

Laboratorio di Nematologia Agraria del C.N.R. - 70126 Bari, Italy

STUDIES ON *XIPHINEMA AMERICANUM SENSU LATO* WITH
DESCRIPTIONS OF FIFTEEN NEW SPECIES
(NEMATODA, LONGIDORIDAE)

By

FRANCO LAMBERTI AND TERESA BLEVE-ZACHEO

Lima (1965) was the first to hypothesize that *Xiphinema americanum* Cobb, 1913 was a complex of different species in which he listed *X. americanum*, *X. brevicolle* Lordello *et* Da Costa, 1961, *X. opisthohysterum* Siddiqi, 1961 and four undescribed species (Lima, 1968). One of them was later described as *X. mediterraneum* Martelli *et* Lamberti, 1967 (Lamberti and Martelli, 1971) and recently synonymized with *X. pachtaicum* (Tulaganov, 1938) Kirijanova, 1951 (Siddiqi and Lamberti, 1977). The morphometrical variability in *X. americanum* was also studied by Tarjan (1968) who, after having examined 75 world-wide collected populations, concluded that the species status of *X. brevicolle*, *X. opisthohysterum* and Lima's Mediterranean species, presently *X. pachtaicum*, was justified but that all the other variations he had observed should be considered as geographical variants, correlated with climatic influences, within the *X. americanum* complex (Tarjan, 1969). In 1974 Heyns stated that « demarcation of species within the group is problematical and unsatisfactory although several of the species proposed by Lima seem to be justified ».

Because of the importance of *X. americanum* as a vector of some plant viruses (Taylor and Robertson, 1975) we thought it useful to carry out studies which would clarify the identity of several populations from different geographical locations and establish the relationships with this and the other related species. This would contribute not only to better understanding of virus-vector specificity (Taylor and Robertson, 1975) but could also explain the failure of

some populations of *X. americanum* to transmit viruses for which it is considered an efficient vector.

Therefore a study was made of several hundred populations belonging to the *X. americanum* group, either collected personally by the senior author or received from different parts of the world over a period of 15 years. Specimens were mounted in either glycerine or lactophenol.

RESULTS

Since Cobb's original type material of *X. americanum* is lost, Tarjan (1958) designated as the neotype for this species a male which he had described in 1956 from a population from Rhode Island. Although Tarjan's material was not collected in any of the localities generally indicated by Cobb, it is identical with the population from Falls Church, Virginia, on which Cobb based his original description (Lima, 1965). Therefore, according to the rules of the International Code of Zoology it can be accepted as the neotype for this species. These requirements are not fulfilled by Siddiqi (1959) who proposed, anyway at a later date, as neotype a female of a population collected around the roots of Citrus at Aligarh, North India, whose males have « certain differences in the form and size of spicules and arrangement of supplementary papillae ».

Although Tarjan's description (1958) of *X. americanum* is sufficiently accurate and Siddiqi (1973) has based his C.I.H. description and illustrations on four topotypes, we thought it useful to redescribe it in more detail from topotypes kindly provided by Dr. A. C. Tarjan, to provide the basis for the comparison of the new species described here. Moreover, we present for the first time the measurements of the juvenile stages of this species.

XIPHINEMA AMERICANUM (Fig. 1, Table I) (Topotypes)

Females: body tapering very gradually toward the extremities and forming an open spiral when killed. Cuticle finely striated, generally 1-2 μm thick along most of the body but more thickened at the posterior extremity with maximum thickness 4-5 μm dorsally at the beginning of tail. Labial region rounded, 5 μm high, not expanded

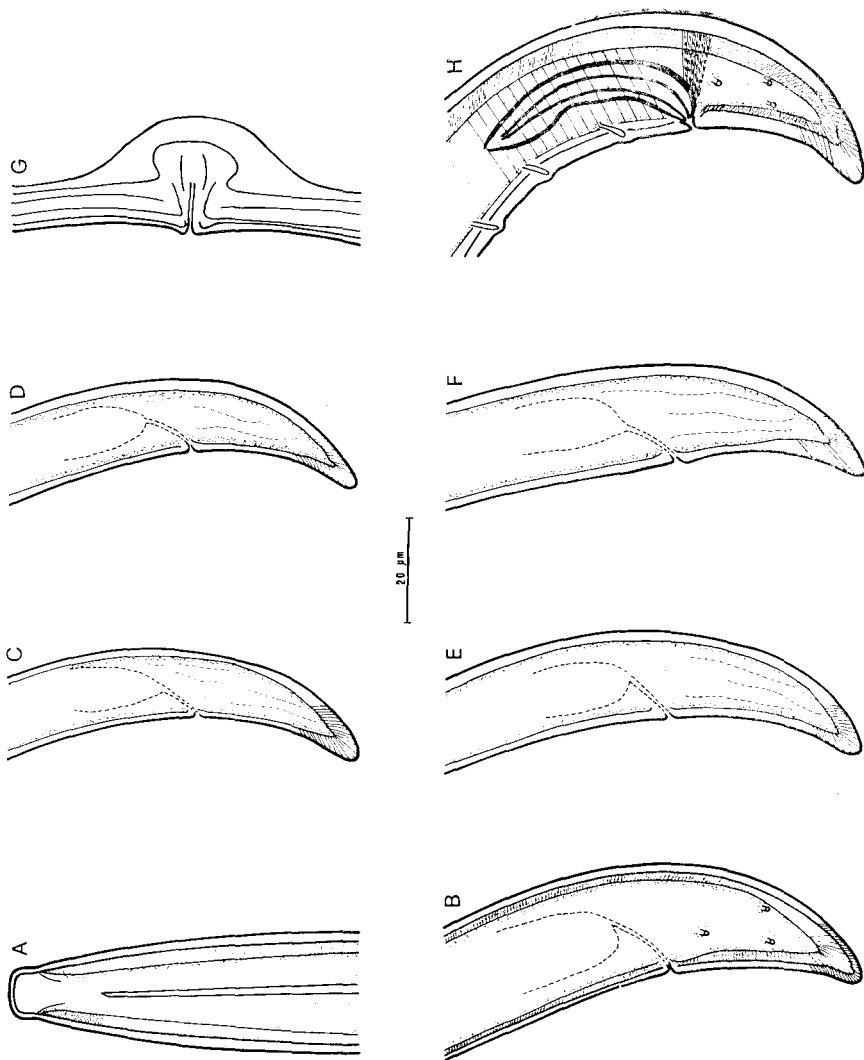


Fig. 1 - *Xiphinema americanum* (topotypes): A and B, anterior and posterior regions of female; C, D, E and F, tails of I, II, III and IV juvenile stages respectively; G, vulvar region; H, posterior region of male.

Table I - *Morphometric characters of topotypes of Xiphinema americanum.*

Stages	♀	♂	L ₁	L ₂	L ₃	L ₄
n	16	3	10	10	10	11
L mm	1.7 (1.6-1.8)	1.5 (1.4-1.6)	0.7 (0.7-0.8)	0.9 (0.8-1)	1.1 (1-1.2)	1.3 (1.2-1.3)
a	51 (43-59)	51 (45-57)	38 (35-42)	43 (40-47)	48 (44-54)	50 (45-54)
b	6.9 (5.8-8.1)	5.7 (5.1-6.6)	4.8 (4.2-6.2)	4.9 (4.3-5.7)	5.4 (4.7-5.9)	5.6 (4.9-6.1)
c	52 (39-59)	44 (40-50)	25 (23-31)	28 (23-34)	34 (29-37)	38 (35-42)
c'	1.7 (1.5-1.9)	1.6 (1.5-1.7)	2.1 (2-2.5)	2.4 (2-2.7)	2.2 (1.8-2.5)	2 (1.8-2.3)
V	51 (49-53)	—	—	—	—	—
Odontostyle µm	68 (63-73)	67 (60-73)	38 (35-39)	44 (42-46)	50 (45-54)	54 (52-57)
Odontophore µm	42 (38-50)	41 (40-45)	27 (24-30)	32 (29-35)	34 (28-38)	37 (31-41)
Replacement odontostyle µm	—	—	42 (39-45)	55 (52-57)	64 (53-70)	68 (66-70)
Oral aperture to guiding ring µm	58 (49-66)	54 (49-58)	27 (25-29)	34 (32-37)	40 (32-37)	43 (38-47)
Tail µm	32 (28-37)	34 (33-35)	30 (23-32)	33 (26-38)	33 (30-37)	33 (30-37)
J µm	8 (5-9.5)	8 (6-9.5)	5 (4-8.5)	5 (4-7)	6 (4.5-7)	6 (5-7)
Body diam at lip region µm	10 (8.5-10.5)	10 (9.5-10.5)	7 (6.5-8)	8 (7.5-8.5)	9 (8.5-9.5)	9 (8.5-9.5)
Body diam at guiding ring µm	22 (20-26)	23 (21-25)	14 (12-15)	16 (15.5-17.5)	17 (16-20)	18 (16-20)
Body diam at base of oesophagus µm	30 (26-34)	28 (25-31)	18 (17-19)	20 (19-21)	22 (20-25)	24 (22-27)
Body diam at vulva or middle body µm	34 (28-38)	30 (25-35)	20 (17-21)	21 (21-23)	23 (20-27)	26 (23-28)
Body diam at anus µm	19 (17-22)	21	13 (11-13)	14 (12-15)	15 (14-17)	16 (14-17.5)
Body diam at beginning of J µm	8 (6.5-9)	8 (6-9.5)	5 (4.5-5.5)	5 (4.5-6)	6 (4.5-7)	6 (5-8)
Spicules µm	—	36 (34-38)	—	—	—	—

but set off from rest of body by slight depression. Amphidial pouches stirrup-shaped with slitlike aperture. Odontostyle robust, 2 μm diameter, followed by a well-developed odontophore typical of *Xiphinema*. Guide sheath also typical of the genus, with the two guiding rings up to 30 μm apart when odontostyle is extruded. Oesophagus dorylaimoid with posterior part enlarged and occupying 1/3 to 1/4 of its total length. Muscular oesophageal bulb measuring 80-90 μm long and 15-22 μm wide, containing 3 nuclei. Oesophagus-intestinal valve large, heart-shaped. Vulva, a transverse slit with slightly prominent lips, located approximately equatorially; vagina occupying 1/3 of corresponding body diameter. Gonads opposed, reflexed, with short uteri, more or less one body-width long, and without spermatheca or any « Z » differentiation (Grimaldi De Zio *et al.*, 1979). Prerectum indistinct 25-35 μm long; rectum as long as 2/3 to 4/5 of body diameter at the anus. Tail conoid, well curved dorsally, with 2-3 caudal pores. Tail tip more or less rounded.

Males: body similar to female but smaller in size and more tightly curved in the posterior third; spicules moderately sclerotized, widely arcuate; adanal pair of ventromedian supplements preceded by 7-11 ventromedian papillae; one male was found without supplements.

Juveniles: morphologically similar to adult females, differing mainly in the smaller body and longer tail.

Variability within *X. americanum* (Table II)

Several populations of *X. americanum* from various geographical locations have been studied. Those from Canada and South Carolina have a smaller body size and longer odontostyle and tail. A population collected from the rhizosphere of vines at Shreveport in Louisiana is identical to the topotypes, while the only relevant difference observed on specimens collected at Beltsville, Maryland (from rose) is the longer odontostyle.

Comments on the geographical distribution of *X. americanum*

After studying illustrations and descriptions of Cobb (1913, 1915 and 1918) and specimens collected near the localities from where Cobb had obtained his material Lima (1965) concluded that he was handling

Table II - *Morphometric characters of females of four populations of X. americanum.*

Populations: locality and host	Canada, locality and host unknown	South Carol., USA, Aiken; Zoysia grass	Maryland, USA, Beltsville; Rose	Louisiana, USA, Shreveport; Vines
n	10	13	5	4
L mm	1.6 (1.5 - 1.8)	1.5 (1.4 - 1.6)	1.7 (1.6 - 1.8)	1.8 (1.7 - 1.9)
a	51 (46 - 54)	43 (39 - 48)	50 (48 - 53)	56 (55 - 58)
b	6.7 (4.7 - 8)	6.2 (4.6 - 6.9)	6.4 (5.8 - 6.9)	6.4 (5.8 - 6.8)
c	47 (43 - 51)	46 (40 - 54)	49 (45 - 55)	54 (48 - 59)
c'	1.8 (1.7 - 2)	1.7 (1.4 - 1.9)	1.8 (1.7 - 2)	1.8 (1.7 - 1.9)
V	50 (49 - 52)	50 (47 - 54)	52 (50 - 54)	51 (50 - 54)
Odontostyle μm	80 (71 - 85)	70 (64 - 77)	79 (75 - 83)	67 (63 - 69)
Odontophore μm	42 (38 - 50)	43 (40 - 46)	45 (41 - 48)	46 (43 - 53)
Oral aperture to guiding ring μm	65 (57 - 70)	57 (53 - 64)	67 (63 - 71)	59 (57 - 60)
Tail μm	35 (34 - 40)	32 (27 - 34)	34 (32 - 36)	34 (28 - 40)
J μm	9 (8 - 12)	8 (6.5 - 9)	9 (7.5 - 10)	8 (6 - 9)
Body diam at lip region μm	10 (9 - 10.5)	10 (9.5 - 11)	10 (9.5 - 10)	10.5 (10 - 11.5)
Body diam at guiding ring μm	23 (22 - 25)	23 (22 - 25)	23 (22 - 25)	23 (21 - 24)
Body diam at base of oesophagus μm	29 (27 - 31)	30 (27 - 33)	29 (27 - 30)	29 (26 - 32)
Body diam at vulva μm	32 (28 - 35)	35 (31 - 38)	33 (32 - 34)	33 (28 - 34)
Body diam at anus μm	19 (17 - 21)	19 (17 - 20)	19 (17 - 21)	19 (16 - 21)
Body diam at beginning of J μm	8 (7 - 9.5)	8 (6.5 - 8.5)	8 (7.5 - 8.5)	7 (5.5 - 9)

two species: the true *X. americanum* from Falls Church, Virginia, and a different undescribed species from Oxnard, California. The latter looks identical to populations collected by one of us (Lamberti) in various Californian localities and described here as a new species.

Imamura in 1931 reported *X. americanum* from Japan. However, his illustrations are poor and his description is too approximative to decide which species he was dealing with. Nevertheless Imamura's report is perhaps sufficient to indicate that he was not handling *X. americanum*.

Thorne's descriptions of *X. americanum* (1939 and 1961) indicate that he had a broad conception of this species and although he noted some differences amongst populations collected in various parts of the United States he regarded them as intraspecific variations. But Lima (1965) studying Thorne's slides distinguished at least two different species, one of which was *X. americanum*. We believe that only a few of Thorne's populations, and all those from the Eastern States, are the true *X. americanum*.

Neither description nor measurements that Loos (1949) gives of *X. americanum* from Sri Lanka fit with those of topotypes and again Lima (1965) hypothesized that it is a distinct species.

Our observations on populations of *Xiphinema* collected from Ischia island, and from additional localities to those referred to by Meyl (1954 and 1961) show that he was dealing with either *X. pachtaicum* (syn. *X. mediterraneum* Martelli et Lamberti) or *X. italiae* Meyl, 1961. The erroneous identification of *X. americanum* later reported from Italy has already been discussed (Martelli and Lamberti, 1967).

By studying original material Lima (1965) has also clarified that *X. americanum* reported from Brazil (Carvalho, 1955 and 1962) is in reality *X. brevicolle* Lordello et Da Costa, 1961, as hypothesized similarly by Lordello and Da Costa (1961). Lima's opinion is supported by Heyns (1974), Luc and Dalmasso (1975) and Lamberti and Loof (1977) who synonymized *X. brevicolle* with *X. saopaolense*, the latter having been proposed as a new species by Khan and Ahmad (1975) after noting the misidentification of *X. americanum* by Carvalho (1955).

The populations from Northern India described by Siddiqi (1959) as *X. americanum* belong, in our opinion, to a different species because of their longer stylet and more pointed tail, in females, and the different shape and length of the spicules and number (only six beside the adanal pair) and arrangement of the supplements in the male.

The broad conception of the *X. americanum* complex in Tarjan (1969) has already been noted.

Szczygiel *et al.* (1969) reported from Poland the presence of *X. americanum* associated with fruit trees. We have studied these specimens and conclude that they are *X. brevicolle*. In fact, subsequently Szczygiel (1974) corrected his identification.

Heyns (1974) stated that two species of the *X. americanum* group occur in South Africa: *X. americanum* and *X. brevicolle*. However, his illustrations and measurements indicate that *X. americanum* is wrongly named and is another species.

Xiphinema americanum has also been reported from the Philippines (Timm, 1965) and from Azores islands (Sturhan, 1973) but we have not had the opportunity to examine these specimens.

On the basis of our observations of various populations and reappraisal of the literature, we think, in contrast with Thorne (1961) and Tarjan (1969), that *X. americanum* is a species with a very limited geographical distribution which appears to be restricted to the eastern part of the North American continent, mostly in association with grassland.

The position of *X. americanum* as vector of plant viruses (Taylor and Robertson, 1975; Stace-Smith and Hansen, 1976; Martelli, 1978) therefore must be reconsidered.

XIPHINEMA PACHTAICUM (Tulaganov, 1938) Kirjanova, 1951 (Table III).

syn. *Longidorus pachtaicum* Tulaganov, 1938.

Xiphinema mediterraneum Martelli *et* Lamberti, 1967.

X. mediterraneum Martelli *et* Lamberti, in Heyns, 1977.

The morphology and the systematic position of *X. pachtaicum* has amply been illustrated (Lamberti *et* Martelli, 1971; Lamberti *et* Siddiqi, 1977; Siddiqi *et* Lamberti, 1977). This is a species with fairly constant biometrical and morphological characters. Over one hundred populations of this species have been examined for this study and its identification has never caused problems even when only a limited number of specimens was available. In table III are given measurements of 18 of the populations examined from different geographical locations. The only remarkable differences noted were in the position of vulva, posterior with respect to most populations in a population

from Canosa, Bari, Italy, and in the width of the body which was narrower than usual in a population from Pentekeli, Hungary, and in populations from Central Asia (Uzbekistan and Turkmenistan), although the body diameter near the extremities did not differ from the other populations.

Males and juvenile stages of *X. pachtaicum* have been described by Cohn (1969) and Lamberti and Martelli (1971).

Comments on the geographical distribution of *X. pachtaicum*

It is widely distributed throughout the Mediterranean Basin and in Central Asia. It has also been collected from California and Switzerland (Lamberti and Siddiqi, 1977), England (Flegg, 1968), and South Africa (Heyns, 1977).

XIPHINEMA BREVICOLLE Lordello *et* Da Costa, 1961 (Fig. 2 A-C; Table IV).

syn. *X. americanum apud* Carvalho, 1955 and 1962 (Heyns, 1974; Luc *et* Dalmasso, 1975; Lamberti *et* Loof, 1977).

X. saopaolense Khan *et* Ahmad, 1975.

Although the descriptions and illustrations of *X. brevicolle* given by Martelli and Lamberti (1967) and Heyns (1974) are satisfactory we redescribe in more detail in order to point to the differences existing with the related species. Our description is based on female specimens collected from the rhizosphere of grapevine at Tolosva, Hungary.

Body, when killed, coiled in an open C, cylindrical, tapering very gradually only toward the anterior extremity and bearing glandular structures in the lateral cords. Cuticle smooth, about 2 μm thick along the body except at the extremities where it is 3 μm thick anteriorly, just before the lip region, and 4 and 5 μm thick ventrally and dorsally respectively, immediately posterior to anus. Labial region 4-6 μm high, slightly expanded, widely arcuate on top, separated from the rest of the body by a shallow but well evident incisure. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle robust, 2 μm thick near the tip and 3 μm thick just above its junction with the typical *Xiphinema* odontophore. Guide sheath also typical of the

Table III - Morphometric characters of females of various populations of X.

Population: host and locality	n	L	a	b	c	c'	V	Odontostyle
		mm						µm
<i>Rubus</i> sp.; Modugno, Bari, Italy	10	1.8 (1.7-2.1)	61 (56-66)	6.5 (5.5-7.4)	66 (59-73)	1.6 (1.5-1.9)	56 (51-59)	79 (71-87)
Grapevine; Canosa, Bari, Italy	10	2 (1.7-2.1)	67 (60-74)	6.8 (6-7.8)	74 (67-84)	1.6 (1.4-1.8)	59 (56-61)	77 (74-85)
<i>Cistus</i> sp.; Manduria, Taranto, Italy	10	1.9 (1.7-2.1)	63 (57-70)	6.8 (5.4-8.2)	67 (58-72)	1.6 (1.4-1.8)	56 (54-59)	81 (68-87)
Host unknown; Elba Island, Italy	6	2 (1.8-2.2)	55 (50-58)	7.6 (6.5-8.6)	64 (54-73)	1.6 (1.5-1.8)	56 (54-59)	84 (78-93)
Grapevine; Crete, Greece	10	1.8 (1.6-2)	59 (54-67)	6.5 (5.3-7.3)	63 (50-70)	1.6 (1.4-2)	56 (53-58)	84 (81-90)
Walnut; Graziantep, Turkey	10	1.7 (1.5-1.8)	62 (54-66)	6.7 (5.9-9.7)	62 (55-70)	1.7 (1.5-1.9)	57 (55-60)	82 (76-86)
Grapevine; Borovopolje, Vis Island, Jugoslavia	10	1.9 (1.7-2.2)	63 (57-68)	6.1 (5.5-7.9)	65 (52-79)	1.7 (1.5-1.9)	56 (53-59)	85 (78-88)
Peach; Pomorie, Bulgaria	9	1.8 (1.7-2)	56 (44-64)	6.4 (5.5-8.5)	64 (57-75)	1.6 (1.3-1.8)	57 (54-60)	82 (78-87)
Peach; Pentekeli, Hungary	10	1.8 (1.6-1.9)	67 (59-74)	6.3 (5.7-6.9)	60 (52-66)	1.9 (1.7-2.2)	58 (57-59)	86 (82-90)
Citrus; Aït Melloul, Morocco	10	2 (1.8-2.2)	57 (51-63)	7 (5.5-8.2)	61 (56-69)	1.7 (1.4-2.1)	55 (54-57)	88 (85-91)
Grapevine; Murcia, Spain	6	1.6 (1.4-1.7)	54 (44-62)	6.8 (6-7.5)	55 (47-61)	1.6 (1.3-1.9)	54 (52-56)	81 (70-87)
Fig; Antibes, France	12	1.9 (1.6-2.1)	60 (51-69)	7 (5.8-9)	64 (51-85)	1.6 (1.5-2)	57 (53-59)	85 (73-89)
Grapevine; Bordeaux, France	9	1.7 (1.6-1.8)	58 (49-63)	7.6 (5.2-9.7)	57 (47-65)	1.6 (1.5-1.8)	57 (55-59)	86 (87-91)
Grapevine; Setubal Portugal	2	1.5-1.8	37-44	6.9	62-63	1.3-1.4	56-60	80-83
Pear; East Malling, England	3	1.7 (1.6-1.8)	60 (55-62)	5.8 (5.2-6.1)	57 (48-63)	1.8 (1.7-1.9)	58 (57-59)	80 (79-81)
<i>Laurus nobilis</i> ; Karschy, Uzbekistan, URSS	3	1.9 (1.8-2)	67 (64-72)	6.6 (5.9-8)	68 (61-75)	1.6 (1.5-1.7)	57 (56-58)	82 (79-85)
<i>Morus alba</i> , Ipayi Iola, Turkmenistan, URSS	4	1.8 (1.7-1.8)	64 (58-68)	7.1 (6.8-7.6)	62 (56-68)	1.7 (1.6-1.8)	56 (55-56)	79 (77-81)
Apple; Kfur Blum, Israel	6	1.8 (1.5-2)	48 (43-54)	7.3 (6.6-8.3)	61 (51-68)	1.4 (1.3-1.6)	55 (54-58)	83 (80-92)

pachtaicum.

Odontophore	Oral aperture to guiding ring	Tail	J	Body diameters					
				at lip region	at guiding ring	at base of oesophagus	at vulva	at anus	at?beginning of J
μm	μm	μm	μm	μm	μm	μm	μm	μm	μm
46 (40-48)	71 (65-74)	28 (23-31)	8 (6.5-10)	8 (7.5-8.5)	20 (19-21)	26 (23-29)	30 (27-35)	17 (16-18)	8 (6-8.5)
45 (42-49)	70 (66-74)	27 (24-32)	9 (7-11)	8 (7.5-9)	20 (18-22)	26 (24-27)	30 (25-34)	17 (15-19)	7 (6.5-8)
45 (40-48)	71 (54-78)	28 (25-33)	8 (7-9.5)	8 (7.5-9)	21 (18-23)	26 (22-29)	30 (26-33)	17 (15-20)	7 (6-8.5)
47 (44-51)	72 (59-80)	31 (27-38)	10 (9-12)	8 (8-9.5)	25 (21-28)	33 (31-35)	36 (34-38)	19 (17-22)	7 (6-8)
47 (43-53)	73 (67-77)	29 (24-37)	9 (7-10)	9 (8.5-10)	23 (20-27)	29 (25-33)	32 (27-36)	18 (16-20)	8 (7.5-9)
47 (42-50)	71 (66-78)	27 (25-32)	10 (8-11.5)	8 (7.5-9)	21 (19-27)	25 (24-27)	28 (25-32)	16 (14-17)	8 (7-9)
46 (43-49)	76 (63-82)	29 (25-35)	9 (8-10.5)	9 (8.5-9)	21 (20-23)	26 (25-28)	30 (29-33)	17 (16-17)	7 (7-8)
48 (40-52)	72 (58-78)	28 (24-34)	10 (6-12)	8 (8-10)	23 (20-26)	29 (25-34)	32 (28-38)	18 (15-20)	8 (6-10)
46 (43-48)	78 (73-80)	30 (26-34)	9 (6.5-11)	8.5 (8-9)	21 (20-23)	24 (22-25)	27 (24-29)	16 (14-18)	8 (6.5-8.5)
46 (44-49)	74 (69-78)	33 (30-35)	9 (6.5-10)	8 (8-8.5)	23 (20-28)	30 (26-35)	35 (32-41)	20 (16-25)	7.5 (6.5-9.5)
47 (44-52)	64 (51-71)	29 (27-33)	9 (8.5-10.5)	8 (7.5-9)	21 (19-26)	27 (22-35)	30 (25-36)	18 (15-21)	8 (7-9)
45 (37-48)	70 (59-74)	29 (25-38)	11 (8-12)	8 (8-9.5)	21 (19-25)	28 (24-32)	31 (25-38)	18 (16-21)	8 (5.5-10)
44 (41-48)	72 (56-85)	30 (27-34)	10 (8-10.5)	9 (8.5-9)	22 (20-23)	27 (26-29)	30 (27-34)	18 (17-19)	9 (8-10)
44-47	56-59	25-29	9-10	8-9	25-26	33-38	40-41	21-22	9
45 (45-46)	71 (71-72)	30 (29-32)	9 (8-9.5)	8 (8-9)	20 (20-21)	24 (23-25)	29 (28-30)	17 (16.5-17)	7 (6.5-8)
47 (46-48)	73 (71-74)	29 (26-30)	10 (8-11)	8 (8-9)	21 (20-22)	26 (25-28)	29 (27-31)	18 (17-18)	8 (7-9)
46 (45-47)	69 (64-72)	29 (29-31)	11 (9-12)	8 (8-9)	21 (20-23)	26 (25-26)	28 (27-30)	17 (16-19)	9 (7-11)
48 (44-52)	63 (53-72)	29 (27-35)	11 (8-12)						

S p e c i m e n s f l a t t e n e d

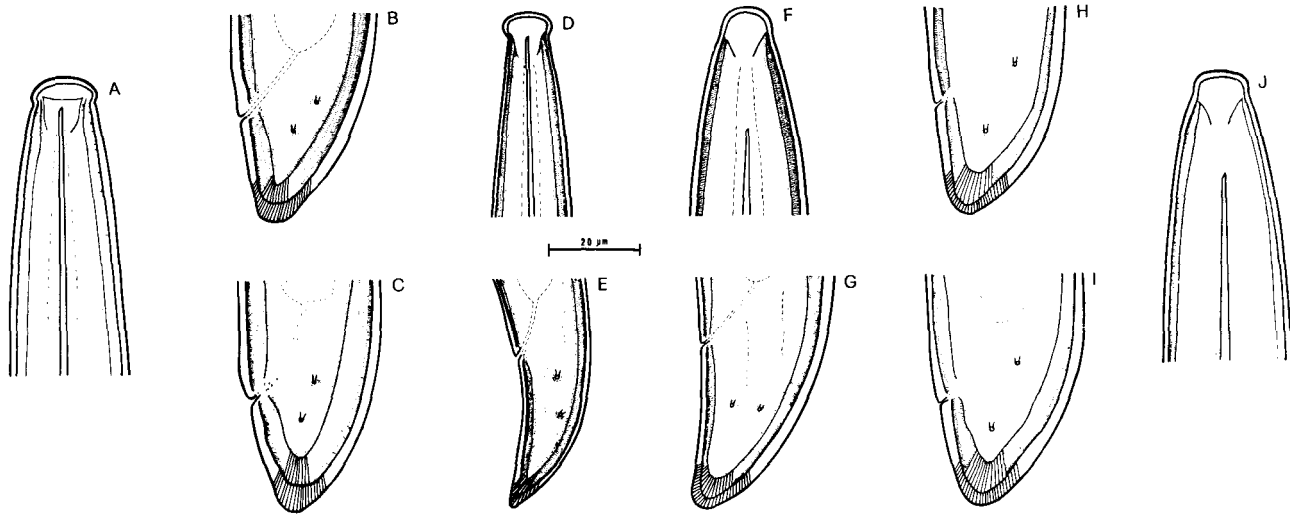


Fig. 2 - Anterior and posterior regions of females of *X. brevicolle* (A, B and C); of *X. opisthohystrum* (D and E); of *X. rivesi* (F and G); and of *X. guirani* (H-J).

Table IV - *Morphometric characters of females of three populations of X. brevicolle.*

Populations: host and locality	Hungary, Tolosa Grapevine	Czechoslovakia Vinicky; Grapevine	Poland, various localities in the South; Strawberry
n	10	4	14
L mm	2.1 (2-2.2)	2.1 (2-2.3)	2.4 (2.2-2.6)
a	44 (39-49)	57 (56-58)	52 (34-60)
b	7.2 (6.4-8.2)	6.4 (6.1-6.9)	7 (6.4-8.3)
c	78 (69-94)	85 (78-94)	86 (79-112)
c'	0.9 (0.8-1)	0.9 (0.8-1)	0.8 (0.9-1.1)
V	50 (49-52)	52 (51-53)	51 (49-52)
Odontostyle μm	93 (91-97)	93 (90-96)	93 (86-100)
Odontophore μm	57 (54-62)	53 (51-54)	55 (51-73)
Oral aperture to guiding ring μm	80 (77-83)	75 (74-76)	72 (64-77)
Tail μm	27 (25-30)	24 (22-27)	28 (21-32)
J μm	8 (6-10)	9 (8-11)	11 (8-13)
Body diam at lip region μm	13 (12-14)	12 (12-13)	13 (12-14)
Body diam at guiding ring μm	30 (28-32)	28 (28-29)	32 (28-43)
Body diam at base of oesophagus μm	38 (36-41)	34 (31-36)	42 (31-52)
Body diam at vulva μm	47 (44-51)	37 (34-40)	49 (40-68)
Body diam at anus μm	29 (28-31)	26 (24-27)	31 (27-40)
Body diam at beginning of J μm	15 (13-18)	16 (15-17)	17 (15-21)

genus with the basal ring about 5-8 μm distant from the anterior one. Oesophagus dorylaimoid with posterior enlarged part occupying between 1/3 and 1/4 of its total length. The muscular oesophageal bulb, measuring 80-90 μm long and 20-25 μm wide, shows clearly only one nucleus, situated anteriorly in the dorsal position. Oesophagus intestinal valve flattened, of indefinite shape. Vulva almost equatorial with lips not raised, in line with the axis of the body. The vagina occupying 1/3 of corresponding body diameter; gonads opposed, reflexed without spermatheca or « Z » differentiation evident. Prerectum distinct, 100-120 μm long; rectum as long as 1/2 of the body diameter at anus. Tail short conical with rounded terminus. On the tail there are two lateral pores.

This and the other two central European populations of *X. brevicolle* (Tab. IV) do not differ morphometrically from the type population from Brazil and from Mediterranean population reported by Martelli and Lamberti (1967). Males of *X. brevicolle* have been described by Cohn (1969), Heyns (1974) and Bajaj and Jairajpuri (1978).

Amended differential diagnosis

Xiphinema brevicolle is similar to *X. americanum*, *X. pachtaicum* and *X. opisthohystrum*. It differs from *X. americanum* in having the lip region separated from the rest of the body by an incisure (a depression in *X. americanum*), a larger and more robust body ($c = 78-86$ viz. 49-60), a longer odontostyle (93 viz. 67-80 μm) and a shorter tail and a lower c' (0.8-1.1 viz. 1.5-2); from *X. pachtaicum* because of its less expanded lip region, much more robust body ($a = 40-60$ viz. 54-70), longer odontostyle (93 viz. 79-85 μm), anterior position of vulva (50-53 viz. 56-60%), and a less pointed tail. It also differs from *X. opisthohystrum* in having less expanded lip region, shorter odontostyle (93 viz. 62-73 μm), higher c value (78-86 viz. 46-74), anterior vulva (50-53 viz. 56-61), and broader and less pointed tail.

Comments on the geographical distribution of *X. brevicolle*

Although it is a widespread species, found under different environmental situations, *X. brevicolle* seems to be less common than previously thought. It is certainly present in South America, Central and Southern Europe and Israel. The reports of Jairajpuri and Siddiqi (1963) from India and Heyns (1974) from South Africa need confirmation. The first authors do not give any measurements of their specimens. Heyns was probably handling a mixture of two species, namely *X. brevicolle* and what is herein described as *X. diffusum* n. sp., since the deviations of some characters (lengths of body and odontostyle) are too wide to be considered intraspecific and the illustrations of the anterior extremity of the body resemble *X. diffusum* rather than *X. brevicolle*. Finally, it seems from the male description of Bajaj and Jairajpuri (1978) that in India they are dealing with the true *X. brevicolle* although the illustration of the labial region is not typical of the species.

XIPHINEMA OPISTHOHYSTRUM Siddiqi, 1961 (Fig. 2 D and E).

This description is based on 2 paratype females collected by M. R. Siddiqi at Aligarh, Northern India, from around the roots of *Aegle marmelos* Correa. $L = 1.8-1.85$ mm; $a = 56-63$; $b = 7.4-7.5$;

c = 50-62; c' = 1.9-2; V = 56-59; odontostyle = 64-68 μm ; odontophore = 38-34 μm ; oral aperture to guiding ring = 48-51 μm ; tail = 30-36 μm ; J = 6-7 μm ; body diameter at lip region = 9 μm ; body diameter at guiding ring = 17 μm ; body diameter at base of oesophagus = 24-25 μm ; body diameter at vulva = 28-33 μm ; body diameter at anus = 16 μm ; body diameter at beginning of J = 6-7.5 μm .

Body, when killed, coiled in single spiral; tapering very gradually toward the extremities. Cuticle smooth and thin, 1-1.5 μm thick along the body, except at the extremities where it is 1.5-2 μm thick just behind the lip region, and 2 μm both ventrally and dorsally immediately posterior to anus. Labial region well expanded, of elliptical shape, separated from the rest of the body by a narrow depression; amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle delicate, about 1 μm diameter with very weakly sclerotized odontophore; guide sheath typical of the genus with the basal ring 3-4 μm distant from the anterior one. Oesophagus dorylaimoid with posterior enlarged part occupying 1/4 of the total length. The muscular oesophageal bulb, measures 60 \times 10-13 μm and contains three nuclei. Oesophageal intestinal valve inconspicuous. Vulva slightly posterior with respect to the centre of the body, with lips not raised. The vagina occupies 1/2 of corresponding body diameter; gonads opposed reflexed, without any particular feature. Prerectum indistinct, 30-35 μm long; rectum as long as the body diameter at anus. Tail conical, elongated with almost pointed terminus. On the tail there are two caudal pores.

One male of *X. opisthohystrum* has recently been described by Bajaj and Jairajpuri (1978).

Amended differential diagnosis

Xiphinema opisthohystrum differs from *X. americanum* in having a much more expanded labial region, a posterior vulva and a more elongated tail; from *X. pachtaicum* because of its shorter odontostyle and jalin portion of the tail and its more elongated tail; and from *X. brevicolle* in its more slender body, posteriorly located vulva, shorter odontostyle and higher c' value.

To our knowledge, North India is the only place where *X. opisthohystrum* has been found.

XIPHINEMA VARIABLE Heyns, 1966

In table V are given the measurements of specimens of *X. variable* collected by G. C. Martin in Northern (now Zambia) and Southern Rhodesia (now Rhodesia). These morphometrics fit well with those of populations described by Heyns (1966), although no males were present in the Rhodesian populations.

Table V - *Morphometric characters of females of two populations of X. variable.*

Populations: locality and host	North Rhodesia (Now Zambia), Zimba; Tobacco	South Rhodesia (Now Rhodesia) Chipinga; Tea
n	3	4
L mm	2.3 (2.2-2.4)	2.2 (2.1-2.3)
a	85 (83-88)	78 (71-84)
b	8.6 (8.2-9.2)	8 (7.5-9.5)
c	49 (44-55)	52 (46-58)
c'	2.7 (2.4-2.9)	2 (1.9-2.4)
V	51 (49-53)	53 (52-54)
Odontostyle μm	63 (62-65)	68 (67-70)
Odontophore μm	44 (42-46)	41 (39-44)
Oral aperture to guiding ring μm	58 (56-60)	56 (52-58)
Tail μm	47 (40-51)	41 (37-45)
J μm	8 (6-9)	9 (7.5-9.5)
Body diam at lip region μm	9 (9-9.5)	9.5 (9-9.5)
Body diam at guiding ring μm	19 (18-20)	20 (19-20)
Body diam at base of oesophagus μm	24 (23-26)	25 (23-26)
Body diam at vulva μm	27 (25-28)	28 (24-32)
Body diam at anus μm	17 (16-18)	20 (19-20.5)
Body diam at beginning of J μm	7 (6.5-7.5)	8 (7-9)

Amended differential diagnosis

Xiphinema variable resembles two other species in the genus: *X. italiae* Meyl, 1953, and *X. opisthohysterum*. It differs from the first in the shorter odontostyle (60-70 viz. over 85 μm of the *X. italiae*) and posterior vulva (51 viz. 43-49), and from the second in the anterior position of the vulva (51 viz. 56-59) and the longer body and tail.

XIPHINEMA RIVESI Dalmasso, 1969 (Fig. 2 F and G, Table VI).

This description is based on specimens collected at Eureka, Kansas, from walnut, oak and hackberry soil.

Body, assuming the posture of a single spiral when killed, cylindrical, tapering very gradually toward the extremities and more abruptly in the proximity of the tail tip and of the lip region. Cuticle smooth, 2 μm thick along body, more thickened at the posterior extremity with maximum width of 5-6 μm dorsally on tail. Glandular structures 8-10 μm apart are present in the lateral cords. Labial region rounded, continuous with the rest of the body. Amphidial pouches stirrup-shaped with slit-like aperture. Odontophore narrow, 1.5-2 μm diameter, inserted in an inconspicuous odontophore. Guide sheath very short with the two guide rings only 3-6 μm apart. The basal bulb of the oesophagus occupies 1/4 of the total oesophageal length and measures 70-80 μm long and 16-20 μm wide; two or three

Table VI - *Morphometric characters of females of two populations of X. rivesi.*

Populations: locality and host	USA, Kansas, Eureka; Walnut, oak and hackberry	USA, Nebraska, Victoria Springs; Cottonwood
n	8	3
L mm	1.7 (1.6-1.9)	1.9 (1.9-2)
a	41 (37-44)	45 (41-50)
b	6.4 (6.1-6.9)	6.6 (6.5-6.9)
c	51 (48-57)	59 (58-61)
c'	1.4 (1.2-1.6)	1.3
V	52 (50-53)	52
Odontostyle μm	84 (80-92)	85 (83-90)
Odontophore μm	51 (48-55)	48 (44-50)
Oral aperture to guiding ring μm	74 (70-78)	74 (73-77)
Tail μm	34 (32-36)	33
J μm	7 (6-8)	6.5 (6-7.5)
Body diam at lip region μm	10 (9.5-10)	10
Body diam at guiding ring μm	28 (27-31)	27 (26-27)
Body diam at base of oesophagus μm	37 (30-40)	37 (34-39)
Body diam at vulva μm	42 (37-47)	43 (39-46)
Body diam at anus μm	25 (22-26)	24 (23-25)
Body diam at beginning of J μm	11 (9.5-11.5)	12 (11-14)

nuclei are evident. Oesophagus-intestinal valve large, heart-shaped. Vulva about equatorial, vagina occupying 1/2 of corresponding body diameter. Gonads opposed, reflexed, with short uteri almost or as long as body width at vulva, and without spermatheca or any « Z » differentiation. The distal end of ovary returns almost to the vulva level. Prerectum 100-120 μm long; rectum as long as 2/3 of the body diameter at anus. Tail conoid, dorsally convex with rounded end. Two caudal pores have been observed.

American (Kansas) populations of *X. rivesi*, and further specimens found at Victoria Springs, Nebraska, differ from the types only in the shorter odontostyle (80-90 viz. 90-101 μm) (Dalmasso, 1969). These, to our knowledge, are the first extra-European records for *X. rivesi* which previously has been reported only from France (Dalmasso, 1969) and Spain (Arias and Navacerrada, 1973).

Amended differential diagnosis

Xiphinema rivesi is another species which might fall within *X. americanum sensu lato*, but clearly differs from all the related species in having a lip region continuous with the rest of the body.

XIPHINEMA INAEQUALE (Khan *et* Ahmad, 1975) Khan *et* Ahmad, 1977 (Fig. 5 G and H).
syn. *X. neoamericanum* Khan *et* Ahmad, 1975.

It was described in 1975 as *X. neoamericanum* n. sp. by Khan *et* Ahmad, unaware that a species had been described under the same name in 1973 by Saxena *et al.* Later the authors renamed the species *X. inaequale* (1977). Luc and Dalmasso (1975) considered this species invalid and that the specimens described by Khan *et* Ahmad belong to *X. americanum sensu lato*. Lamberti *et* Loof (1977) examined a paratype specimen of *X. inaequale* and suggested that it could be identical with *X. brevicolle*.

Having studied numerous populations of *X. brevicolle* and re-examined the paratype female of *X. inaequale*, we believe that there is no relation at all between the two species and therefore propose to revert to *X. inaequale* as a valid species.

Amended differential diagnosis

Xiphinema inaequale is similar to *X. americanum*, *X. rivesi* and *X. neoamericanum* Saxena, Chhabra and Joshi, 1973. It differs from *X. americanum* in the continuous lip region, longer odontostyle and posterior basal guiding ring; from *X. rivesi* because of the shorter odontophore, and more pointed tail; and from *X. neoamericanum* in the shorter odontostyle and much higher c value.

XIPHINEMA GUIRANI Luc *et* Williams, 1978 (Fig. 2 H-J).

According to the original description this species does not fall within the *X. americanum* group. However, a population provided by M. Luc and collected in the rhizosphere of vanilla plants at Antalaha, in Madagascar, a locality where a population reported by Luc and Williams (1978) was also collected, was found to have exactly the same biometrical characters of *X. guirani*, with the exception of a shorter body and a more pointed tail, similar to that of *X. brevicolle* (Fig. 2 C). We consider these to be intraspecific variations within *X. guirani*. The morphometrical characters of our population of *X. guirani* are (n = 11 ♀ ♀): L = 1.9 (1.6-2) mm; a = 46 (41-51); b = 5.9 (5-6.5); c = 87 (67-106); c' = 0.8 (0.7-0.9); V = 54 (52-58); odontostyle = 106 (92-112) μm ; odontophore = 55 (52-56) μm ; oral aperture to guiding ring = 86 (73-90) μm ; tail = 22 (18-27) μm ; J = 9.5 (8-10.5) μm ; body diam. at lip region = 11 (10-12) μm ; body diam. at guiding ring = 30 (27-32) μm ; body diam. at base of oesophagus = 36 (33-41) μm ; body diam. at vulva = 40 (35-48) μm ; body diam. at anus = 26 (23-31) μm ; body diam. at beginning of J = 17 (14-19) μm .

Amended differential diagnosis

Xiphinema guirani is similar to *X. brevicolle*, *X. arcum* Khan, 1964 and *X. macrostylum* Esser, 1966. It differs from *X. brevicolle* in the less expanded and lower lip region, posterior vulva and longer odontostyle; from *X. arcum* because of its posterior vulva; and from *X. macrostylum* in the posterior vulva and shorter odontostyle.

XIPHINEMA OXYCAUDATUM n. sp. (Fig. 3 A and B).

Paratypes (3 females): L = 1.6 (1.5-1.7) mm; a = 47 (45-51); b = 5.5 (5.1-5.9); c = 51 (48-54); c' = 1.6 (1.3-1.7); V = 52.5 (51-54); odontostyle = 82 (78-84) μ m; odontophore = 45 (43-46) μ m; oral aperture to guiding ring = 71 (66-75) μ m; tail = 33 (27-35) μ m; J = 9 (7.5-11) μ m; body diam. at lip region = 10 (9-10) μ m; body diam. at guiding ring = 24 (22-26) μ m; body diam. at base of oesophagus = 31 (30-34) μ m; body diam. at vulva = 34 (32-37) μ m; body diam. at anus = 20 (19-21) μ m; body diam. at beginning of J = 9 (7-10) μ m.

Holotype female: L = 1.6 mm; a = 51; b = 5.8; c = 57; c' = 1.4; V = 52.5; odontostyle = 85 μ m; odontophore = 45 μ m; oral aperture to guiding ring = 75 μ m; tail = 29 μ m; J = 10 μ m; body diam. at lip region = 10 μ m; body diam. at guiding ring = 25 μ m; body diam. at base of oesophagus = 30 μ m; body diam. at vulva = 32 μ m; body diam. at anus = 20 μ m; body diam. at beginning of J = 10 μ m.

Description

Body ventrally arcuate, when killed, tapering very gradually toward the extremities and bearing glandular structures in the lateral cords. Cuticle very finely striated, 1.5 μ m thick along the body except at the posterior extremity where it is 4-5 μ m thick both dorsally and ventrally, immediately posterior to anus. Labial region widely rounded separated by a constriction from the rest of the body. Amphidial pouches stirrup-shaped, with slit-like aperture. Odontostyle robust, 2 μ m thick along its length. Odontophore and guiding sheath typical of the genus, the basal ring is 12 μ m distant from the anterior one. The oesophageal basal bulb occupies 1/4 of the oesophagus total length. Muscular bulb 60 μ m long and 15 μ m wide with only a single nucleus evident, situated ventrally in the anterior position. Oesophagus-intestinal valve large, heart-shaped. Vulva equatorial and vagina occupying almost 1/3 of the corresponding body diameter. Gonads opposed, reflexed without any clear « Z » differentiation. Prerectum over 200 μ m long, and rectum a little longer than body diameter at anus. Tail, elongated, conoid, dorsally convex with pointed terminus, bearing two caudal pores.

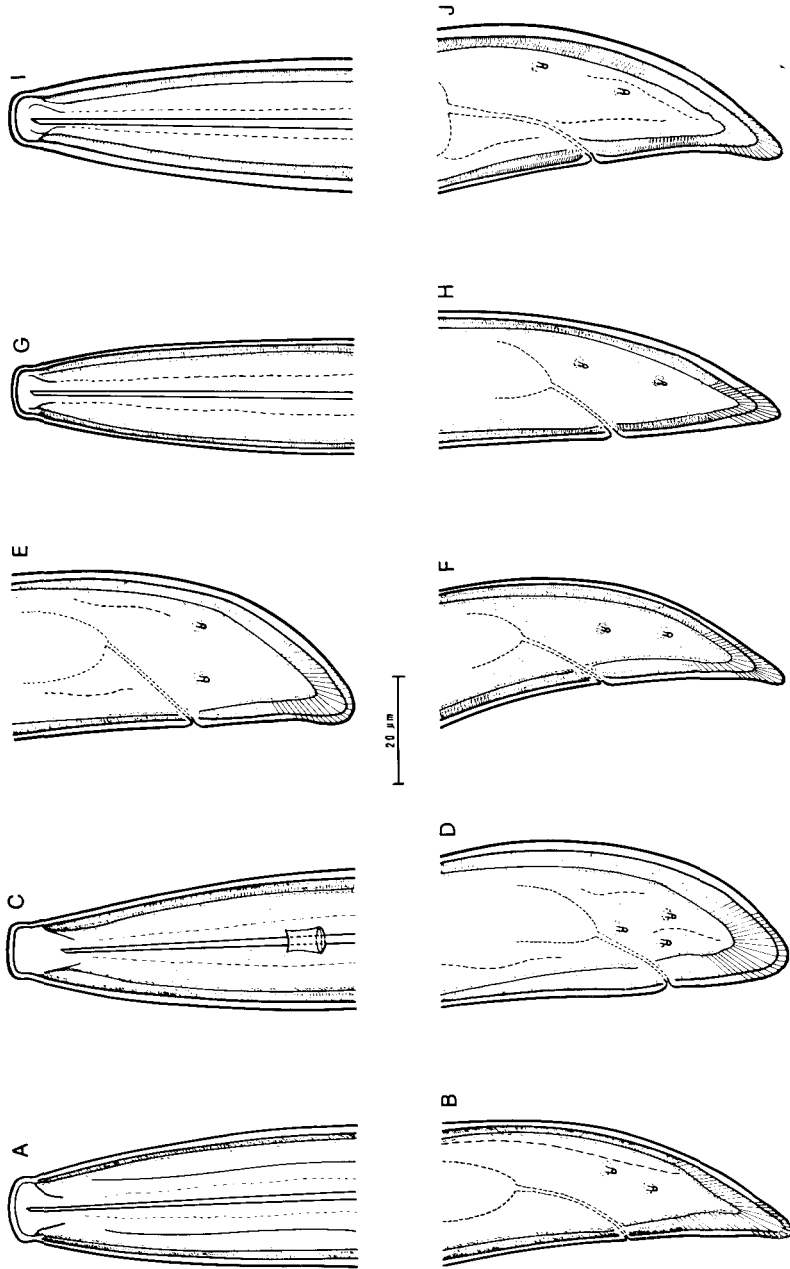


Fig. 3 - Anterior and posterior regions of females of *X. oxycaudatum* n. sp. (A and B); of *X. diffusum* n. sp. (C-E); of *X. tenuicutis* n. sp. (F-H); and of *X. laevistriatum* n. sp. (I and J).

Male: not found.

Type material (provided by M. Luc): holotype and one paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy, 2 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France.

Type habitat and locality: rhizosphere of oil palm, *Elaeis guineensis* Jacq. at Koko, Ibadan, Nigeria.

Differential diagnosis

Xiphinema oxycaudatum n. sp. is similar to *X. americanum*, *X. variabile*, *X. lambertii* Bajaj et Jairajpuri, 1976, and *X. neolongatum* Bajaj and Jairajpuri, 1976. It differs from *X. americanum* in having a more expanded lip region, more pointed tail, longer odontostyle and lower c' value; from *X. variabile* because of the longer odontostyle and shorter tail; from *X. lambertii* because of the more rounded lip region, lower value of c' and longer odontostyle; and from *X. neolongatum* because of the more rounded lip region, less pointed tail, anterior vulva and shorter odontostyle.

XIPHINEMA DIFFUSUM n. sp. (Fig. 3 C-E; Table VII).

Holotype female: L = 1.8 mm; a = 46; b = 6.7; c = 67; c' = 1; V = 49; odontostyle = 88 μ m; odontophore = 46 μ m; oral aperture to guiding ring = 64 μ m; tail = 27 μ m; J = 14 μ m; body diam. at lip region = 12 μ m; body diam. at guiding ring = 27 μ m; body diam. at base of oesophagus = 36 μ m; body diam. at vulva = 40 μ m; body diam. at anus = 27 μ m; body diam. at beginning of J = 20 μ m.

Description

Habitus as C when killed. Body tapering very gradually toward the anterior extremity and more abruptly in the posterior region. Cuticle smooth, 2 μ m thick along body but more thickened at the extremities where it is 3 μ m thick just behind the lip region and 6 μ m

ventrally and 8 μm dorsally, immediately posterior to anus. Labial region 4 μm high, flat on top, separated from the body by a shallow incisure. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle robust, 2 μm diameter along its length with odontophore typical of the genus, although little sclerotized. Guiding sheath also typical of the genus with the posterior ring 17 μm distant from the anterior one. The oesophageal basal bulb occupies 1/4 of the oesophagus total length and is 70 μm long and 22 μm wide. Oesophagus-intestinal valve heart-shaped. Vulva in median position, vagina occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed without any « Z » differentiation. Prerectum 85 μm long; rectum as long as body diameter at anus. Tail conoid, dorsally convex, with rounded terminus, bearing two acaudal pores.

Male: not found.

Type material (provided by M. Luc): holotype and 7 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 10 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France.

Type habitat and locality: rhizosphere of *Pelargonium* sp. at Piton St. Leu, La Reunion, Africa.

Differential diagnosis

X. diffusum n. sp. is similar to *X. brevicolle* and to *X. oxycaudatum*. It differs from the former in its smaller size, less expanded lip region, shorter odontostyle and more rounded tail and from the latter because of its more rounded tail and lower c' value.

Comments on the geographical distribution of *X. diffusum*

It seems to be a widely distributed species especially on the African Continent. Populations have been studied originating from Jamaica, Florida, U.S.A. and Sri Lanka (Table VII). In the two populations from Africa, and those from Sri Lanka and Jamaica, the adult indi-

Table VII - *Morphometric characters of females of various populations of X.*

Populations: locality and host	La Reunion, Madagascar, Piton St. Leu; <i>Pelargonium</i> sp. paratypes	Nyasaland (now Malawi), Zomba Expr St; <i>Coffea arabica</i>	Nyasaland (now Malawi), Mlanje; <i>Citrus</i> sp.	Gambia, Cape St Mary; <i>Citrus</i> sp.
n	10	10	6	6
L mm	1.7 (1.6-1.8)	1.7 (1.6-1.8)	1.5 (1.4-1.7)	1.7 (1.6-1.8)
a	47 (46-51)	37 (32-41)	42 (37-45)	39 (36-41)
b	6.9 (5.3-8.9)	6.3 (4.9-7.1)	6.2 (5.8-6.6)	6.3 (5.8-6.7)
c	72 (63-84)	69 (56-89)	60 (48-76)	69 (60-86)
c'	0.9 (0.8-1.1)	0.9 (0.7-1.1)	1.1 (0.9-1.2)	0.9 (0.8-1.1)
V	50 (47-52)	53 (51-55)	52 (50-54)	51 (49-52)
Odontostyle μm	87 (84-89)	87 (73-95)	85 (82-88)	84 (81-87)
Odontophore μm	50 (48-51)	53 (49-57)	48 (44-51)	49 (46-52)
Oral aperture to guiding ring μm	62 (60-64)	70 (65-77)	70 (69-74)	63 (60-66)
Tail μm	24 (21-28)	25 (18-29)	26 (19-33)	25 (23-29)
J μm	12 (10-14)	10 (8.5-12)	9 (6-10)	12 (11-14)
Body diam at lip region μm	11 (10-12)	12 (11-13)	11 (11-12)	12 (11.5-12)
Body diam at guiding ring μm	26 (26-27)	29 (26-37)	28 (27-30)	29 (27-30)
Body diam at base of oesophagus μm	33 (31-35)	38 (35-49)	33 (29-39)	39 (37-41)
Body diam at vulva μm	36 (33-38)	45 (39-54)	37 (34-44)	43 (41-47)
Body diam at anus μm	25 (23-28)	28 (23-30)	24 (20-28)	27 (25-30)
Body diam at beginning of J μm	17 (15-20)	16 (14-18)	13 (10-15)	18 (17-20)

diffusum n. sp.

South Africa, Trans., Nelspruit; host unknown	Ivory Coast, Lamto; host unknown	Ivory Coast, Abidjan; <i>Citrus</i> sp.	Sri Lanka, Dimbula; Grasses	USA, Florida, Key West; <i>Cocos nucifera</i>	Jamaica, Cayman Brac; Bread tree
8	4	7	5	10	10
1.8 (1.6-1.9)	1.7 (1.6-1.8)	1.5 (1.4-1.7)	1.5 (1.4-1.6)	1.7 (1.6-1.8)	1.5 (1.3-1.7)
34 (30-38)	42 (37-46)	45 (43-48)	36 (32-38)	45 (41-57)	43 (40-45)
5.7 (4.2-7.5)	6.4 (5.5-7.1)	6.3 (5.8-6.6)	6.2 (5.4-7.2)	5.8 (4.9-6.2)	5.8 (5.1-6.6)
75 (52-89)	67 (57-77)	65 (58-77)	58 (49-70)	74 (69-80)	60 (53-69)
0.8 (0.7-0.9)	0.9 (0.8-0.9)	1 (0.8-1.1)	1 (0.9-1.1)	0.9 (0.8-1)	1.1 (1-1.1)
52 (49-55)	53 (52-55)	51 (49-53)	51 (49-53)	53 (41-54)	54 (52-57)
87 (84-91)	84 (81-89)	83 (81-85)	83 (77-87)	87 (83-91)	87 (71-99)
56 (50-76)	51 (49-53)	47 (44-51)	49 (44-51)	45 (39-48)	49 (43-66)
76 (62-95)	71 (65-74)	69 (67-72)	77 (73-83)	68 (61-74)	76 (70-88)
24 (20-32)	26 (22-29)	24 (21-26)	26 (22-30)	23 (21-24)	24 (21-27)
11 (9-13)	11 (9-13)	10 (8-12)	9 (8-9.5)	6 (5-8.5)	6 (5-7)
	12 (11.5-12)	12 (11-13)	12 (11-13)	11 (10-11)	10 (9.5-10)
Specimens	29 (28-30)	27 (26-28)	31 (29-34)	26 (23-29)	25 (23-28)
flattened	34 (33-36)	31 (29-32)	35 (32-38)	34 (28-39)	29 (26-31)
	41 (39-46)	35 (31-37)	42 (38-44)	38 (29-41)	34 (31-38)
	29 (26-31)	24 (22-27)	25 (23-29)	24 (22-26)	22 (20-25)
	17 (16-19)	15 (13-20)	14 (13-20)	13 (12-17)	10 (8-14)

viduals are smaller and the tail shape differs (Fig. 3 E) with respect to the type specimens.

XIPHINEMA INCOGNITUM n. sp. (Fig. 4; Table VIII).

Syn. *Xiphinema americanum apud* Southey, 1973.

Holotype female: L = 1.8 mm; a = 46; b = 6.3; c = 60; c' = 1.1; V = 49; odontostyle = 83 μ m; odontophore = 49 μ m; oral aperture to guiding ring = 68 μ m; tail = 30 μ m; J = 9 μ m; body diam. at lip region = 11 μ m; body diam. at guiding ring = 25 μ m; body diam. at base of oesophagus = 36 μ m; body diam. at vulva = 40 μ m; body diam. at anus = 28 μ m; body diam. at beginning of J = 19 μ m.

Allotype male: L = 1.6 mm; a = 47; b = 5.7; c = 63; c' = 1; odontostyle = 86 μ m; odontophore = 52 μ m; oral aperture to guiding ring = 68 μ m; spicules = 51 μ m; tail = 26 μ m; J = 8 μ m; body diam. at lip region = 11.5 μ m; body diam. at guiding ring = 28 μ m; body diam. at base of oesophagus = 33 μ m; body diam. at middle body = 35 μ m; body diam. at anus = 26 μ m; body diam. at beginning of J = 13 μ m.

Description

Habitus an open spiral when killed. Body tapers very gradually toward the extremities. Cuticle very finely striated, 2-3 μ m thick along body, but thicker at the posterior extremity where it is 4 μ m thick ventrally and 6 μ m dorsally, just behind the anus. Labial region hemielliptical, 5 μ m high, very slightly expanded, separated from rest of the body by a shallow depression. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle robust, 2 μ m thick along its length, with odontophore typical of the genus. Only the posterior ring of the guiding sheath is clearly visible. The oesophagus basal bulb occupies about 1/4 of the total length of the oesophagus and is 67 μ m long and 16 μ m wide. Oesophagus-intestinal valve hemispherical. Vulva in median position with vagina occupying 1/3 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any «Z» differentiation visible. Prerectum indistinct, 29 μ m long, rectum as long as 1/2 of body diameter at anus. Tail conoid slightly elongated, dorsally convex, bearing two caudal pores.

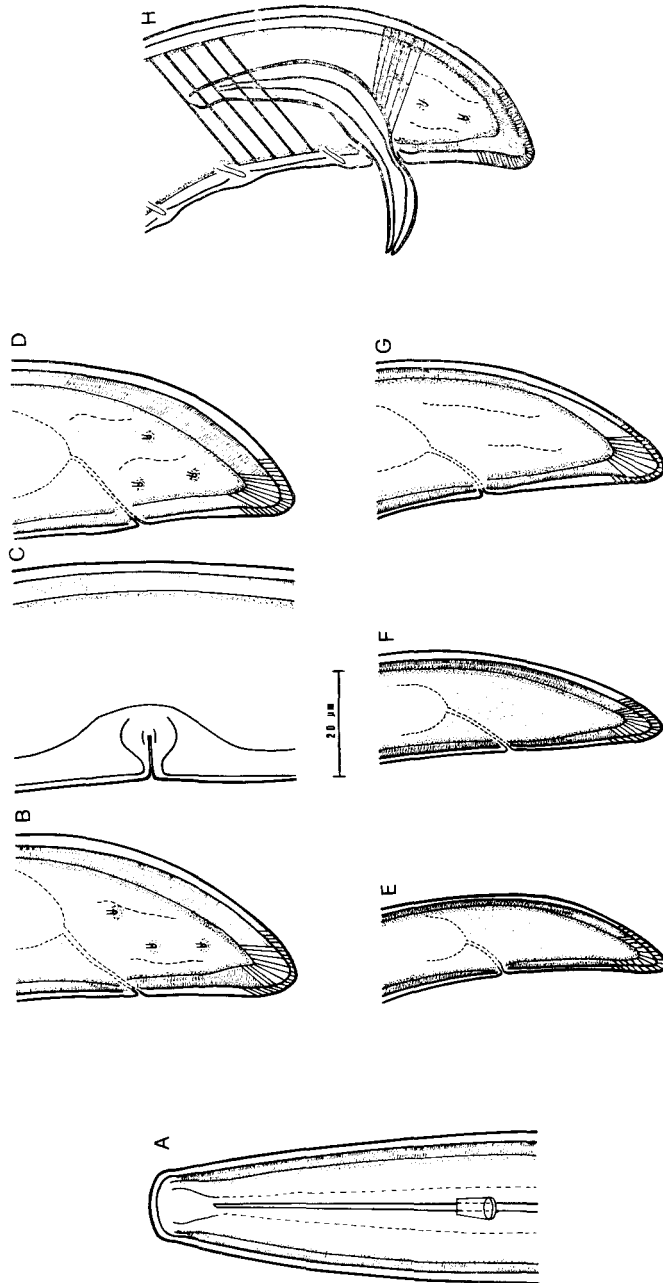


Fig. 4 - *X. incognitum* n. sp.: A, B and D, anterior and posterior regions of female; C, vulvar region; E, F and G, tails of II, III and IV juvenile stages respectively; H, posterior region of male.

Table VIII - *Morphometric characters of paratypes of X. incognitum n. sp.*

Stages	♀	L ₂	L ₃	L ₄
n	20	10	1	10
L mm	1.9 (1.7-2.1)	1 (0.8-1.1)	1.2	1.5 (1.5-1.6)
a	45 (41-49)	37 (33-44)	44	42 (39-47)
b	6.3 (5.2-7.9)	4.6 (4.3-5.1)	5.4	5.8 (5.2-6.4)
c	62 (47-75)	35 (25-43)	36	49 (45-55)
c'	1.1 (0.9-1.3)	1.7 (1.4-1.9)	1.8	1.3 (1.1-1.4)
V	51 (48-53)	—	—	—
Odontostyle µm	87 (82-93)	54 (45-59)	65	69 (64-72)
Odontophore µm	52 (46-56)	37 (33-41)	43	44 (40-48)
Replacement odontostyle µm	—	65 (55-70)	73	85 (81-89)
Oral aperture to guiding ring µm	72 (67-78)	45 (34-58)	55	59 (54-70)
Tail µm	30 (25-38)	29 (25-33)	35	31 (28-33)
J µm	10 (8.5-12.5)	7 (5-8)	5.5	10 (9-14)
Body diam at lip region µm	12 (11-13)	9 (8.5-9.5)	10	10 (10-11)
Body diam at guiding ring µm	28 (26-31)	20 (17-22)	23	24 (23-26)
Body diam at base of oesophagus µm	37 (34-42)	26 (22-28)	27	33 (30-36)
Body diam at vulva or middle body µm	42 (36-45)	30 (23-31)	28	36 (32-38)
Body diam at anus µm	28 (24-33)	17 (15-20)	20	25 (23-26)
Body diam at beginning of J µm	15 (12-18)	8 (6.5-9)	7.5	12 (11-14)

Male: the only male found is smaller than the female and has a body widely arcuate, coiled at the posterior extremity. The adanal pair of supplements is 5 µm anterior to anus and is preceded by 9 ventromedian supplements.

Juveniles: the II, III and IV larval stages are morphologically similar to adult females, differing mainly in the smaller body, shorter odontostyle and longer tail. The 1st juvenile stage has not been found.

Type material (provided by J. F. Southey): holotype, allotype, 12 paratype females and juveniles in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari Italy; 3 paratype females and 3 juveniles, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; 3 paratype females, Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.; and 2 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France.

Type habitat and locality

Unknown. The specimens were provided by J. F. Southey, Plant Pathology Laboratory, Harpenden, Herts, England, who has found them associated with various bonsai trees imported from Japan.

Differential diagnosis

Xiphinema incognitum n. sp. has many similarities to *X. diffusum* from which differs in having a finely striated cuticle (smooth in *X. diffusum*) a less expanded lip region and a more elongated tail.

XIPHINEMA LAEVISTRIATUM sp. n. (Fig. 3 I and J).

Paratypes (6 females): L = 1.6 (1.4-1.8) mm; a = 49 (43-56); b = 7 (5.9-8.5); c = 49 (45-56); c' = 1.5 (1.4-1.6); V = 51 (47-53); odontostyle = 79 (76-84) μm ; odontophore = 41 (35-45) μm ; oral aperture to guiding ring = 57 (54-61) μm ; tail = 34 (29-36) μm ; J = 12 (11-13) μm ; body diam. at lip region = 10 (9-11) μm ; body diam. at guiding ring = 25 (24-28) μm ; body diam. at base of oesophagus = 32 (29-34) μm ; body diam. at vulva = 34 (31-40) μm ; body diam. at anus = 22 (20-24) μm ; body diam. at beginning of J = 11 (10.5-11.5) μm .

Holotype female: L = 1.7 mm; a = 50; b = 6; c = 51; c' = 1.5; V = 53; odontostyle = 79 μm ; odontophore = 44 μm ; oral aperture to guiding ring = 57 μm ; tail = 33 μm ; J = 12 μm ; body diam. at lip region = 11.5 μm ; body diam. at guiding ring = 25 μm ; body diam. at base of oesophagus = 31 μm ; body diam. at vulva = 33 μm ; body diam. at anus = 22 μm ; body diam. at beginning of J = 12 μm .

Description

Habitus a single spiral or closed C when killed. Body tapers gradually toward the extremities. Cuticle very finely striated, 2 μm thick along body but thicker, 4 μm ventrally and 5 μm dorsally, just behind the anus. Labial region 3-4 μm high; continuous with the rest of the body. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle robust, 2 μm diameter along its length; odontophore little

sclerotized. Guiding sheath typical of the genus with the two rings 17 μm apart. The oesophagus basal bulb is 1/3 to 1/4 of the oesophagus total length and measures 65 μm long and 20 μm wide. Oesophagus intestinal valve triangular. Vulva in median position occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed without any special « Z » structure. Prerectum indistinct about 20 μm long; rectum as long as 2/3 of body diameter at anus. Tail conoid, elongated, dorsally convex and slightly concave ventrally, bearing two caudal pores.

Male: not found.

Type material (provided by A. C. Tarjan): holotype and 3 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 3 paratype females, Department of Entomology and Nematology Collection, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Around citrus and weed roots at Indian Town, Florida, U.S.A.

Differential diagnosis

Xiphinema laevistriatum n. sp. resembles to *X. americanum* and *X. rivesi*. However, it differs from the former in having the lip region continuous with the rest of the body, longer odontostyle and lower c' value and from *X. rivesi* because of its anteriorly situated guiding sheath, more elongated tail and longer J.

XIPHINEMA TENUICUTIS n. sp. (Fig. 3 F-H).

Paratypes (5 females): L = 1.8 (1.6-1.9) mm; a = 46 (40-53); b = 7.3 (6-8); c = 61 (58-65); c' = 1.5 (1.4-1.7); V = 51 (47-52); odontostyle = 76 (73-80) μm ; odontophore = 45 (38-46) μm ; oral aperture to guiding ring = 60 (55-64) μm ; tail = 29 (26-32) μm ; J = 8 (6.5-10) μm ; body diam. at lip region = 9 (9-10) μm ; body diam. at guiding ring = 23 (22-27) μm ; body diam. at base of oesophagus = 33 (31-35) μm ; body diam. at vulva = 38 (33-42) μm ; body diam. at anus = 22 (18-29) μm ; body diam. at beginning of J = 8 (7-9) μm .

Holotype female: L = 1.8 mm; a = 53; b = 7; c = 56; c' = 1.6; V = 51; odontostyle = 80 μm ; odontophore = 48 μm ; oral aperture to guiding ring = 64 μm ; tail = 31 μm ; J = 7 μm ; body diam. at lip region = 9 μm ; body diam. at guiding ring = 24 μm ; body diam. at base of oesophagus = 31 μm ; body diam. at vulva = 33 μm ; body diam. at anus = 19 μm ; body diam. at beginning of J = 6.5 μm .

Description

Habitus a single spiral or closed C when killed. Body tapers gradually toward the extremities. Cuticle finely striated and unusually thin, less than 1 μm thick along body except at the posterior extremity, just behind the anus, where both dorsally and ventrally it is 3 μm thick. Labial region 4 μm high separated by a slight depression from the rest of the body. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle 1-1.5 μm diameter along its length and odontophore little sclerotized. Guiding sheath with only the basal ring clearly visible. The oesophagus basal bulb occupies 1/4 of the oesophagus total length and is 72 μm long and 14 μm wide. Oesophagus-intestinal valve of indefinite shape. Vulva in median position and vagina occupying 1/3 of the corresponding diameter. Gonads paired, the posterior one projecting anteriorly beyond the vagina (as observed in holotype and two paratypes, regularly opposed and reflexed in three paratypes). No «Z» differentiation evident. Prerectum 75 μm long; rectum as long as 3/4 of the body diameter at anus. Tail elongated conoid with pointed tip, bearing two caudal pores.

Male: not found.

Type material (provided by A. C. Tarjan): holotype and 2 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 3 paratype females, Department of Entomology and Nematology Collection, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Meadow at Oliver Springs, Tennessee, U.S.A.

Differential diagnosis

We consider that the thin cuticle of *X. tenuicutis* n. sp. makes it unique within the genus. However, it resembles *X. americanum* and *X. laevistriatum*, differing from the former in the longer odontostyle and lower c' value and from the latter because of its set off lip region and more elongated, with shorter J, tail.

XIPHINEMA LUCI n. sp. (Fig. 5 D, I and J).

Paratypes (7 females): L = 1.8 (1.7-1.9) mm; a = 51 (47-60); b = 7 (5-8.8.); c = 65 (54-81); c' = 1.2 (1-1.4); V = 51 (49-52); odontostyle = 95 (93-99) μm ; odontophore = 50 (47-53) μm ; oral aperture to guiding ring = 76 (68-85) μm ; tail = 28 (23-34) μm ; J = 8.5 (7-9.5) μm ; body diam. at lip region = 10.5 (10-11) μm ; body diam. at guiding ring = 26 (24-29) μm ; body diam. at base of oesophagus = 34 (30-38) μm ; body diam. at vulva = 35 (31-40) μm ; body diam. at anus = 24 (22-27) μm ; body diam. at beginning of J = 14 (12-15) μm .

Holotype female: L = 1.9 mm; a = 50; b = 7; c = 72; c' = 1.1; V = 52; odontostyle = 97 μm ; odontophore = 55 μm ; oral aperture to guiding ring = 77 μm ; tail = 26 μm ; J = 7 μm ; body diam. at lip region = 10 μm ; body diam. at guiding ring = 26 μm ; body diam. at base of oesophagus = 34 μm ; body diam. at vulva = 39 μm ; body diam. at anus = 25 μm ; body diam. at beginning of J = 13 μm .

Description

Habitus a single spiral when killed. Body tapers gradually toward the extremities. Cuticle finely striated, 2 μm thick along body, except at the posterior extremity where it is 5-6 μm either ventrally or dorsally, just behind the anus. Labial region flat on top, 4 μm high, continuous with the rest of the body. Amphidial pouches stirrup-shaped with slit-like aperture. Odontostyle robust, 2 μm thick along its length, with odontophore little sclerotized. Guiding sheath typical of the genus with the two guiding rings 7 μm apart. The oesophagus basal bulb occupies 1/4 of the oesophagus total length and is 64 μm long and 17 μm wide; oesophagus-intestinal valve heart-shaped, of conspicuous size; vulva in median position and vagina with heavily sclerotized

walls (4-5 μm thick) occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed without any « Z » structure visible. Prerectum 138 μm long, rectum as long as body diameter at anus. Tail short, conoid with rounded terminus, bearing three caudal pores.

Male: not found.

Type material (provided by M. Luc): holotype and 3 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 4 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France.

Type habitat and locality

Rhizosphere of celery at Diourbel, Senegal.

Differential diagnosis

Xiphinema luci n. sp. is similar to *X. rivesi*, *X. diffusum*, *X. incognitum* and *X. inaequale*. It differs from *X. rivesi* in having the lip region flattened on top, higher a and c values and shorter and more rounded tail; from *X. diffusum* because of its continuous and less expanded labial region, and longer odontostyle; and from *X. incognitum* in having a shorter odontostyle, more slender body with less broad tail, and differently shaped and more sclerotized vaginal walls. *X. luci* differs from *X. inaequale* in the shape of the lip region (hemispherical in the latter) and tail (more pointed in *X. inaequale*) and because of its less sclerotized vaginal walls.

XIPHINEMA FLORIDAE n. sp. (Fig. 5 A-C; Table IX).

Holotype female: L = 1.8 mm; a = 44; b = 5.4; c = 70; c' = 1.2; V = 50; odontostyle = 94 μm ; odontophore = 55 μm ; oral aperture to guiding ring = 77 μm ; tail = 26 μm ; J = 9 μm ; body diam. at lip region = 12.5 μm ; body diam. at guiding ring = 29 μm ; body diam. at base of oesophagus = 35 μm ; body diam. at vulva = 42 μm ; body diam. at anus = 22 μm ; body diam. at beginning of J = 9 μm .

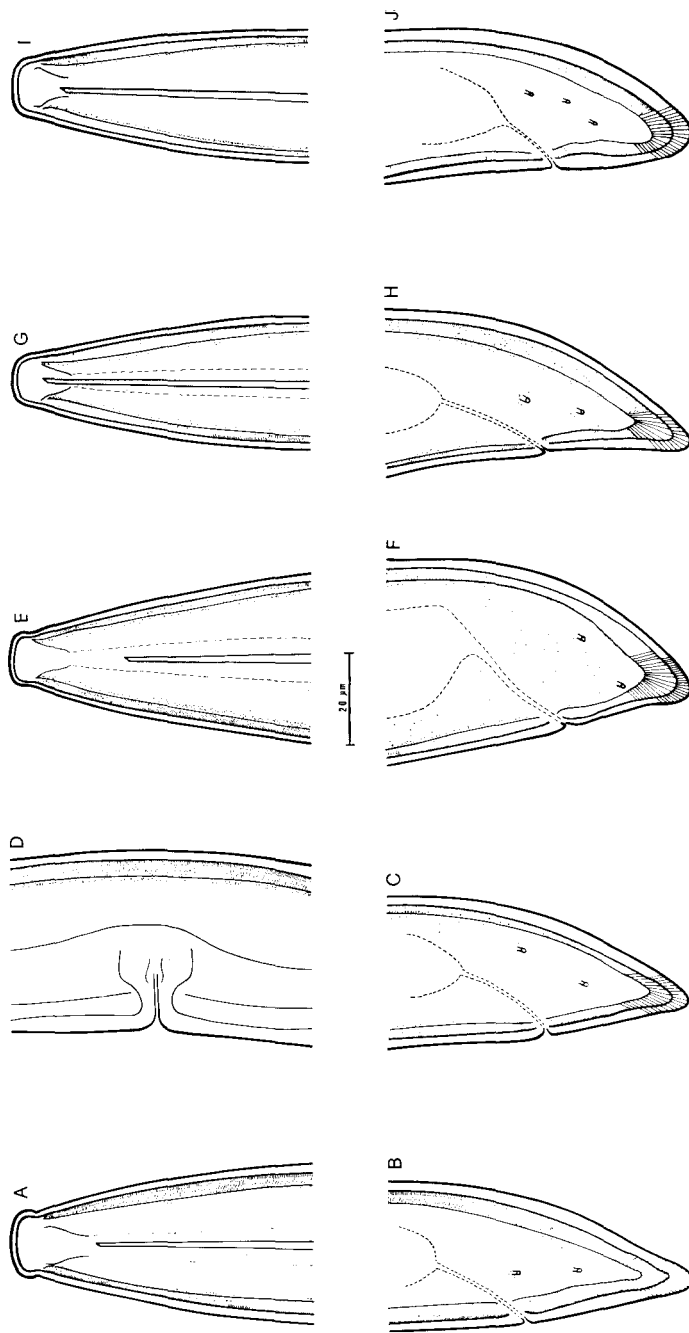


Fig. 5 - Anterior and posterior regions of females of *X. floridae* n. sp. (A-C); of *X. sheri* n. sp. (E and F); of *X. inaequale* (G and H); and of *X. luci* n. sp. (I and J); D, vulvar region of *X. luci* n. sp.

Table IX - *Morphometric characters of females of three populations of X. floridae n. sp.*

Populations: locality and host	USA, Florida Eustis; Citrus paratypes	USA, Florida Merrit Island; host unknown	USA, Florida Flagler Beach; <i>Monarda punctata</i>
n	20	10	9
L mm	1.8 (1.7-1.9)	1.7 (1.5-1.8)	1.8 (1.6-1.9)
a	44 (41-48)	43 (38-48)	43 (38-47)
b	6.3 (5.6-7)	6 (5.5-6.7)	5.9 (5.2-6.3)
c	59 (52-67)	63 (52-70)	67 (62-77)
c'	1.3 (1.2-1.4)	1.1 (1-1.3)	1.1 (1-1.3)
V	51 (49-53)	51 (48-54)	51 (49-52)
Odontostyle μm	90 (86-96)	87 (82-92)	91 (88-94)
Odontophore μm	54 (50-59)	52 (47-57)	55 (53-59)
Oral aperture to guiding ring μm	74 (68-77)	74 (68-86)	76 (72-78)
Tail μm	31 (27-34)	27 (22-31)	27 (24-30)
J μm	9 (7.5-11)	7 (5.5-8)	6 (5-6)
Body diam at lip region μm	13 (12.5-13.5)	13 (11.5-13.5)	
Body diam at guiding ring μm	29 (28-31)	30 (28-34)	Specimens
Body diam at base of oesophagus μm	36 (33-38)	36 (32-44)	flattened
Body diam at vulva μm	42 (37-46)	40 (35-47)	
Body diam at anus μm	25 (22-27)	24 (21-27)	
Body diam at beginning of J μm	9 (7.5-11)	9 (8-12)	

Description

Habitus ventrally arcuate when killed. Body tapers toward the extremities, but more gradually in the anterior region. Cuticle smooth, 2 μm thick along body except in the post labial region where it is 3 μm thick, and in the caudal region where it is 4 μm ventrally and 5 μm dorsally immediately posterior to anus. Labial region hemielliptical, separated from the rest of the body by an incisure. Amphidial pouches and aperture typical of the genus. Odontostyle 2 μm diameter with well sclerotized odontophore. Guiding sheath with only the basal ring well evident. The oesophagus basal bulb is 67 μm long and 20 μm wide and occupies 1/4 of the oesophagus total length. Three large nuclei are evident in the basal bulb. Oesophagus-intestinal valve inconspicuous, triangular. Vulva in median position, vagina occupying 1/3 of the corresponding body diameter. Gonads paired, opposed and reflexed without any « Z » differentiation evident. Prerectum 100 μm long; rectum as long as 3/4 of the body diameter at anus. Tail cuneiform bearing two caudal pores.

Male: not found.

Type material (collected by R. N. Inserra): holotype and 14 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 5 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France; 5 paratype females, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England and 5 paratype females, Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Type habitat and locality

Rhizosphere of citrus trees at Eustis, Florida, U.S.A.

Differential diagnosis

Xiphinema floridae n. sp. is similar to *X. brevicolle* and *X. oxycaudatum*. It differs from both in the different tail shape, which is more elongated in *X. oxycaudatum* and wider and more rounded at the end in *X. brevicolle*. It differs from *X. brevicolle* in having a shorter body and a higher value of c' and from *X. oxycaudatum* because of its larger size, shorter odontostyle and lower c' value.

XIPHINEMA CALIFORNICUM n. sp. (Fig. 6 A-G; Table X).

Holotype female: L = 1.9; a = 68; b = 6.1; c = 58; c' = 1.7; V = 51.5; odontostyle = 95 μm ; odontophore = 51 μm ; oral aperture to guiding ring = 81 μm ; tail = 33 μm ; J = 5.5 μm ; body diam. at lip region = 10 μm ; body diam. at guiding ring = 22 μm ; body diam. at base of oesophagus = 27 μm ; body diam. at vulva = 28 μm ; body diam. at anus = 20 μm ; body diam. at beginning of J = 8 μm .

Allotype male: L = 1.8 mm; a = 68; b = 5.9; c = 61; c' = 1.5; odontostyle = 89 μm ; odontophore = 48 μm ; oral aperture to guiding ring = 78 μm ; tail = 31 μm ; J = 5 μm ; spicules = 35 μm ; body diam. at lip region = 11 μm ; body diam. at guiding ring = 22 μm ; body diam. at base of oesophagus = 29 μm ; body diam. at middle body = 27 μm ; body diam. at anus = 21 μm ; body diam. at beginning of J = 7 μm .

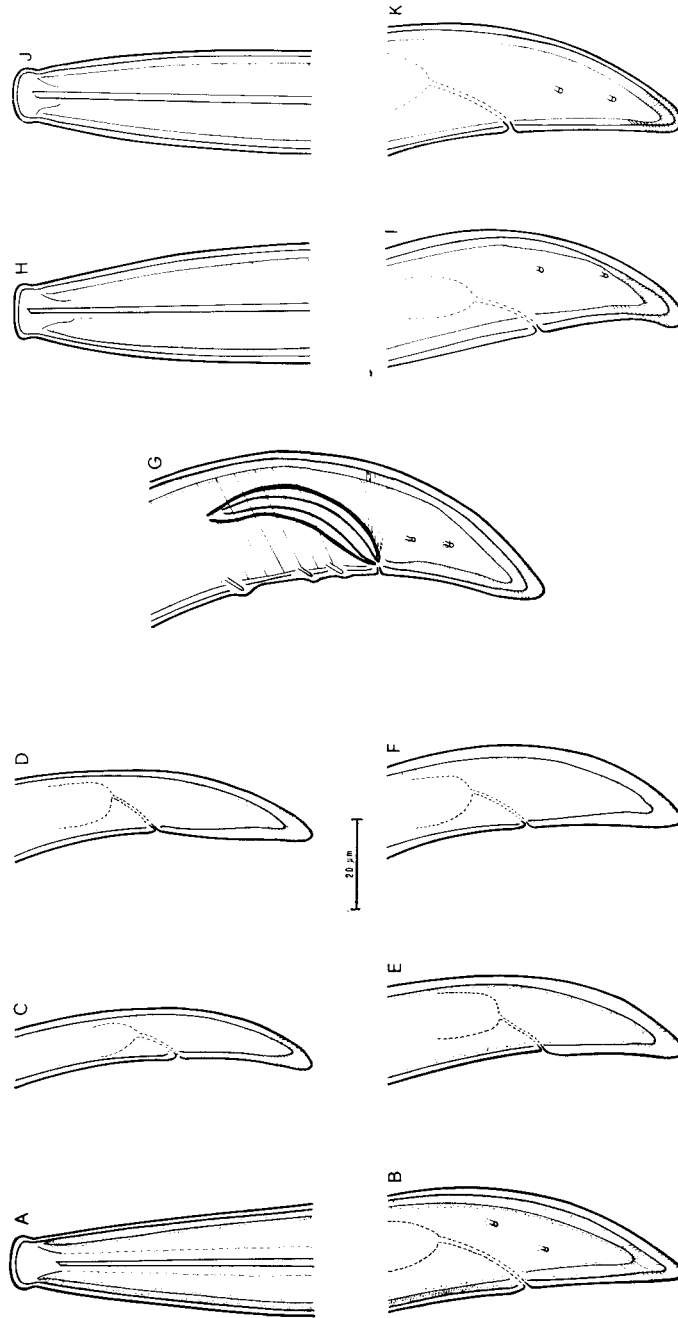


Fig. 6 - *X. californicum* n. sp.: A and B, anterior and posterior regions of females; C, D, E and F, tails of I, II, III and IV juvenile stages respectively; G, posterior region of male; *X. intermedium* n. sp.: H and I, anterior and posterior regions of females; *X. utahense* n. sp.: J and K, anterior and posterior regions of females.

Table X - Morphometric characters of three populations of *X. californicum* n. sp.

Populations: locality and host	USA, California, Riverside; Olive trees, paratypes					USA, California, Bakersfield; Grapevine	Mexico, Hermosillo; Grapevine
	L ₁	L ₂	L ₃	L ₄	♀	♀	♀
n	10	10	10	10	20	4	19
L mm	0.8 (0.7-0.9)	1 (0.9-1.2)	1.4 (1.3-1.5)	1.4 (1.3-1.6)	2 (1.8-2.2)	1.9 (1.6-2.1)	1.9 (1.7-2)
a	46 (43-47)	53 (46-56)	59 (54-61)	59 (57-60)	60 (52-68)	61 (53-67)	56 (44-68)
b	4 (3.3-4.6)	4.4 (4-4.8)	5.2 (4.5-5.7)	5.1 (4.4-6.6)	6.8 (5.5-8)	7 (5.5-8.9)	6.9 (5.9-7.9)
c	25 (22-28)	32 (29-33)	43 (36-49)	44 (37-51)	63 (58-76)	69 (65-72)	58 (50-67)
c'	2.7 (2.2-3.2)	2.4 (2.2-2.8)	2.1 (1.8-2.5)	1.9 (1.7-2.2)	1.6 (1.3-1.9)	1.5 (1.4-1.8)	1.7 (1.4-2.1)
V	—	—	—	—	51 (49-55)	50 (48-52)	51 (49-53)
Odontostyle µm	48 (46-51)	59 (57-67)	74 (71-79)	76 (72-79)	90 (83-98)	82 (79-85)	86 (78-94)
Odontophore µm	31 (26-32)	37 (27-40)	42 (38-44)	42 (38-44)	48 (44-53)	47 (45-51)	48 (43-58)
Replacement odontostyle µm	59 (55-61)	79 (76-83)	91 (87-96)	93 (89-96)	—	—	—
Oral aperture to guiding ring µm	39 (35-46)	51 (49-53)	62 (43-66)	64 (58-71)	76 (66-83)	70 (64-76)	74 (63-84)
Tail µm	31 (25-36)	33 (28-37)	34 (31-37)	31 (28-36)	31 (27-36)	31 (29-34)	33 (29-36)
J µm	6 (4-9)	7 (5-9.5)	6 (5-9)	6 (5-6.5)	6 (5-8.5)	7 (5.5-8)	8.5 (6-11)
Body diam at lip region µm	7 (7-7.5)	8 (7.5-8)	9 (8.5-9)	9 (8.5-9.5)	10 (10-11)	10 (9.5-10.5)	10.5 (9.5-11.5)
Body diam at guiding ring µm	14 (14-15)	16 (15-19)	19 (16-21)	20 (18-21)	23 (22-24)	23 (22-24)	25 (23-31)
Body diam at base of oesophagus µm	16 (14-18)	19 (17-24)	23 (22-26)	22 (21-26)	29 (26-34)	27 (26-28)	31 (26-36)
Body diam at vulva µm	17 (15-19)	23 (17-24)	24 (22-28)	23 (21-28)	33 (28-40)	31 (29-33)	34 (28-38)
Body diam at anus µm	12 (10-13)	13 (12-17)	16 (16-17.5)	16 (15-17)	19 (17-22)	20 (19-21)	20 (17-21)
Body diam at beginning of J µm	5 (3.5-6.5)	6 (5-8)	6 (5-6.5)	6 (5-6.5)	7 (5.5-9.5)	8.5 (7.5-9.5)	9 (7-11)

Description

Body slender, ventrally arcuate and more coiled at the posterior extremity when killed; almost cylindrical, tapering more or less abruptly only near the extremities. Cuticle smooth and thin 1-2 μm thick along body and 3 μm thick both dorsally or ventrally, just posterior to anus. Labial region 4 μm high, well expanded and clearly separated from the rest of the body by an incisure. Amphidial pouches and apertures typical of the genus. Odontostyle attenuated, 1 μm diameter, with elongated and weakly sclerotized odontophore. Guiding sheath with only the basal ring well evident. The oesophagus basal bulb is 70 μm long and 14 μm wide and occupies 1/4 of the oesophagus total length. Three nuclei are evident in the basal bulb. Oesophagus-intestinal valve inconspicuous and amorphous. Vulva in median position, vagina occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation evident. Prerectum 124 μm long; rectum as long as 3/4 of the body diameter at anus. Tail elongated conoid, dorsally convex bearing two caudal pores.

Male: very rare, biometrically and morphologically similar to the female but more coiled in the posterior region. The adanal pair of supplements, 8-14 μm anterior to anus, is preceded by a ventromedian series of seven. The tail is slightly concave ventrally.

Juveniles: similar to adult females, but differing in size of the body. The tail is also more elongated. It is difficult to distinguish between the third and fourth stages.

Type material: holotype, allotype and 21 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 6 paratype females, Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France; 6 paratype females, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England and 4 paratype females, Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Type habitat and locality

Rhizosphere of olive trees, Hendricks Farm, Riverside, California, U.S.A. This species however is widespread throughout California in association with various woody and herbaceous plants.

Differential diagnosis

Xiphinema californicum n. sp. is similar to *X. americanum*, *X. pachtaicum*, *X. opisthohystrum*, *X. oxycaudatum* and *X. floridae*. It differs from *X. americanum* in having a much more expanded labial region and a longer odontostyle; from *X. pachtaicum* because of its anterior vulva and more elongated tail; from *X. opisthohystrum* in having a much longer odontostyle, anterior vulva and a lower c' value; from *X. oxycaudatum* because of its differently shaped lip region, longer odontostyle, higher a value and anterior vulva; and from *X. floridae* in having higher a and c' values and less pointed and more elongated tail.

XIPHINEMA SHERI n. sp. (Fig. 5 E and F; Table XI).

Holotype female: L = 1.6 mm; a = 33; b = 4.8; c = 62; c' = 0.7; V = 55; odontostyle = 105 μm ; odontophore = 55 μm ; oral aperture to guiding ring = 94 μm ; tail = 25 μm ; J = 9 μm ; body diam. at lip region = 11 μm ; body diam. at guiding ring = 36 μm ; body diam. at base of oesophagus = 44 μm ; body diam. at vulva = 47 μm ; body diam. at anus = 34 μm ; body diam. at beginning of J = 19 μm .

Description

Body squat, arcuate, an open C when killed, tapering gradually toward the extremities. Glandular bodies present in the hypodermal cords. Cuticle smooth 2 μm thick along body except in the caudal region where it is 3 μm thick ventrally and 4 μm thick dorsally, just behind the anus. Labial region slightly expanded and set off from the rest of the body by a depression. Amphidial pouches and apertures typical of the genus. Odontostyle 2 μm diameter with well sclerotized odontophore; guiding sheath typical of the genus with the two annules only 4 μm apart. Oesophagus basal bulb 66 μm long and 18 μm wide, occupying 1/5 of the oesophagus total length; oesophagus-intestinal valve inconspicuous and of indefinite shape. Vulva slightly posterior to median position; vagina occupying 1/3 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation visible. Prerectum 50 μm long; rectum as long as 2/3

Table XI - *Morphometric characters of females of two populations of X. sheri n. sp.*

Populations: locality and host	Thailand, Csuy Carsow; Coffee paratypes	Thailand, Pakchong, Nakouirojasima; loganberry
n	4	5
L mm	1.8 (1.6-1.9)	1.7 (1.6-1.8)
a	40 (38-42)	41 (37-48)
b	5.2 (4.7-5.9)	5.7 (5.5-5.8)
c	68 (58-77)	60 (51-66)
c'	0.7 (0.7-0.8)	0.9 (0.8-1)
V	55 (54-56)	53 (51-54)
Odontostyle μm	107 (104-112)	100 (97-105)
Odontophore μm	58 (52-60)	55 (49-59)
Oral aperture to guiding ring μm	94 (92-96)	84 (68-89)
Tail μm	24 (23-25)	26 (22-28)
J μm	10 (9-11)	10 (9-11)
Body diam at lip region μm	11 (10.5-12)	11 (10.5-11.5)
Body diam at guiding ring μm	31 (29-34)	31 (30-34)
Body diam at base of oesophagus μm	40 (38-44)	39 (34-43)
Body diam at vulva μm	44 (41-50)	42 (34-59)
Body diam at anus μm	32 (29-34)	29 (25-35)
Body diam at beginning of J μm	16 (14-20)	15 (11.5-13)

of the body diameter at anus. Tail conical, with rounded tip, slightly concave ventrally, bearing two pairs of caudal pores.

Male: not found.

Type material (provided by the late S. A. Sher): holotype and 2 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 2 paratype females, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England.

Type habitat and locality

Rhizosphere of coffee tree at Csuy Carsow, Thailand. A population of *X. sheri* has been found also in the rhizosphere of loganberry bushes at Nakouirojasima, Thailand.

Differential diagnosis

Xiphinema sheri n. sp. resembles to *X. brevicolle* but differs from it in smaller size, lower c value, less expanded labial region, longer odontostyle and posterior vulva.

XIPHINEMA PERUVIANUM n. sp. (Fig. 7 D-F).

Paratypes (10 females): L = 1.7 (1.4-1.9) mm; a = 49 (45-56); b = 6.7 (5.9-7.6); c = 56 (49-67); c' = 1.4 (1.2-1.7); V = 52 (49-55); odontostyle = 88 (85-92) μ m; odontophore = 49 (46-52) μ m; oral aperture to guiding ring = 72 (67-78) μ m; tail = 30 (26-35) μ m; J = 8 (6-10.5) μ m; body diam. at lip region = 10 (9-10.5) μ m; body diam. at guiding ring = 26 (23-28) μ m; body diam. at base of oesophagus = 29 (26-31) μ m; body diam. at vulva = 33 (32-36) μ m; body diam. at anus = 21 (18-24) μ m; body diam. at beginning of J = 9 (7.5-12) μ m.

Holotype female: L = 1.9 mm; a = 47; b = 8.9; c = 59; c' = 1.3; V = 53; odontostyle = 88 μ m; odontophore = 50 μ m; oral aperture to guiding ring = 73 μ m; tail = 31 μ m; J = 8.5 μ m; body diam. at lip region = 10 μ m; body diam. at guiding ring = 28 μ m; body diam. at base of oesophagus = 33 μ m; body diam. at vulva = 39 μ m; body diam. at anus = 24 μ m; body diam. at beginning of J = 8 μ m.

Allotype male: L = 1.8 mm; a = 52; b = 7.9; c = 55; c' = 1.3; odontostyle = 88 μ m; odontophore = 46 μ m; oral aperture to guiding ring = 73 μ m; tail = 32 μ m; J = 6 μ m; spicules = 39 μ m; body diam. at lip region = 11 μ m; body diam. at guiding ring = 28 μ m; body diam. at base of oesophagus = 30 μ m; body diam. at middle body = 33 μ m; body diam. at anus = 24 μ m; body diam. at beginning of J = 6 μ m.

Description

Habitus coiled when killed, forming almost a complete ring. Body tapers gradually toward the extremities. Cuticle smooth, 1.5-2 μ m thick along body except at the posterior extremity where it is 3 μ m thick ventrally and 4 μ m dorsally, just posteriad to anus. Labial region 4 μ m high, set off from the rest of the body; amphidial pouches and apertures typical of the genus. Odontostyle 1.5 μ m diameter with

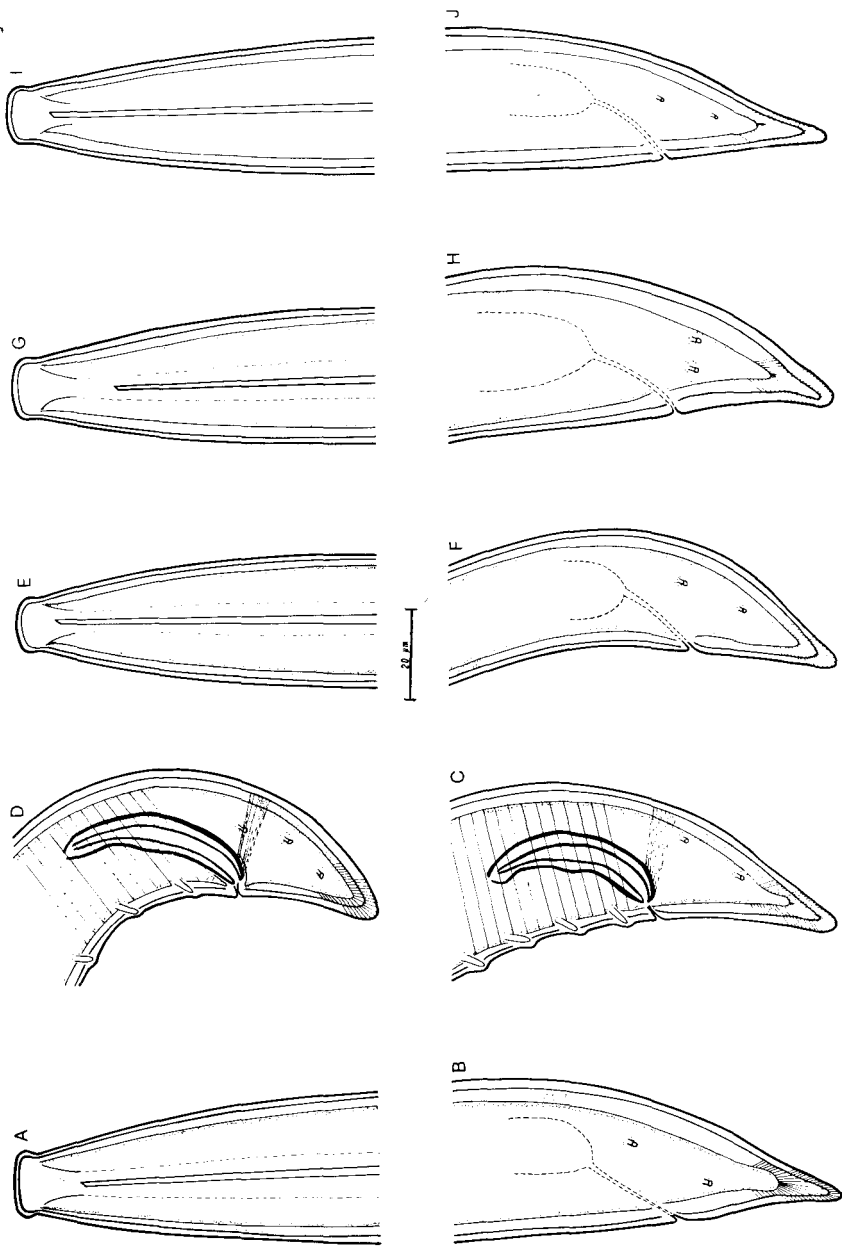


Fig. 7 - Anterior and posterior regions of *X. citricolum* n. sp.: A and B, females; C, male; of *X. peruvianum* n. sp.: D, male; E and F females; of *X. georgianum* n. sp.: G and H, females; and of *X. tarjanense* n. sp.: I and J, females.

heavily sclerotized odontophore. Guiding sheath typical of the genus with the two rings 10 μm apart. Oesophagus basal bulb $67 \times 21 \mu\text{m}$ occupying between 1/3 and 1/4 of the oesophagus total length. Oesophagus-intestinal valve large, almost hemispherical. Vulva in median position, vagina occupying 1/3 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any «Z» structure visible. Prerectum indistinct; rectum as long as body diameter at anus. Tail conoid elongated with subdigitate terminus, dorsally convex, bearing two pairs of caudal pores.

Male: rare, biometrically and morphologically similar to the females, but much more coiled at the posterior extremity. Spicules weakly sclerotized. The adanal pair of supplements, 8 and 11 μm anterior to anus is preceded by a ventromedian series of eleven. The tail is slightly concave ventrally and bears three pairs of caudal pores.

Type material (provided by A. C. Tarjan): holotype female, allotype male and 8 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy, 10 paratype females, Department of Entomology and Nematology Collection, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Roots of *Citrus* sp. at Lima, Perù.

Differential diagnosis

Xiphinema peruvianum n. sp. is similar to *X. floridae*, *X. californicum*, *X. oxycaudatum* and *X. tenuicutis*. It differs from *X. floridae* and *X. californicum* in having a less expanded labial region and a differently shaped subdigitate tail, from *X. oxycaudatum* and *X. tenuicutis* because of its less gradually tapering subdigitate tail and longer odontostyle.

XIPHINEMA CITRICOLUM n. sp. (Fig. 7 A-C).

Paratypes (2 females): L = 1.6-1.8 mm; a = 45-46; b = 5.4-6.6; c = 48-50; c' = 1.6; V = 52-53; odontostyle = 86 μm ; odontophore

= 45-49 μm ; oral aperture to guiding ring = 64-69 μm ; tail = 34-36 μm ; J = 12-14 μm ; body diam. at lip region = 12.5 μm ; body diam. at guiding ring = 31-32 μm ; body diam. at base of oesophagus = 36-37 μm ; body diam. at vulva = 38-39 μm ; body diam. at anus = 21-23 μm ; body diam. at beginning of J = 8.5-9 μm .

Holotype female: L = 1.6 mm; a = 46; b = 5.8; c = 44; c' = 1.7; V = 54; odontostyle = 78 μm ; odontophore = 48 μm ; oral aperture to guiding ring = 72 μm ; tail = 36 μm ; J = 15 μm ; body diam. at lip region = 13 μm ; body diam. at guiding ring = 29 μm ; body diam. at base of oesophagus = 33 μm ; body diam. at vulva = 35 μm ; body diam. at anus = 22 μm ; body diam. at beginning of J = 8 μm .

Allotype male: L = 1.5 mm; a = 44; b = 5; c = 39; c' = 1.5; odontostyle = 80 μm ; odontophore = 49 μm ; oral aperture to guiding ring = 70 μm ; tail = 38 μm ; J = 12 μm ; spicules = 39 μm ; body diam. at lip region = 13 μm ; body diam. at guiding ring = 29 μm ; body diam. at base of oesophagus = 31 μm ; body diam. at middle body = 34 μm ; body diam. at anus = 25 μm ; body diam. at beginning of J = 8.5 μm .

Description

Habitus ventrally arcuate when killed. Body almost cylindrical throughout its length, tapering abruptly only near the extremities. Glandular bodies are present in the hypodermal cords. Cuticle smooth, 2 μm thick along body except at the extremities where it is 3 μm thick in the post labial region and 5 μm thick ventrally and 7 μm dorsally immediately after anus. Labial region 5 μm high, expanded, flat at the anterior extremity, separated by an incisure from the rest of the body. Amphidial pouches and apertures typical of the genus. Odontostyle 2 μm diameter along its length with weakly sclerotized odontophore. Guiding sheath also typical of the genus with the two rings 4 μm apart. The oesophagus basal bulb, 65 μm long and 18 μm wide occupies 1/4 of the oesophagus total length, and has 3 nuclei. Oesophagus-intestinal valve small of conical shape. Vulva almost equatorial with vagina occupying 1/2 of the body corresponding diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation evident. Pre-rectum 63 μm long, rectum as long as the body diameter at anus. Tail conoid, convex dorsally and slightly concave ventrally, with elongated subdigitate terminus, and bearing two pairs of caudal pores.

Male: biometrically and morphologically similar to the females

but more coiled at the posterior extremity. Spicules weakly sclerotized. The adanal pair of supplements, 7 μm anterior to anus is preceded by a ventromedian series of ten. The tail is slightly concave ventrally and bears two pairs of caudal pores.

Type material (provided by A. C. Tarjan): holotype female, allotype male and one paratype female in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 1 paratype female, Department of Entomology and Nematology Collection, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Rhizosphere of rough lemon trees at Eloise, Florida, U.S.A.

Differential diagnosis

Xiphinema citricolum n. sp. is similar to *X. neoelongatum* Bajaj et Jairajpuri, 1976, *X. floridae* and *X. peruvianum*. It differs from *X. neoelongatum* in its differently shaped labial region and shorter odontostyle; from *X. floridae* because of its differently shaped labial region and tail (subdigitate), its longer tail and higher c' value and its posterior vulva; and from *X. peruvianum* in having a more expanded lip region, longer tail and longer J.

XIPHINEMA INTERMEDIUM n. sp. (Fig. 6 H and I).

Paratypes (15 females): L = 1.6 (1.4-1.9) mm; a = 43 (38-51); b = 6 (5.2-7.2); c = 47 (41-59); c' = 1.5 (1.3-1.7); V = 52 (50-57); odontostyle = 76 (68-80) μm ; odontophore = 45 (39-50) μm ; oral aperture to guiding ring = 63 (58-67) μm ; tail = 33 (31-38) μm ; J = 10 (9-12) μm ; body diam. at lip region = 10.5 (9.5-11) μm ; body diam. at guiding ring = 27 (24-29) μm ; body diam. at base of oesophagus = 34 (32-38) μm ; body diam. at vulva = 37 (34-40) μm ; body diam. at anus = 22 (20-24) μm ; body diam. at beginning of J = 9 (7-11.5) μm .

Holotype female: L = 1.5 mm; a = 43; b = 5.9; c = 49; c' = 1.4; V = 52; odontostyle = 78 μm ; odontophore = 43 μm ; oral aperture to

guiding ring = 65 μm ; tail = 30 μm ; J = 11 μm ; body diam. at lip region = 11 μm ; body diam. at guiding ring = 25 μm ; body diam. at base of oesophagus = 34 μm ; body diam. at vulva = 34 μm ; body diam. at anus = 22 μm ; body diam. at beginning of J = 10 μm .

Description

Habitus coiled as C when killed. Body tapers gradually toward the extremities. Cuticle finely striated, 2 μm thick along body but thicker at the posterior extremity where it is 3 μm thick ventrally and 4 μm dorsally, just behind the anus. Labial region 4 μm high, expanded, separated from the rest of the body by a shallow incisure. Amphidial pouches and apertures typical of the genus. Odontostyle 2 μm diameter throughout its length with well sclerotized odontophore. Guiding sheath typical of the genus with the two rings 11 μm apart. Oesophagus basal bulb 74 μm long and 16 μm wide, occupying 1/3-1/4 of the total oesophagus length. No nuclei are clearly visible in the oesophageal bulb. Oesophagus-intestinal valve inconspicuous, hemispherical. Vulva in median position with vagina occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation visible. Prerectum indistinct, 100 μm long; rectum as long as 2/3 of the body diameter at anus. Tail conoid elongated, dorsally convex and ventrally concave, bearing two pairs of caudal pores.

Male: not found.

Type material (provided by A. C. Tarjan): holotype female and 7 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 3 paratype females, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England; 4 paratype females, Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.; 10 paratype females, Department of Entomology and Nematology Collection, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Rhizosphere of citrus trees at Fort Pierce, Florida, U.S.A.

Differential diagnosis

Xiphinema intermedium n. sp. occupies an intermediate position between *X. americanum* and *X. oxycaudatum*. However, it differs from the former in having a more expanded lip region, lower value of a, c and c' and longer odontostyle and from the latter because the lip region is less deeply separated from the rest of the body, the tail dorsally convex and more elongated and the odontostyle shorter.

XIPHINEMA GEORGIANUM n. sp. (Fig. 7 G and H).

Paratypes (10 females): L = 1.9 (1.8-2.1) mm; a = 47 (43-50); b = 6.1 (5.3-7.4); c = 64 (58-72); c' = 1.3 (1.2-1.5); V = 53 (51-54); odontostyle = 112 (97-117) μ m; odontophore = 53 (46-56) μ m; oral aperture to guiding ring = 98 (89-107) μ m; tail = 31 (26-34) μ m; J = 12 (10-15) μ m; body diam. at lip region = 12 (11-12.5) μ m; body diam. at guiding ring = 32 (30-34) μ m; body diam. at base of oesophagus = 38 (35-41) μ m; body diam. at vulva = 41 (37-44) μ m; body diam. at anus = 23 (21-27) μ m; body diam. at beginning of J = 10 (8-12) μ m.

Holotype female: L = 1.9 mm; a = 45; b = 6.7; c = 57; c' = 1.3; V = 53; odontostyle = 113 μ m; odontophore = 59 μ m; oral aperture to guiding ring = 98 μ m; tail = 33 μ m; J = 11.5 μ m; body diam. at lip region = 11.5 μ m; body diam. at guiding ring = 32 μ m; body diam. at base of oesophagus = 38 μ m; body diam. at vulva = 42 μ m; body diam. at anus = 25 μ m; body diam. at beginning of J = 11.5 μ m.

Description

Habitus an open C when killed. Body tapers gradually toward the posterior extremity and more abruptly from the oesophageal region forward. Glandular bodies present in the hypodermal cords. Cuticle smooth, 2 μ m thick along body but more thickened at the extremities, where it is 3 μ m thick just behind the lip region and 5 μ m thick ventrally and 6 μ m dorsally just after the anus. Labial region 5 μ m high, slightly expanded, separated from the rest of the body by a shallow incisure. Amphidial pouches and apertures typical of the genus. Odontostyle 2 μ m diameter along its length with well sclerotized odontophore. Only the basal ring of the guiding sheath is well evident.

The oesophagus basal bulb measures 65 μm long and 19 μm wide and occupies 1/5-1/6 of the oesophagus total length. Oesophagus-intestinal valve is small and of indefinite shape. Vulva in median position with vagina occupying 1/2 of the corresponding body diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation visible. Prerectum 125 μm long; rectum as long as the body diameter at anus. Tail conoid, elongated, with subdigitate terminus, bearing two pairs of caudal pores.

Male: not found.

Type material (provided by A. C. Tarjan): holotype female and 5 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 6 paratype females, Department of Entomology and Nematology, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Rhizosphere of *Juniperus* sp. at Jekyll Island, Georgia, U.S.A. Also three specimens of this species have been found in the rhizosphere of oak trees at Winter Haven, Florida, U.S.A.

Differential diagnosis

Xiphinema georgianum n. sp. is similar to *X. peruvianum* and *X. citricolum*. It differs from both in the larger body size and longer odontostyle. Moreover, it differs from *X. peruvianum* because of its wider body and longer J and from *X. citricolum* in having higher c and lower c' values and shorter tail.

XIPHINEMA UTAHENSE n. sp. (Fig. 6 J and K).

Paratypes (7 females): L = 2.1 (2-2.3) mm; a = 63 (60-67); b = 6.7 (6.3-7.2); c = 64 (60-69); c' = 1.4 (1.2-1.6); V = 54 (52-56); odontostyle = 93 (87-100) μm ; odontophore = 49 (46-53) μm ; oral aperture to guiding ring = 81 (77-82) μm ; tail = 33 (31-37) μm ; J = 5 (3.5-7) μm ; body diam. at lip region = 11 (10-11.5) μm ; body diam. at guiding ring = 24 (22-26) μm ; body diam. at base of oesophagus = 29 (26-31)

μm ; body diam. at vulva = 34 (31-36) μm ; body diam. at anus = 23 (22-26) μm ; body diam. at beginning of J = 8 (6.5-10.5) μm .

Holotype female: L = 2.1 mm; a = 53; b = 6.9; c = 60; c' = 1.5; V = 55; odontostyle = 98 μm ; odontophore = 48 μm ; oral aperture to guiding ring = 81 μm ; tail = 34 μm ; J = 4 μm ; body diam. at lip region = 10.5 μm ; body diam. at guiding ring = 23 μm ; body diam. at base of oesophagus = 31 μm ; body diam. at vulva = 39 μm ; body diam. at anus = 22 μm ; body diam. at beginning of J = 7 μm .

Description

Habitus coiled as single spiral when killed. Body tapers very gradually toward the extremities. Hypodermal cords bearing glandular bodies along their length. Cuticle very finely striated, 1.5-2 μm thick along body except in the posterior region, where it is 3 μm thick both ventrally or dorsally, just behind anus. Labial region rounded, 4 μm high, separated by an incisure from the rest of the body. Amphidial pouches and apertures typical of the genus. Odontostyle 1.5 μm thick with weakly sclerotized odontophore. Guiding sheath typical of the genus with the two rings 26 μm apart. The oesophagus basal bulb measures 70 μm long and 16 μm wide and occupies 1/4 of the oesophagus total length. Oesophagus intestinal valve, small and of indefinite shape. Vulva in median position, vagina occupying 1/2 of the corresponding diameter. Gonads paired, opposed and reflexed, without any « Z » differentiation visible. Prerectum 108 μm long, rectum as long as body diameter at anus. Tail conoid, elongated with rounded terminus, bearing two pairs of caudal pores.

Male: not found.

Type material (provided by the late S. A. Sher): holotype female and 3 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 2 paratype females, Nematology Department, Rothamsted Experimental Station, Harpenden, Herts, England, and 2 paratype females, Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, U.S.A.

Type habitat and locality

Rhizosphere of *Rhus trilobata*, Cold Creek Canyon, Utah, U.S.A.

Differential diagnosis

Xiphinema utahense n. sp. is similar to *X. oxycaudatum*, *X. tenuicutis*, *X. floridae* and *X. intermedium*. It differs from all these in having a longer body. It differs from *X. oxycaudatum* and *X. tenuicutis* in its higher value of a, longer odontostyle and more elongated and gradually tapering tail; from *X. floridae* in having a less expanded lip region, higher value of a and posterior vulva; and from *X. intermedium* because of its higher values of a and c and longer odontostyle.

XIPHINEMA TARJANENSE n. sp. (Fig. 7 I and J).

Paratypes (5 females): L = 1.3 (1.2-1.4) mm; a = 38 (34-42); b = 5.7 (5.4-6.1); c = 40 (38-42); c' = 1.6 (1.5-1.7); V = 54 (53-56); odontostyle = 81 (78-88) μ m; odontophore = 45 (43-47) μ m; oral aperture to guiding ring = 62 (54-65) μ m; tail = 33 (33-34) μ m; J = 13 (11.5-13.5) μ m; body diam. at lip region = 12 (11.5-12.5) μ m; body diam. at guiding ring = 29 (27-31) μ m; body diam. at base of oesophagus = 33 (31-34) μ m; body diam. at vulva = 36 (32-40) μ m; body diam. at anus = 21 (18-23) μ m; body diam. at beginning of J = 8 (7-8.5) μ m.

Holotype female: L = 1.4 mm; a = 38; b = 6; c = 42; c' = 1.6; V = 53; odontostyle = 85 μ m; odontophore = 41 μ m; oral aperture to guiding ring = 65 μ m; tail = 34 μ m; J = 12 μ m; body diam. at lip region = 12 μ m; body diam. at guiding ring = 30 μ m; body diam. at base of oesophagus = 34 μ m; body diam. at vulva = 37 μ m; body diam. at anus = 21 μ m; body diam. at beginning of J = 7.5 μ m.

Description

Habitus arcuate ventrally when killed. Body tapers very gradually toward the extremities. Cuticle very finely striated, 2 μ m thick along body, except at the extremities where it is 3 μ m thick anteriorly, just behind the lip region and 5 μ m thick ventrally and 6 μ m dorsally posteriad to anus. Labial region 5 μ m high, rounded on top, slightly expanded, separated by a constriction from the rest of the body. Amphidial pouches and apertures typical of the genus. Odontostyle 2 μ m diameter with weakly sclerotized odontophore. Guiding sheath typical of the genus with the two rings 12 μ m apart. The oesophagus

basal bulb measures 55 μm long and 18 μm wide and occupies 1/4 of the oesophagus total length. Oesophagus-intestinal valve inconspicuous, of indefinite shape. Vulva in median position with the vagina occupying 1/3 of the corresponding diameter. Gonads paired, opposed and reflexed, with no « Z » differentiation evident. Prerectum 74 μm long, rectum as long as body diameter at anus. Tail conical with acute, subdigitate terminus, bearing two pairs of caudal pores.

Male: not found.

Type material (provided by A. C. Tarjan): holotype female and 2 paratype females in the collection of the Laboratorio di Nematologia Agraria del Consiglio Nazionale delle Ricerche, Bari, Italy; 3 paratype females, Department of Entomology and Nematology, University of Florida, Gainesville, Florida, U.S.A.

Type habitat and locality

Rhizosphere of oak trees at Winter Haven, Florida, U.S.A.

Differential diagnosis

Xiphinema tarjanense n. sp. is similar to *X. neoelongatum* Bajaj et Jairajpuri, 1976 and *X. floridae*. It differs from both in its shorter odontostyle, lower value of *c* and less deeply set off lip region; moreover, it differs from *X. floridae* in having a posterior vulva and because it is smaller.

DISCUSSION

On the basis of the experience acquired after years of studying thousands of specimens and hundreds of populations classified by various authors within the *X. americanum* group, we suggest that the denomination *X. americanum sensu lato* should no longer be retained. We prefer to recognise a group of 25 species with characters typical of the genus *Xiphinema* Cobb, 1913 as originally described. Grouping these species according to their similarities and relationships the genus could be subdivided in six different groups:

i) characterized by having the lip region separated from the rest of the body by a depression and the tail conoid, elongated, with rounded tip. It includes: *X. americanum* Cobb, 1913, *X. oxycaudatum* n. sp., *X. tenuicutis* n. sp., *X. peruvianum* n. sp., *X. intermedium* n. sp., and *X. utahense* n. sp.;

ii) characterized by having the lip region expanded, glandiform. It includes: *X. pachtaicum* (Tulaganov, 1938) Kirjanova, 1951, *X. opisthohysterum* Siddiqi, 1961, *X. variabile* Heyns, 1966, and *X. californicum* n. sp.;

iii) characterized by having a squat body, a button-like lip region, separated by incisure or depression from the rest of the body, and a triangular short tail. It includes: *X. brevicolle* Lordello *et* Da Costa, 1961, *X. floridae* n. sp., and *X. sheri* n. sp.;

iv) characterized by having the lip region continuous with the rest of the body and a conoid with more or less rounded terminus tail. It includes: *X. rivesi* Dalmasso, 1969, *X. neoamericanum*, Saxena, Chhabra *et* Joshi, 1973, *X. inaequale* (Khan *et* Ahmad, 1975) Khan *et* Ahmad, 1977, *X. laevistriatum* n. sp. and *X. luci* n. sp.;

v) characterized by having the lip region separated from the rest of the body by a slight depression and a short conoid tail with widely rounded terminus. It includes: *X. diffusum* n. sp. and *X. incognitum* n. sp.

vi) characterized by having a clearly set off lip region and a conoid subdigitate tail. It includes: *X. lambertii* Bajaj *et* Jairajpuri, 1976, *X. neoelongatum* Bajaj *et* Jairajpuri, 1976, *X. citricolum* n. sp., *X. georgianum* n. sp. and *X. tarjanense* n. sp.

Therefore the morpho-biometrics of all the other species described in this genus must be re-examined to evaluate the importance and the variability of their differential characters with a view to considering the adoption of a division into subgenera, as suggested by Cohn and Sher (1972) or the splitting of the genus into other genera.

We wish to express our gratitude to all those that provided material, however particular thanks are due to Dr. A. C. Tarjan and Dr. M. Luc for loan of their collections, to Dr. C. E. Taylor for critically reading the manuscript, to Mrs. A. Agostinelli and Mr. F. Elia for technical assistance and to Mrs. A. Tosi for typing the manuscript.

S U M M A R Y

Xiphinema americanum Cobb is redescribed from topotype specimens and its geographical distribution discussed. Additional information is provided on morphology, biometrics and geographical occurrence of *X. pachtaicum* (Tulaganov) Kirjanova, *X. brevicolle* Lordello et Da Costa, *X. opisthohysterum* Siddiqi, *X. variabile* Heyns, *X. rivesi* Dalmasso, *X. inaequale* (Khan et Ahmad) Khan et Ahmad, and *X. guirani* Luc et Williams. Fifteen new species are described within the genus *Xiphinema*, namely: *X. oxycaudatum*, *X. diffusum*, *X. incognitum*, *X. laevistriatum*, *X. tenuicutis*, *X. luci*, *X. floridae*, *X. californicum*, *X. sheri*, *X. peruvianum*, *X. citricolum*, *X. intermedium*, *X. georgianum*, *X. utahense*, and *X. tarjanense*. The 25 species with the characters typical of the original *Xiphinema* as described by Cobb are subdivided in six groups.

R I A S S U N T O

Studi su Xiphinema americanum sensu lato con descrizioni di quindici nuove specie (Nematoda, Longidoridae).

Viene ridescritto *Xiphinema americanum* Cobb sulla base di esemplari topotipi ed è discussa la distribuzione geografica di questa specie. Sono riportate ulteriori informazioni su morfologia, biometria e distribuzione geografica di *X. pachtaicum* (Tulaganov) Kirjanova, *X. brevicolle* Lordello et Da Costa, *X. opisthohysterum* Siddiqi, *X. variabile* Heyns, *X. rivesi* Dalmasso, *X. inaequale* (Khan et Ahmad) Khan et Ahmad e *X. guirani* Luc et Williams. Vengono descritte 15 nuove specie in seno al genere *Xiphinema*; esse sono: *X. oxycaudatum*, *X. diffusum*, *X. incognitum*, *X. laevistriatum*, *X. tenuicutis*, *X. luci*, *X. floridae*, *X. californicum*, *X. sheri*, *X. peruvianum*, *X. citricolum*, *X. intermedium*, *X. georgianum*, *X. utahense* e *X. tarjanense*. Le 25 specie con i caratteri tipici della descrizione originale di *Xiphinema* secondo Cobb, vengono suddivise in sei gruppi.

L I T E R A T U R E C I T E D

- ARIAS M. and NAVACERRADA G., 1973 - Geographical distribution of *Xiphinema* Cobb in Spanish vineyards. *Nematol. medit.*, 1: 28-35.
- BAJAJ H.K. and JAIRAJPURI M.S., 1976 - Two new species of *Xiphinema* from India. *Nematol. medit.*, 4: 195-200.
- BAJAJ H.K. and JAIRAJPURI M.S., 1978 - Males of *Xiphinema opisthohysterum* Siddiqi, 1961 and *X. brevicolle* Lordello et Da Costa, 1961 with abnormal gonads. *Nematologica*, 24: 334-337.
- CARVALHO J.C., 1966 - Plantas ornamentais parasitadas por espécies do genero *Xiphinema*. *Rev. Inst. Ad. Lutz*, 15: 180-185.
- CARVALHO J.C., 1962 - Observacoes em torno de duas espécies de *Xiphinema*. *Arg. Inst. Biol.*, 25: 217-221.
- COBB N.A., 1913 - New nematode genera found inhabiting fresh water and non-brackish soils. *J. Wash. Acad. Sci.*, 3: 432-444.
- COBB N.A., 1915 - Nematodes and their relationships. *Yb. U.S. Dept. Agric.* (1914): 456-490.
- COBB N.A., 1918 - Estimating the nema population of soil, with special reference to the sugar-beet and root-gall nemas, *Heterodera schachtii* Schmidt and *Heterodera radicolica* (Greef) Müller, and with a description of *Tylencho-*

- laimus aequalis* n. sp. Agric. Tech. Circ. U.S. Dept. Agric. Bur. Pl. Ind., 1: 1-48.
- COHN E., 1969 - The occurrence and distribution of species of *Xiphinema* and *Longidorus* in Israel. *Nematologica*, 15: 179-192.
- COHN E. and GIER S.A., 1972 - A contribution to taxonomy of the genus *Xiphinema* Cobb, 1913. *J. Nematol.*, 3: 36-45.
- DALMASSO A., 1969 - Étude anatomique et taxonomique des genres: *Xiphinema*, *Longidorus* et *Paralongidorus* (Nemata: Dorylaimida). *Mem. Mus. Hist. Nat. Nouv. Série A., Zool.*, 61: 33-82.
- FLEGG J.J.M., 1968 - The occurrence and depth distribution of *Xiphinema* and *Longidorus* species in Southern England. *Nematologica*, 14: 189-196.
- GRIMALDI-DE ZIO S., D'ADDABBO-GALLO M., LAMBERTI F. and MORONE-DE LUCIA M.R., 1979 - The «Z» differentiation in *Xiphinema* Cobb: an hypothesis of its function in relation to amphigony. *Nematologica*, 25: 36-41.
- HEYNS J., 1966 - Studies on South African *Xiphinema* species, with description of two new species displaying sexual dimorphism of the tail (Nematoda: Dorylaimoidea). *Nematologica*, 12: 369-384.
- HEYNS J., 1974 - The genus *Xiphinema* in South Africa. I. *X. americanum*-group (Nematoda: Dorylaimida). *Phytophylactica*, 6: 157-164.
- HEYNS J., 1977 - The genus *Xiphinema* in South Africa. IV. *X. krugi* Lordello, 1955, *X. mediterraneum* Martelli et Lamberti, 1967 and a new species of the *X. hallei* group (Nematoda: Dorylaimida). *Phytophylactica*, 9: 109-114.
- IMAMURA S., 1931 - Five species of soil nematodes. *Jap. J. appl. Zool.*, 3: 35-38 (In Japanese).
- JAIRAJPURI M.S. and SIDDIQI A.H., 1963 - *Xiphinema brevicolle* Lordello et Da Costa, 1961 (Nematoda: Dorylaimoidea) from Dalhousie (H.P), North India. *Curr. Sci.*, 32: 508.
- KHAN S.H. and AHMAD S., 1975 - Longidoroidea (Thorne, 1935) n. rank (Nematoda: Dorylaimina) with description of *Xiphinema neoamericanum* n. sp. from India and proposal of a new name for *X. americanum sensu* Carvalho (1956) non Cobb, 1913. *Nematol. medit.*, 3: 23-28.
- KHAN S.H. and AHMAD S., 1977 - *Xiphinema inaequale* nom. nov. (syn. *X. neoamericanum* Khan et Ahmad, 1975). *Nematol. medit.*, 5: 93.
- LAMBERTI F. and LOOF P.A.A., 1977 - A note on *Xiphinema inaequale* (Khan et Ahmad) and *X. saopaulense* Khan et Ahmad. *Nematol. medit.*, 5: 109-111.
- LAMBERTI F. and MARTELLI G.P., 1971 - Notes on *Xiphinema mediterraneum* (Nematoda: Longidoridae). *Nematologica*, 17: 75-81.
- LAMBERTI F. and SIDDIQI M.R., 1977 - *Xiphinema pachtaicum* [= *X. mediterraneum*]. C.I.H. Description of Plant-parasitic Nematodes, n. 94, 3 pp.
- LIMA M.B., 1965 - Studies on species of the genus *Xiphinema* and other nematodes. Ph. D. Thesis Univ. London, 165 pp.
- LIMA M.B., 1968 - A numerical approach to the *Xiphinema americanum* complex. *Compt. Rend. VIII Symp. Int. Nematol. Antibes, 1965, France*, E.J. Brill, Leiden, Holland, p. 30.
- LOOS C.A., 1949 - Notes on free-living and plant parasitic nematodes of Ceylon. *No. 5 J. Zool. Soc. India*, 1: 23-29.
- LORDELLO L.G.E. and DA COSTA C.P., 1961 - A new nematode parasite of coffeea roots in Brazil. *Rev. Brasil. Biol.*, 21: 363-366.
- LUC M. and DALMASSO A., 1975 - Considerations on the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) and a «lattice» for the identification of species. *Cah. ORSTOM, Sér. Biol.*, 10: 303-327.
- LUC M. and WILLIAMS J.R., 1978 - *Xiphinema guirani* n. sp. et *X. silvaticum* n. sp. (Nematoda: Longidoridae). *Rev. Nématol.*, 1: 87-97.
- MARTELLI G.P., 1978 - Nematode-borne viruses of grapevine, their epidemiology and control. *Nematol. medit.*, 6: 1-27.

- MARTELLI G.P. and LAMBERTI F., 1967 - Le specie di *Xiphinema* Cobb, 1913 trovate in Italia e commenti sulla presenza di *Xiphinema americanum* Cobb (Nematoda, Dorylaimoidea). *Phytopath. medit.*, 6: 65-85.
- MEYL A.H., 1954 - Die bischer in Italien gefundenen freilebenden Erd und Süßwasser-Nematoden. *Arch. Zool. Ital.*, 39: 161-264.
- MEYL A.H., 1961 - Freilebenden Nematoden. In: Tierwelt Mitteleuropas (Eds. P. Brohmer, R. Ehrman and G. Ulmer), Quelle and Meyer, Lipsia, 164 pp.
- SAXENA P.K., CHHABRA H.K. and JOSHI R., 1973 - *Xiphinema neoamericanum* sp. n. (Nematoda: Longidoridae) from India. *Zool. Anz. Leipzig*, 191: 130-132.
- SIDDIOI M.R., 1959 - Studies on *Xiphinema* spp. (Nematoda: Dorylaimoidea) from Aligarh (North India), with comments on the genus *Longidorus* Micolescky, 1922. *Proc. helm. Soc. Wash.*, 26: 150-163.
- SIDDIOI M.R., 1961 - On *Xiphinema opisthohysterum* n. sp. and *X. pratense* Loos, 1949, two dorylaimid nematodes attacking fruit trees in India. *Z. Parasitkde*, 20: 457-465.
- SIDDIOI M.R., 1973 - *Xiphinema americanum*. C.I.H. Descriptions of Plant-parasitic Nematodes, n. 29, 4 pp.
- SIDDIOI M.R. and LAMBERTI F., 1977 - *Xiphinema mediterraneum* Martelli et Lamberti, a junior synonym of *X. pachticum* (Tulaganov) Kirjanova. *Nematol. medit.*, 5: 133-135.
- SOUTHEY J.F., 1973 - Identification of *Xiphinema* species.. In: A manual prepared for the Workshop sponsored by the Nematology Group of the A.A.B. held at Rothamsted Exp. Stat., June 1973, pp. 37-50.
- STACE-SMITH R. and HANSEN A.J., 1976 - Cherry rasp leaf virus. C.M.I./A.A.B. Descriptions of Plant Viruses, n. 159, 4 pp.
- STURHAN D., 1973 - Zur Nematodenfauna der Azoren. *Bol. Mus. Munic. Funchal.*, 28: 18-25.
- SZCZYGIEL A., 1974 - Plant parasitic nematodes associated with strawberry plantations in Poland. *Zeszyty problemowe, Postepow Nauk Rolnczych*, n. 154, 132 pp.
- SZCZYGIEL A., GONDEK J. and KARAS W., 1969 - The occurrence of plant parasitic nematodes in fruit three nurseries in Southern Poland. *Acta Agraria et Silv., ser. Agraria*, 9: 99-120.
- TARJAN A.C., 1956 - Known and suspected plant-parasitic nematodes of Rhode Island. II. *Xiphinema americanum* with notes on *Tylencholaimus brevicaudatus* n. comb. *Proc. helm. Soc. Wash.*, 23: 88-92.
- TARJAN A.C., 1958 - Note on the selection of types for certain nematodes species. *Nematologica*, 3: 79-80.
- TARJAN A.C., 1968 - Variability in *Xiphinema americanum*. *Compt. Rend. VIII Symp. Int. Nematol., Antibes, 1965, France* E. J. Brill, Leiden, Holland, p. 29.
- TARJAN A.C., 1969 - Variation within the *Xiphinema americanum* group (Nematoda: Longidoridae). *Nematologica*, 15: 241-252.
- TAYLOR C. E. and ROBERTSON W. M., 1975 - Aquisition, retention and trasmission of viruses by nematodes. In: *Nematode Vectors of Plant Viruses* (Eds. F. Lamberti, C. E. Taylor and J. W. Seinhorst) Plenum Press, London and New York, 253-275.
- THORNE G., 1939 - A monograph of the nematodes of the superfamily Dorylaimoidea. *Capita zool.*, 8: 1-261.
- THORNE G., 1961 - Principles of Nematology. McGraw-Hill, New York, Toronto and London, 553 pp.
- TIMM R. W., 1965 - A preliminary survey of the plant parasitic nematodes of Thailand and the Philippines. Thai Sambhand Press, Bangkok, 71 pp.

Accepted for publication on 28 December 1978.