 (26.5-28)	25 (24-26.5)
Body diameter at midbody or vulva μm	33 (31-35)	29 (27-31)	27 (25-29)	26 (23.5-26.5)	39 (38-42)	32	32 (31-34)	28 (27-31)
Body diameter at anus μm	21 (20-22)	21 (19-22)	17 (16.5-17)	18 (16.5-19)	24 (22-27)	26	19 (18-20)	19 (19-21)
Body diameter at beginning of J μm	11 (11-11)	10 (9-11)	8 (8-9)	8 (7-8)	11 (10-12)	9	9 (9-11)	9 (8-9)
Spicules μm	—	42 (38-44)	—	37 (35-38)	—	53	—	42 (41-44)

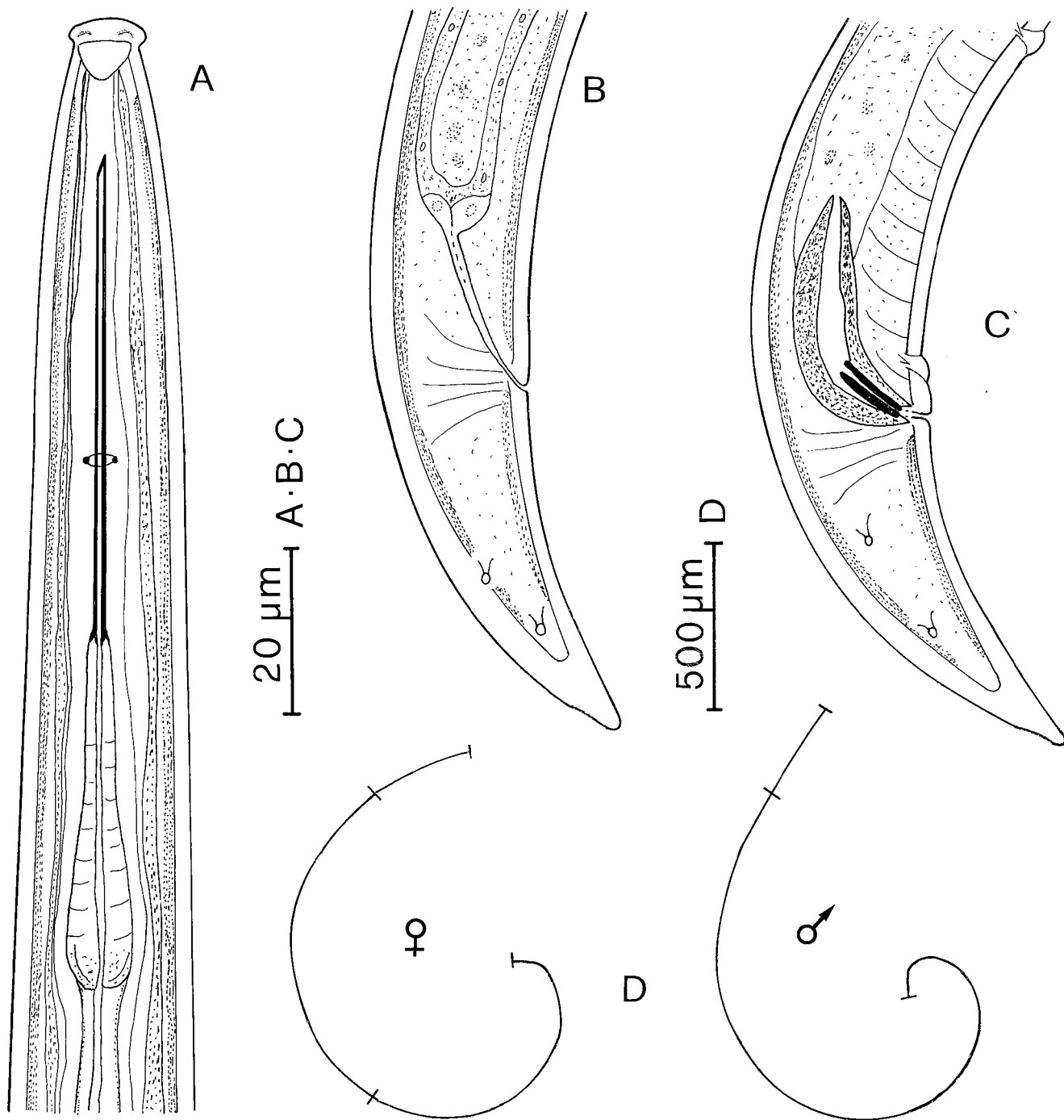


Fig. 9 - *X. brevisicum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male; D, *habitus*.

TABLE XII - *Morphometrics of Portuguese populations of X. brevisicum sp.n.*

Locality	Tapada Vale de Bouro, Celorico de Bastos		Mata, Vale de Bouro, Celorico de Bastos		Quinta de Sergudes, Felgueiras		Quinta do Seixo, Valença do Douro, Tabuaço	
Host	Grapevine (paratypes)		Natural vegetation		Pine		Grapevine	
n	13 ♀♀	9 ♂♂	5 ♀♀	5 ♂♂	5 ♀♀	5 ♂♂	5 ♀♀	4 ♂♂
L mm	2.2±0.15 (2.0-2.4)	2.2±0.17 (2.1-2.5)	2.4 (2.3-2.5)	2.1 (1.9-2.3)	2.5 (2.5-2.6)	2.3 (2.1-2.5)	2.3 (2.1-2.4)	2.1 (2.1-2.2)
a	87±3.79 (79-91)	88±3.99 (81-92)	89 (83-91)	87.5 (79-95)	91 (72.5-98)	90.5 (85-96.5)	87 (83-91)	90.5 (83-96)
b	7.6±0.66 (7.0-9.1)	7.8±0.42 (7.3-8.6)	8.3 (7.1-9.5)	7.6 (6.9-8.5)	9 (8.8-10)	8.2 (7.8-8.7)	9 (8-10)	7.9 (7.6-8.3)
c	58±3.85 (50-60)	56±6.20 (48-68)	58 (53-68)	54 (50-57)	59 (57-61.5)	54 (52.5-61)	52.5 (50-55)	50 (46-57)
c'	2.5±0.10 (2.4-2.7)	2.2±0.13 (2.0-2.4)	2.6 (2.2-2.8)	2.25 (2.1-2.5)	2.6 (2.5-2.7)	2.3 (2.1-2.4)	2.9 (2.6-3.1)	2.4 (2.2-2.5)
V or T	56±1.18 (54-57)	40±3.92 (38-45)	56 (54-56.5)	—	55 (53-58)	—	56 (55-57)	—
Odontostyle µm	60±1.55 (57-62)	59±2.66 (53.5-61)	60 (59-62)	61 (59-63.5)	63.5 (62-65)	63 (61-65)	60 (59-62)	59 (58-61)
Odontophore µm	43±1.75 (39-45)	41±1.26 (39-43.5)	42 (41-43.5)	41 (40-42)	44 (43-45)	43 (42-45)	43 (41-45)	41 (39-43.5)
Oral aperture to guiding ring µm	53±1.22 (52-56)	52±1.95 (50-55)	52 (51-53)	54 (53-55)	54 (52-55)	52 (49-56)	53 (52-54)	50 (50-51)
Tail µm	41±2.49 (38-45)	40±2.37 (37-44)	41 (35-43)	39 (37-42)	44 (42-46)	42 (40-43)	44 (40-47)	43 (39-46)
J (hyalin portion) µm	9±1.12 (7-10)	10±0.74 (9-12)	9 (9-9)	9 (8-9)	11 (10-12)	12 (10-13)	9 (9-10)	11 (10-11)
Body diameter at lip region µm	9±0.31 (9-9.5)	9±0.43 (9-9)	9 (9-9)	9 (9-9)	10 (9-11)	9 (8-10)	9 (9-9)	9 (8-9)
Body diameter at guiding ring µm	18±0.60 (17-19)	18±0.57 (18-19)	19 (18-19)	18 (18-19)	19 (18-19)	19 (18-20)	18 (18-18)	18 (17-19)
Body diameter at base of oesophagus µm	23±0.96 (21-25)	22.5±1.39 (21-24)	23.5 (22-25)	22 (21-22)	24 (23-25)	23 (22-23)	23 (22-23.5)	22 (21-23.5)
Body diameter at midbody or vulva µm	26±0.97 (24-28)	25.5±1.43 (24-27)	27 (25-28)	24 (23.5-24)	27 (26-28)	25.5 (25-26)	26 (25-27)	24 (23-25)
Body diameter at anus µm	16±0.74 (15-17)	18±0.42 (18-19)	16 (15-16.5)	18 (17-18)	17 (16-17)	18 (17-19)	15 (15-16)	18.5 (18-19)
Body diameter at beginning of J µm	6±0.43 (6-8)	7±0.76 (6.5-8)	7 (6.5-8)	6.5 (6.5-6.5)	7.5 (6.5-8)	7 (7-8)	7 (6-8)	6 (5-7)
Spicules µm	—	37±2.45 (35-41)	—	41 (41-41)	—	35 (35-35)	—	36 (35-38)

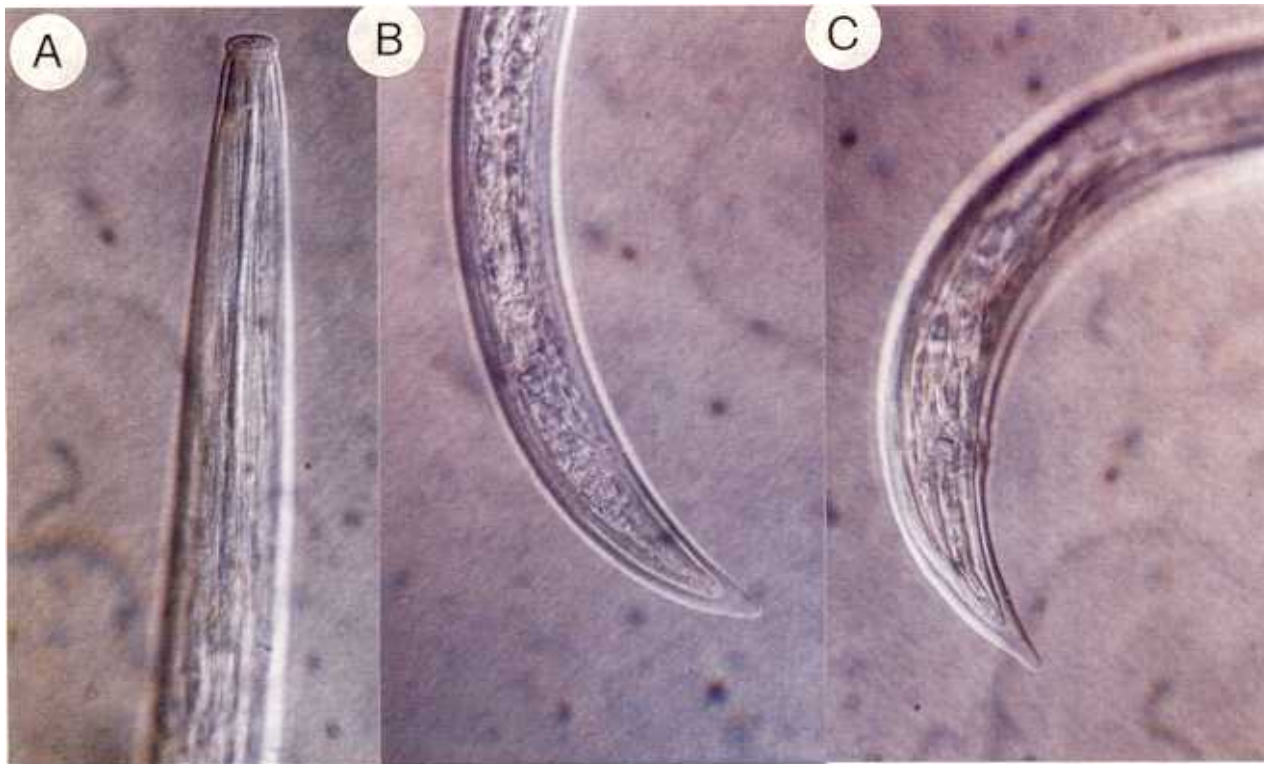


Fig. 10 - *X. brevisicum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male

tuutum), lower *c'* value (1.9 in *X. fortuitum*), posterior vulva ($V = 54$ in *X. fortuitum*) and shorter tail ($35\ \mu\text{m}$ in *X. fortuitum*); from *X. madeirense* for its longer body (2.2 mm in *X. madeirense*), higher *a* value (69 in *X. madeirense*), higher *c* value (59 in *X. madeirense*), lower *c'* value (1.9 in *X. madeirense*), shorter odontostyle ($105\ \mu\text{m}$ in *X. madeirense*) and shorter tail ($38\ \mu\text{m}$ in *X. madeirense*); and from *X. duriense* in its longer body (1.8 mm in *X. duriense*), higher *a* value (74 in *X. duriense*), higher *c* value (58 in *X. duriense*), lower *c'* value (2.1 in *X. duriense*), posterior vulva ($V = 60$ in *X. duriense*), longer odontostyle ($70\ \mu\text{m}$ in *X. duriense*) and posterior guiding ring ($61\ \mu\text{m}$ from oral aperture in *X. duriense*).

Compared with the other four bisexual species included in the *X. americanum*-group, *X. mesostilum* differs from *X. pachydermum* Sturhan, 1983 in the higher value of *a* (63-76 in *X. pachydermum*), higher value of *c* (70-83 in *X. pachydermum*) and posterior guiding ring ($64\text{--}76\ \mu\text{m}$ from oral aperture in *X. pachydermum*); from *X. brevisicum* sp.n. in the higher *c* value 50-59 in *X. brevisicum*), lower *c'* value (2.4-2.9 in *X. brevisicum*), longer odontostyle ($60\text{--}63\ \mu\text{m}$ in *X. brevisicum*), posterior guiding ring ($52\text{--}54\ \mu\text{m}$ from oral aperture in *X. brevisicum*) and wider

and shorter tail ($41\text{--}44\ \mu\text{m}$ in *X. brevisicum*); from *X. longistilum* sp.n. in the higher *a* value (76 in *X. longistilum*), higher *c* value (80 in *X. longistilum*), shorter odontostyle ($112\ \mu\text{m}$ in *X. longistilum*), anterior guiding ring ($104\ \mu\text{m}$ from oral aperture in *X. longistilum*) shorter tail ($35\ \mu\text{m}$ in *X. longistilum*) and shorter spicules in the male ($49\ \mu\text{m}$ in *X. longistilum*) and finally *X. mesostilum* differs from *X. microstilum* in the higher value of *a* (83-86 in *X. microstilum*), lower *c'* value (1.7-1.8 in *X. microstilum*), longer odontostyle ($74\ \mu\text{m}$ in *X. microstilum*), posterior guiding ring ($62\text{--}63\ \mu\text{m}$ from oral aperture in *X. microstilum*) and shorter tail ($33\text{--}35\ \mu\text{m}$ in *X. microstilum*).

Type material

Holotype female, nine paratype females and thirteen paratype males in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females and two paratype males in each of the following collections: Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, United Kingdom; Plant Nematology Laboratory,

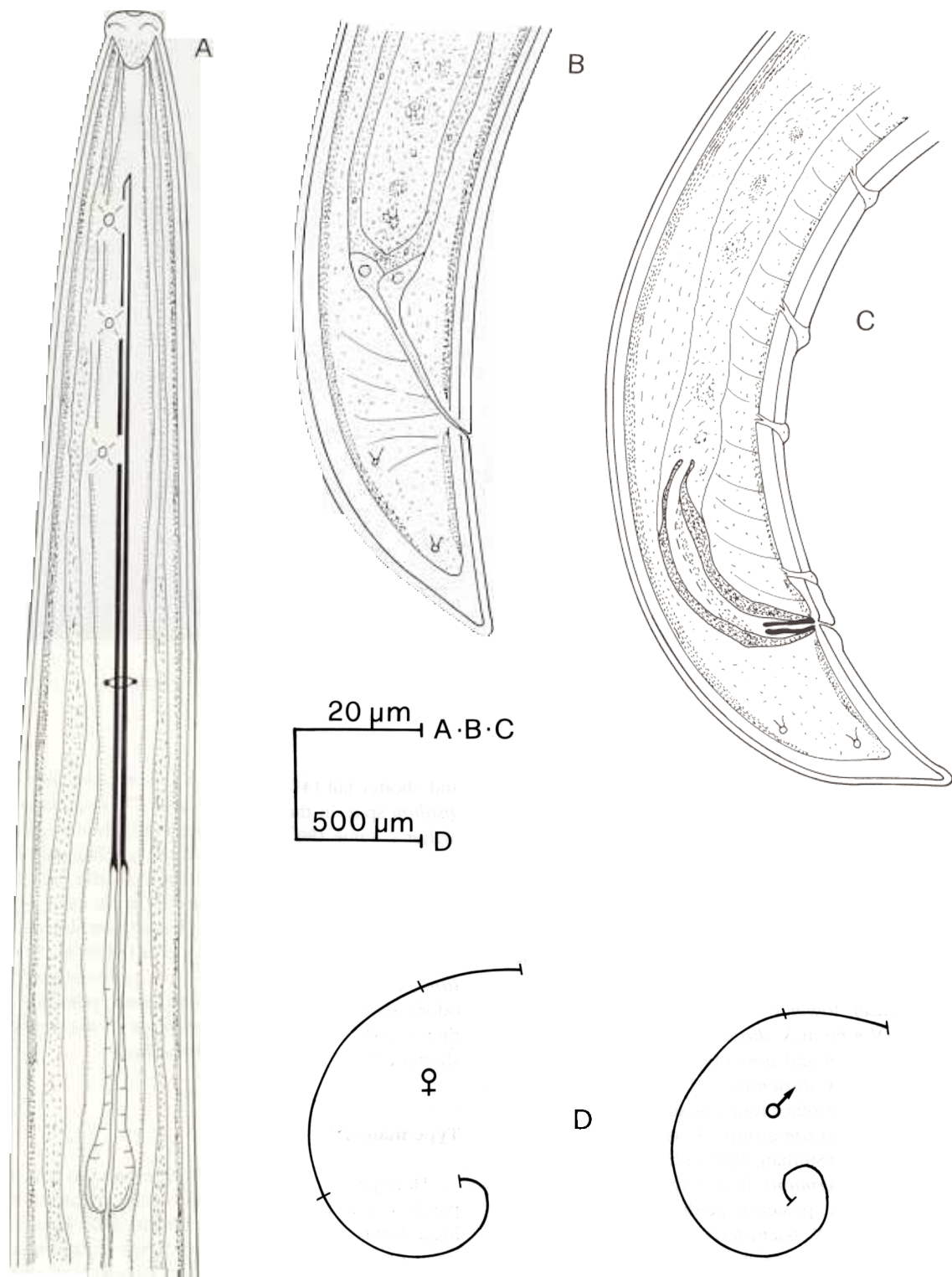


Fig. 11 - *X. longistilum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male; D, *habitus*.

TABLE XIII *Morphometrics of paratypes of X. longistilum sp.n.*

Locality	Quinta da Adúia, Montemor-o-Novo	
Host	Unidentified weeds	
n	13 ♀♀	9 ♂♂
Lmm	2.8±0.17 (2.6-3.1)	2.7±0.15 (2.5-3.0)
a	76±3.34 (70-81)	84±2.98 (79-87)
b	6.9±0.65 (6.2-8.5)	6.7±0.47 (6.0-7.7)
c	80±7.71 (68-94)	80±7.51 (70-90)
c'	1.5±0.14 (1.3-1.7)	1.5±0.07 (1.4-1.6)
V or T	56±1.46 (54-58)	43±3.04 (39-48)
Odontostyle µm	112±3.25 (109-118)	114±1.92 (110-118)
Odontophore µm	53±2.23 (47-56)	50±3.01 (46-54)
Oral aperture to guiding ring µm	104±5.52 (92-113)	102±3.42 (92-108)
Tail µm	35±2.91 (31-41)	35±2.72 (32-38)
J (hyalin portion of tail) µm	11±1.00 (8-13)	11±1.33 (8-12)
Body diameter at lip region µm	9±0.40 (9-10)	9±0.47 (9-10)
Body diameter at guiding ring µm	26±0.80 (25-27)	25±0.85 (24-26.5)
Body diameter at base of oesophagus µm	31±1.52 (29-35)	30±1.23 (28-31)
Body diameter at mid body or vulva µm	36±2.05 (33-41)	32.5±1.12 (31-35)
Body diameter at anus µm	23±0.61 (22-24)	24±1.12 (22-25)
Body diameter at beginning of J µm	10±0.94 (9-12)	10±0.99 (9-12)
Spicules µm	—	49±1.47 (47-50)

TABLE XIV *Morphometrics of paratypes of X. mesostilum sp.n.*

Locality	Quinta da Lameira, Silves	
Host	Olive	
n	15 ♀♀	19 ♂♂
Lmm	2.5±0.12 (2.4-2.8)	2.4±0.18 (2.1-2.6)
a	91±5.76 (82-99)	91±5.35 (83-100)
b	8.0±0.46 (7.4-8.5)	7.4±0.56 (6.2-8.3)
c	98±24.3 (85-115)	84±6.52 (75-92)
c'	1.5±0.11 (1.4-1.7)	1.5±0.09 (1.4-1.7)
V or T	57±1.84 (54-60)	43±2.93 (38.5-46)
Odontostyle µm	93±3.43 (85-97)	90±3.53 (88-95)
Odontophore µm	50±2.67 (45-53.5)	46±2.15 (43.5-50)
Oral aperture to guiding ring µm	80±3.81 (73-85)	78±2.98 (73.5-83.5)
Tail µm	26±1.88 (23.5-28)	28±1.11 (26-30)
J (hyalin portion of tail) µm	9±1.30 (8-11)	8.5±1.93 (7-9)
Body diameter at lip region µm	9±0.28 (9-9)	9±1.87 (8-9)
Body diameter at guiding ring µm	21±0.71 (19-21)	19±0.64 (18-21)
Body diameter at base of oesophagus µm	24.5±1.16 (23-27)	23±0.98 (22-24)
Body diameter at mid body or vulva µm	28±1.50 (25-30)	26±4.45 (23.5-27)
Body diameter at anus µm	17±0.63 (16.5-18)	18.5±0.77 (17-19)
Body diameter at beginning of J µm	9±0.87 (8-11)	8±0.61 (7-9)
Spicules µm	—	40±1.93 (35-45)

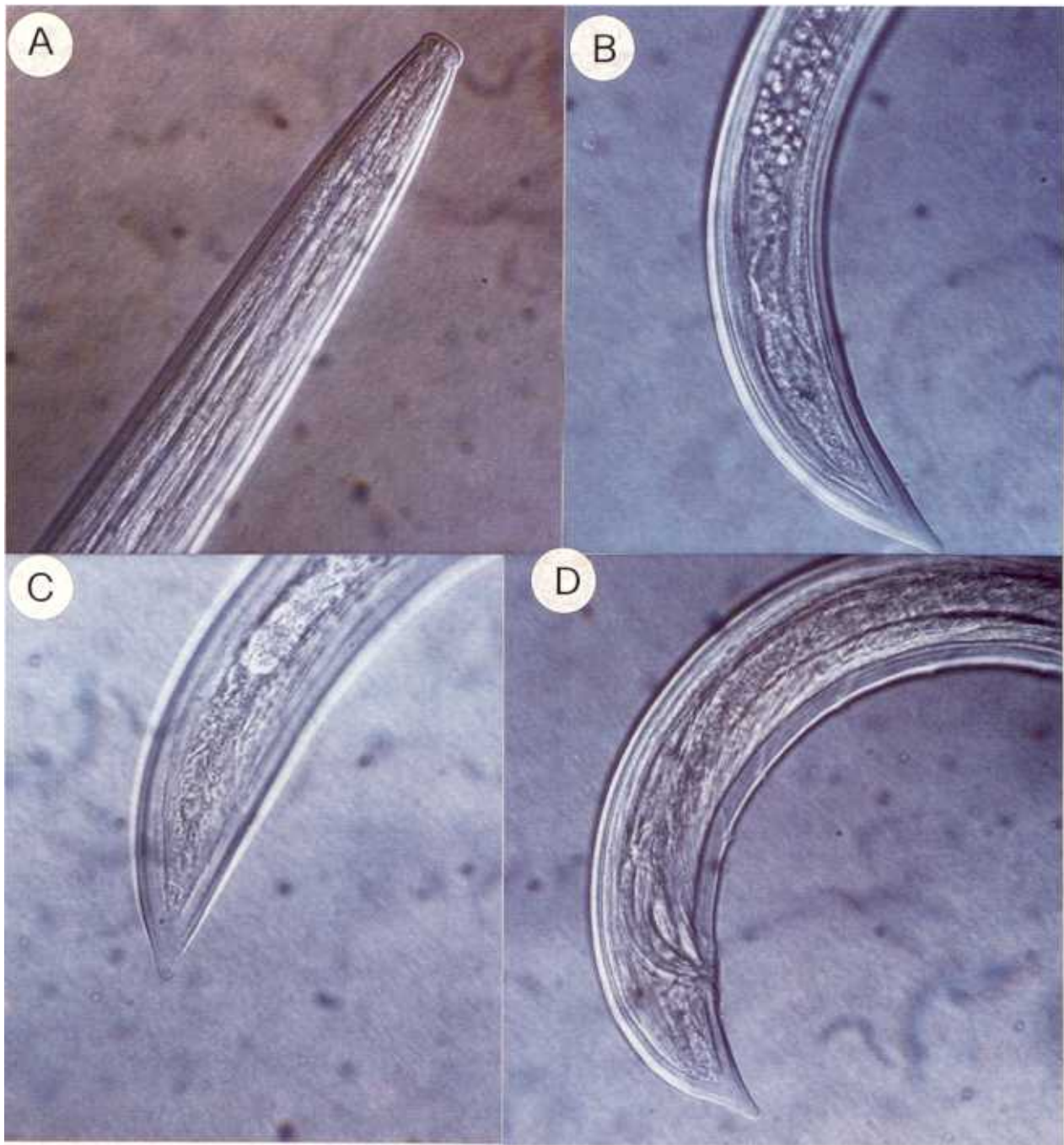


Fig. 12 - *X. longistilum* sp.n.: A, anterior region of female; B and C, posterior region of female; D, posterior region of male.

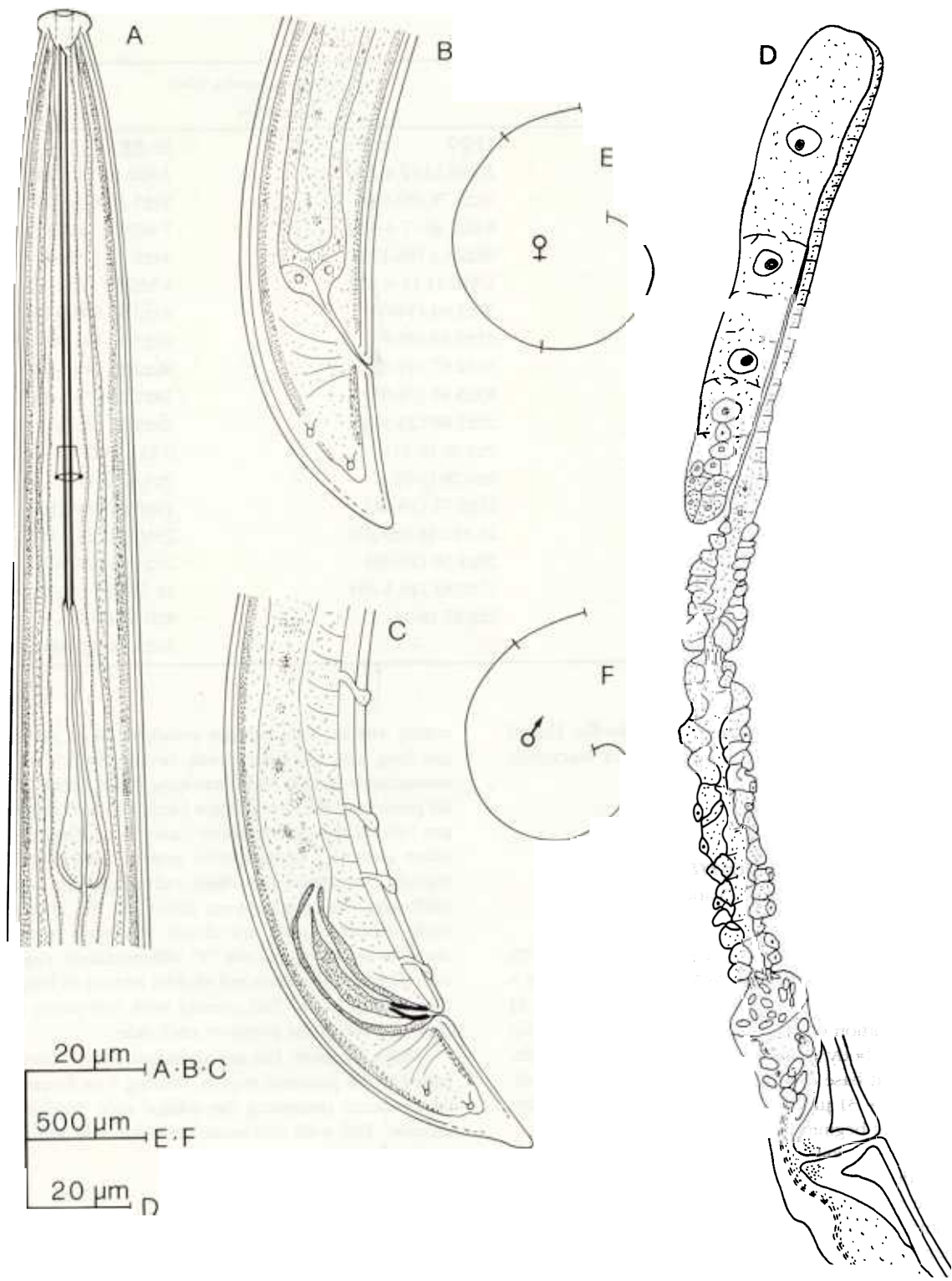


Fig. 13 - *X. mesostilum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male; D, female gonade; E and F, *habitus*.

TABLE XIV *Morphometrics of paratypes of X. mesostilum sp.n.*

Locality	Quinta da Lameira, Silves	
Host	Olive	
n	15 ♀♀	19 ♂♂
L mm	2.5±0.12 (2.4-2.8)	2.4±0.18 (2.1-2.6)
a	91±5.76 (82-99)	91±5.35 (83-100)
b	8.0±0.46 (7.4-8.5)	7.4±0.56 (6.2-8.3)
c	98±24.3 (85-115)	84±6.52 (75-92)
c'	1.5±0.11 (1.4-1.7)	1.5±0.09 (1.4-1.7)
V or T	57±1.84 (54-60)	43±2.93 (38.5-46)
Odontostyle µm	93±3.43 (85-97)	90±3.53 (88-95)
Odontophore µm	50±2.67 (45-53.5)	46±2.15 (43.5-50)
Oral aperture to guiding ring µm	80±3.81 (73-85)	78±2.98 (73.5-83.5)
Tail µm	26±1.88 (23.5-28)	28±1.11 (26-30)
J (hyalin portion of tail) µm	9±1.30 (8-11)	8.5±1.93 (7-9)
Body diameter at lip region µm	9±0.28 (9-9)	9±1.87 (8-9)
Body diameter at guiding ring µm	21±0.71 (19-21)	19±0.64 (18-21)
Body diameter at base of oesophagus µm	24.5±1.16 (23-27)	23±0.98 (22-24)
Body diameter at mid body or vulva µm	28±1.50 (25-30)	26±4.45 (23.5-27)
Body diameter at anus µm	17±0.63 (16.5-18)	18.5±0.77 (17-19)
Body diameter at beginning of J µm	9±0.87 (8-11)	8±0.61 (7-9)
Spicules µm		40±1.93 (35-45)

United States Department of Agriculture, Beltsville, United States of America, and Estação Agronómica Nacional, I.N.I.A., Oeiras, Portugal.

XIPHINEMA MICROSTILUM sp.n.

(Table XV; Figs 15 and 16)

Holotype female: L = 2.6 mm; a = 83; b = 7.8; c = 79; c' = 1.7; V = 56; odontostyle = 76.5 µm; odontophore = 46.5 µm; oral aperture to guiding ring = 65 µm; tail = 33 µm; J (hyalin portion of tail) = 8 µm; body diameter at lip region = 9 µm; body diameter at guiding ring = 21 µm; body diameter at base of oesophagus = 26.5 µm; body diameter at vulva = 31 µm; body diameter at anus = 19 µm; body diameter at beginning of J = 8 µm.

Female *habitus* coiled in a closed C when killed. Body tapering gradually towards the extremities, but abruptly in the extreme anterior region. Cuticle smooth transversally and longitudinally striated, 2-2.5 µm thick at midbody. Lip region hemielliptical, 3.5 µm high, offset from the rest of the body by a depression. Amphids large, stirrup shaped. Odontostyle 2 µm in diameter at its base, odontophore strongly flanged. Guiding sheath with only the basal ring

readily visible. Oesophagus enlarged basal portion 78-85 µm long and 13-15 µm wide, occupying 1/3 of the total oesophagus length and containing three nuclei. The tubular portion of the oesophagus bears a mucro situated 25-47 µm behind the odontophore base. Oesophageal intestinal valve globular. Reproductive system amphidelphic, with equally developed branches; vulva slit-like, posterior to midbody; vagina occupying about 1/2 the corresponding body diameter; uteri not clearly separated from the oviduct; no spermatheca nor "Z" differentiation visible; ovaries reflexed. Prerectum not visible; rectum as long as body diameter at anus. Tail conoid with sub-acute terminus, bearing two caudal pores on each side.

Males frequent, but not abundant. More coiled than females in the posterior region, bearing 5 or 6 ventromedian supplements preceding the adanal pair. Spicules slightly arcuate. Tail with sub-acute terminus and two pores on each side.

Type locality

Quinta Nova, Montemor-o-Novo, Portugal, in rhizosphere of unidentified weeds.

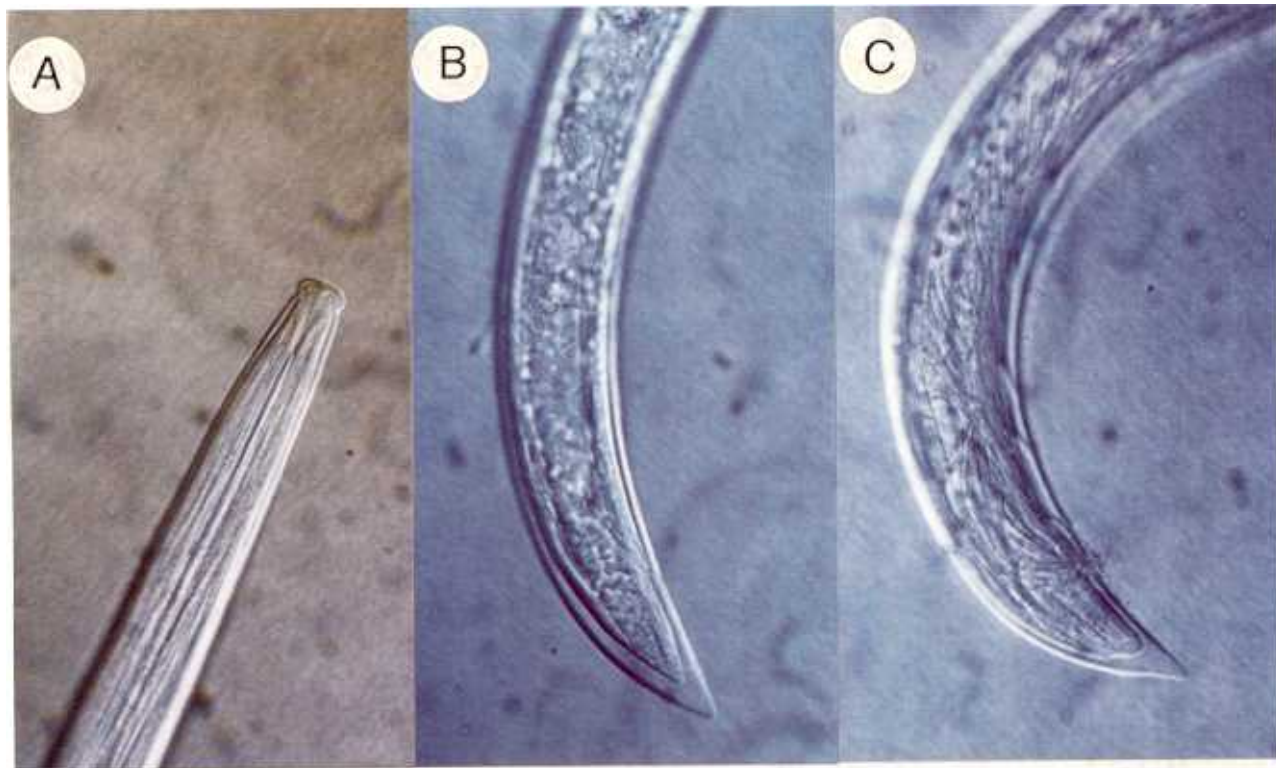


Fig. 14 - *X. mesostilum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male.

Diagnosis and relationships

Xiphinema microstilum sp.n. is a bisexual species characterized by 2.6 mm body length, hemielliptical lip region, offset from the rest of the body by depression, odontostyle length of 74 μ m, vulva at 57%, amphidelphic, with equally developed branches of the female reproductive system and conoid elongate tail.

Xiphinema microstilum is similar to *X. pachtaicum* (Tulaganov, 1938) Kirjanova, 1951, *X. fortuitum* Roca, Lamberti et Agostinelli, 1987, *X. madeirense* Brown, Faria, Lamberti, Halbrendt, Agostinelli et Jones, 1992 and *X. duriense* Lamberti, Lemos, Agostinelli et D'Addabbo, 1993. However, it differs from *X. pachtaicum* in its longer body (1.8-1.9 mm in *X. pachtaicum*), higher a value (48-67 in *X. pachtaicum*), shorter odontostyle (79-85 μ m in *X. pachtaicum*) and longer tail (28-30 μ m in *X. pachtaicum*); from *X. fortuitum* in the posterior vulva ($V = 54$ in *X. fortuitum*), shorter odontostyle (102 μ m in *X. fortuitum*) and anterior guiding ring (83 μ m from oral aperture in *X. fortuitum*); from *X. madeirense* in its longer body (2.2 mm in *X. madeirense*), higher a value (69 in *X. madeirense*), higher c value (59 in *X. madeirense*), shorter odontostyle (105 μ m in *X. madeirense*) and anterior guiding ring (90 μ m from

the oral aperture in *X. madeirense*); and from *X. duriense* in its longer body (1.8 mm in *X. duriense*), higher a value (74 in *X. duriense*), higher c value (58 in *X. duriense*), lower c' value (2.1 in *X. duriense*) and anterior vulva ($V = 60$ in *X. duriense*).

Compared to the other four bisexual species included in the *X. americanum*-group, *X. microstilum* differs from *X. pachydermum* Sturhan, 1983 in the higher value of a (63-76 in *X. pachydermum*), higher value of c' (1.2-1.6 in *X. pachydermum*) and shorter odontostyle (77-91 μ m in *X. pachydermum*); from *X. brevisicum* sp.n. in its longer body (2.2-2.5 mm in *X. brevisicum*), higher c value (52-59 in *X. brevisicum*), lower c' value (2.5-2.9 in *X. brevisicum*), longer odontostyle (60-63 μ m in *X. brevisicum*) and less elongate tail; from *X. longistilum* sp.n. in its shorter body (2.8 mm in *X. longistilum*), shorter odontostyle (112 μ m in *X. longistilum*), anterior guiding ring (104 μ m from oral aperture in *X. longistilum*) and less elongate tail; finally *X. microstilum* differs from *X. mesostilum* sp.n. in the lower value of a (91 in *X. mesostilum*), higher c' value (1.5 in *X. mesostilum*), shorter odontostyle (93 μ m in *X. mesostilum*), anterior guiding ring (80 μ m from oral aperture in *X. mesostilum*) and longer tail (26 μ m in *X. mesostilum*).

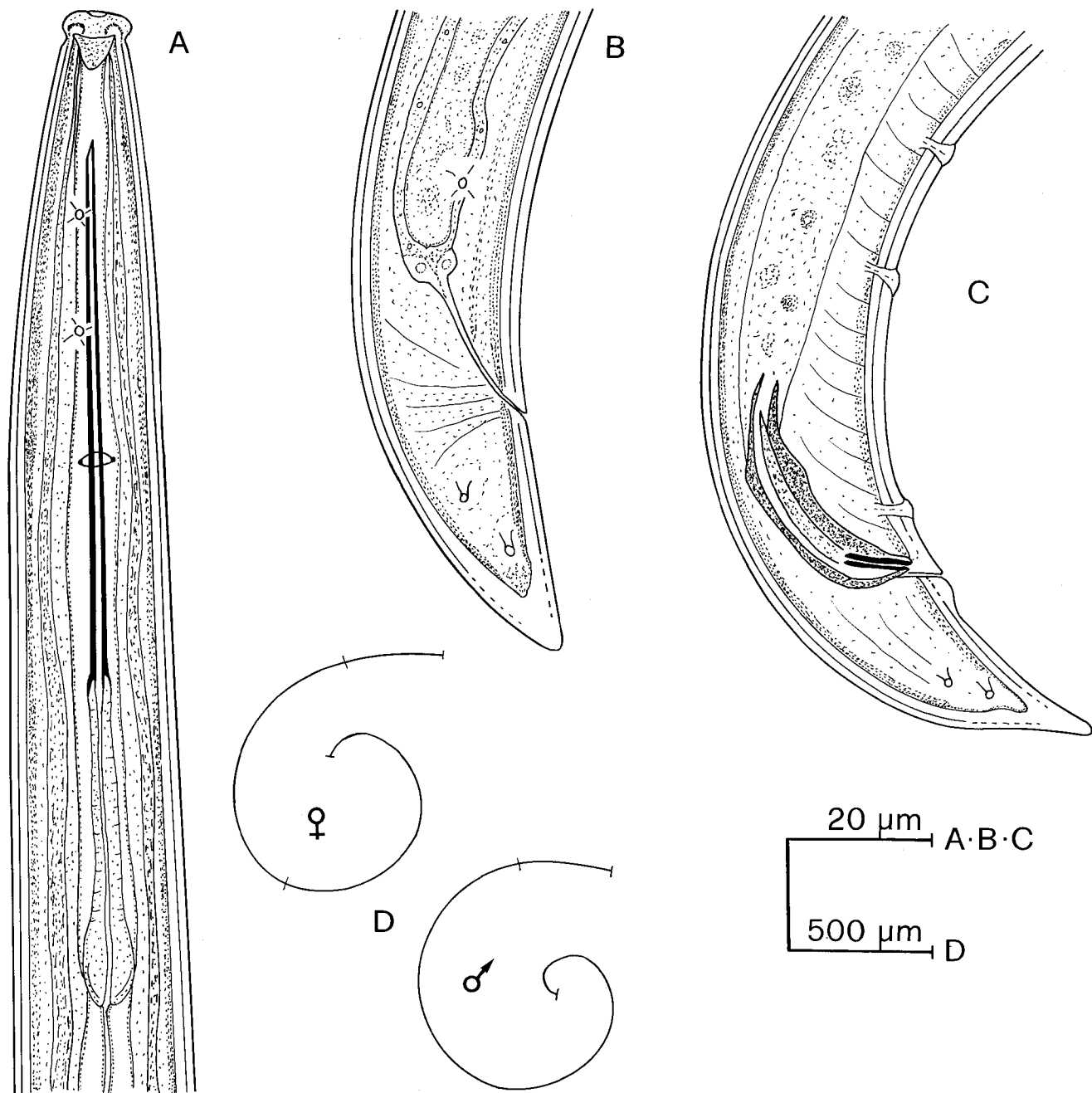


Fig. 15 - *X. microstilum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male; D, *habitus*.

TABLE XV - *Morphometrics of two populations of X. microstilum sp.n.*

Locality	Quinta Nova, Montemor-o-Novo		Quinta da Adúa, Montemor-o-Novo	
Host	Unidentified weeds (paratypes)		Unidentified weeds	
n	15 ♀♀	2 ♂♂	5 ♀♀	1 ♂
L mm	2.6±0.1 (2.5-2.8)	2.5-2.5	2.4 (2.35-2.5)	2.5
a	86±3.8 (77-93)	92-87	83 (82-87)	85
b	8.0±0.4 (7.6-8.9)	7.7-7.7	7.9 (7.5-8.3)	8.6
c	74±6.6 (63-88)	73-76	74 (66.5-82)	71
c'	1.8±0.2 (1.6-2.0)	1.6-1.6	1.7 (1.6-1.9)	1.8
V	57±1.4 (55-60)	—	57 (55-58)	—
Odontostyle µm	74±2.8 (68-77)	75-75	74 (72-78)	79
Odontophore µm	45.5±1.4 (43.5-48)	44-45	45 (44-46.5)	41
Oral aperture to guiding ring µm	63±2.6 (57-68)	65-64	62 (56.5-67)	62
Tail µm	35±2.4 (31-39)	34-33	33 (31-38)	35
J (hyalin portion of tail) µm	10±1.4 (7-12)	8-10	11 (9-12)	12
Body diameter at lip region µm	9±0.3 (9-10)	9-9	9 (9-10)	9
Body diameter at guiding ring µm	21±0.6 (20-22)	21-20	21 (19-23)	20
Body diameter at base of oesophagus µm	26±1.1 (25-28)	24-25	27 (25-28)	26
Body diameter at midbody or vulva µm	30±1.2 (28-32)	27-29	29 (27-31)	29
Body diameter at anus µm	19±0.9 (18-21)	21-21	19 (18-20)	20
Body diameter at beginning of J µm	8±0.8 (6.5-9)	7-7	9 (8-11)	9
Spicules µm	—	44-44	—	41

Type material

Holotype female, eleven paratype females and two paratype males in the collection of the Istituto di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; two paratype females in each of the following collections: Entomology and Nematology Department, Rothamsted Experimental Station, Harpenden, United Kingdom; Plant Nematology Laboratory, Beltsville, United States of America, and Estação Agronómica Nacional, I.N.I.A., Oeiras, Portugal.

XIPHINEMA sp.

(Figs 17 and 18)

Only three females were found in the rhizosphere of maize at Água Todo o Ano, Ponte de Sôr, Castelo Branco. Their measurements are: L = 2.3 (2.2-2.5) mm; a = 75 (73-77); b = 6 (6-7); c = 72 (66-82); c' = 1.6 (1.5-1.7); V = 59 (59-60); odontostyle = 102 (99-104) µm; odontophore = 51

(50-51) µm; oral aperture to guiding ring = 91 (90-92) µm; tail = 32 (31-33) µm; J (hyalin portion of tail) = 10 (9-10) µm; body diameter at lip region = 9 (8.5-9) µm; body diameter at guiding ring = 24 (23.5-24) µm; body diameter at base of oesophagus = 26 (25-28) µm; body diameter at vulva = 30 (29-32) µm; body diameter at anus = 20 (19-21) µm; body diameter at beginning of J = 11 (9-12) µm.

Habitus a closed C when killed. Body cylindrical tapering gradually towards the extremities. Lip region expanded, hemielliptical. Odontostyle thin with slightly sclerotized flanges. Basal oesophagus with three nuclei. Vulva posterior to midbody; vagina 1/2 into body, gonads amphidelphic with reflexed ovaries. Tail conoid, ventrally curved, with two caudal pores on each side.

It resembles to *X. fortuitum* Roca, Lamberti *et* Agostinelli, 1987 and *X. madeirense* Brown, Faria, Lamberti, Halbrendt, Agostinelli *et* Jones, 1992.

There are eleven named species of the *X. american-*group reported from Portugal.

With the aim of helping fellow nematologists to identify them a dichotomous key has been constructed.

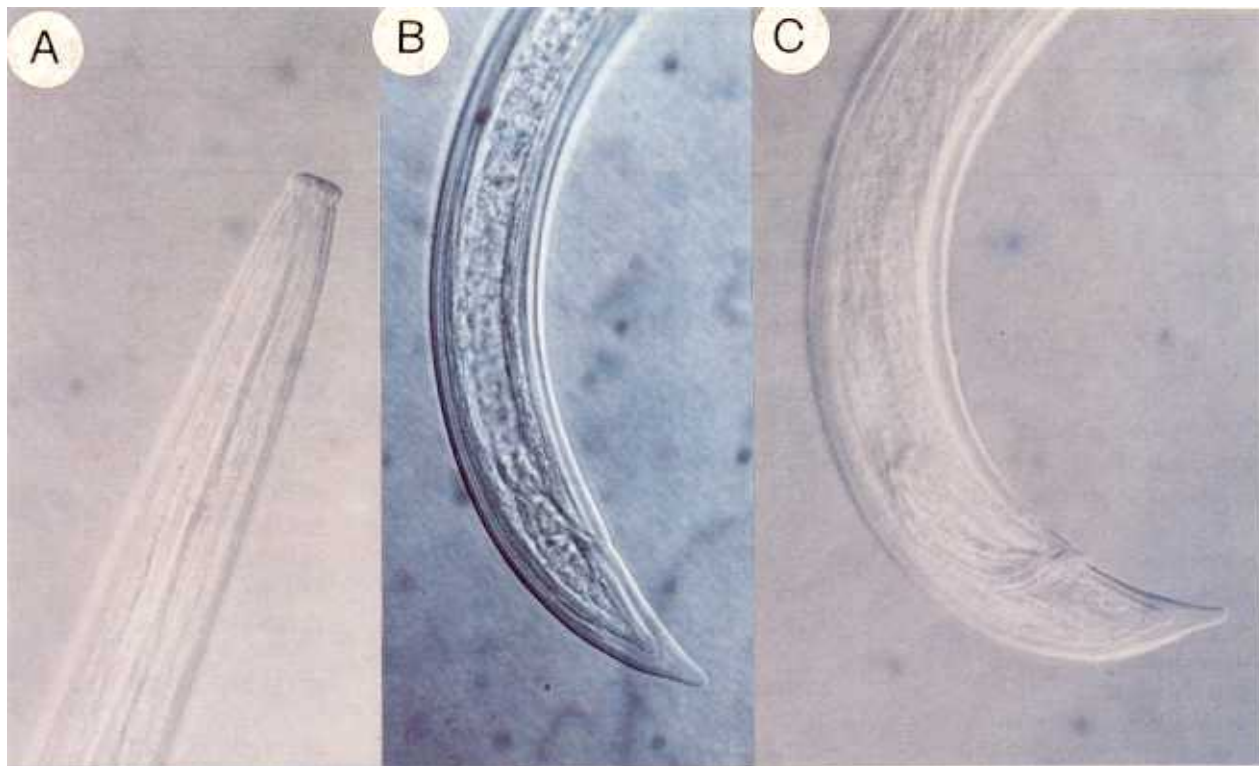


Fig. 16 - *X. microstilum* sp.n.: A, anterior region of female; B, posterior region of female; C, posterior region of male.

The eleven species have a body length between 1.5 and 3.1 mm, odontostyle length between 50 and 120 μm , amphidelphic female genital system with almost equally developed branches and vulva situated between 46 and 68% of the body length, tail conoid-elongate with sub-acute or rounded terminus. They differ from each other in the following characters:

- | | |
|---|--------------------|
| 1 - Males unknown or rare | |
| Males common or numerous | |
| 2 - Lip region continuous or only slightly offset from the rest of the body | 3 |
| Lip region expanded, clearly offset by a depression | 5 |
| 3 - Tail broadly conoid | <i>X. diffusum</i> |
| Tail gradually tapering, elongate with round terminus | 4 |
| 4 - Lip region slightly offset | <i>X. santos</i> |
| Lip region continuous | <i>X. rivesi</i> |

- | | |
|--|-----------------------|
| 5 - Odontostyle length over 100 μm | <i>X. madeirense</i> |
| Odontostyle length less than 100 μm | 6 |
| 6 - Odontostyle length between 85 and 90 μm | <i>X. pachtaicum</i> |
| Odontostyle length less than 75 μm | <i>X. duriense</i> |
| 7 - Odontostyle length less than 65 μm | <i>X. brevisicum</i> |
| Odontostyle length over 65 μm | 8 |
| 8 - Odontostyle length over 100 μm | <i>X. logistilum</i> |
| Odontostyle length between 70 and 100 μm | 9 |
| 9 - Value of 'a' less than 83 | <i>X. pachydermum</i> |
| Value of 'a' over 83 | 10 |
| 10 - Odontostyle length over 80 μm | <i>X. mesostilum</i> |
| Odontostyle length less than 80 μm | <i>X. microstilum</i> |

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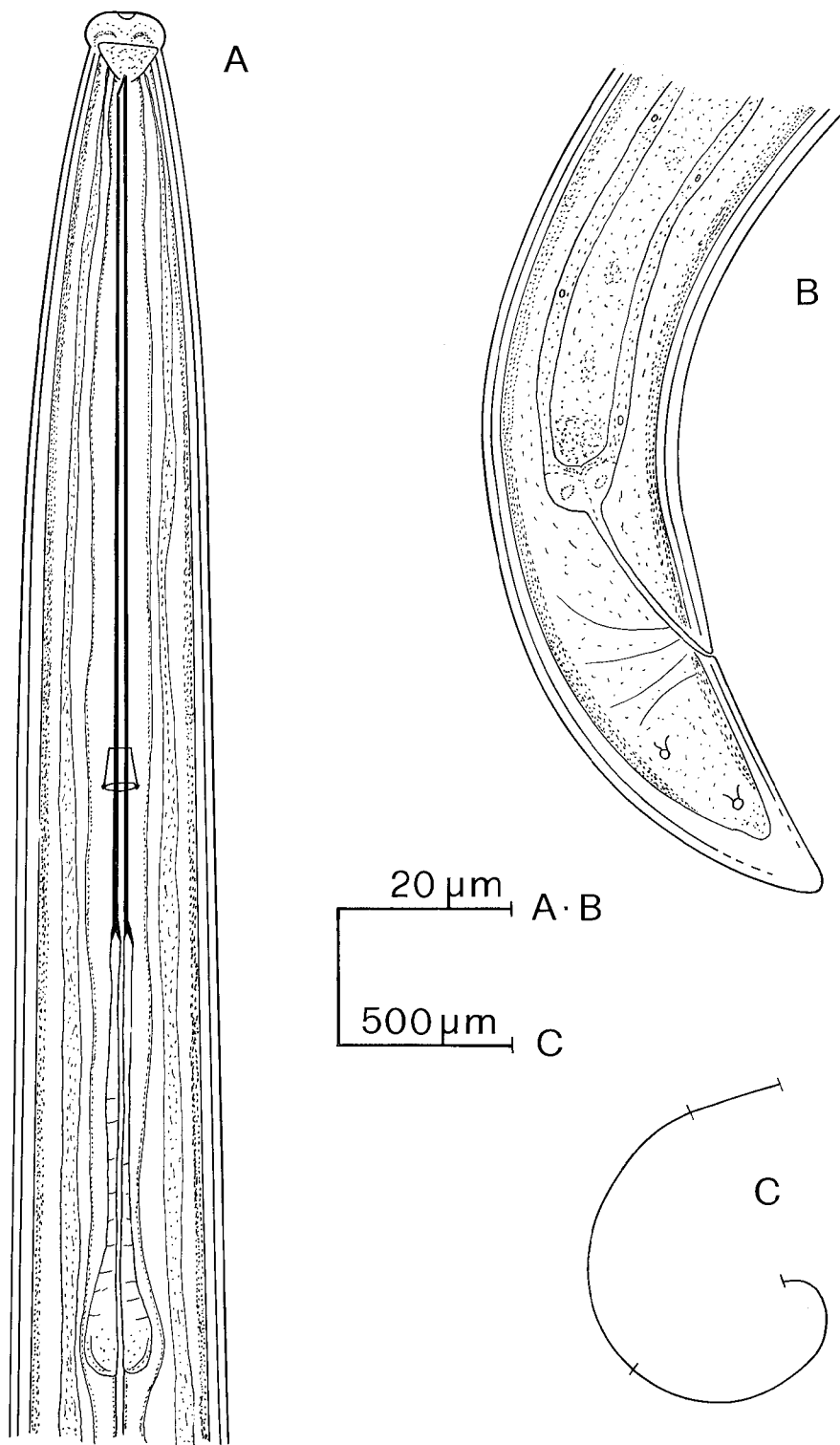


Fig. 17 - Female of *Xiphinema* sp.: A, anterior region; B, posterior region; C, *habitus*.

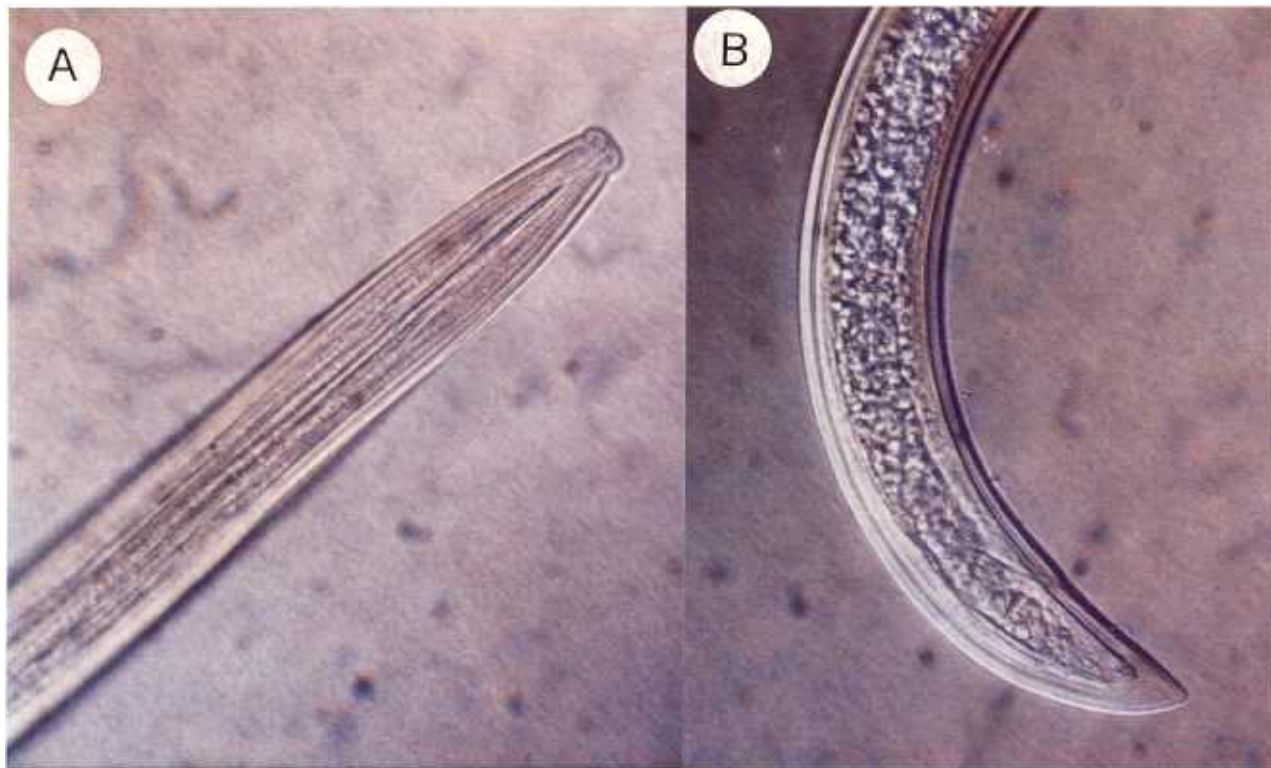


Fig. 18 - Female of *Xiphinema* sp.: A, anterior region; B, posterior region.

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