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FIVE UNDESCRIBED SPECIES OF *XIPHINEMA* (NEMATODA: DORYLAIMIDA) FROM THE FORMER TERRITORY OF YUGOSLAVIA

by
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Summary. Five undescribed species of *Xiphinema* from the former territory of Yugoslavia are described. *X. horvatovicae* sp.n. was found in the rhizosphere of *Pinus nigra* near Cista Provo in Croatia. It is a bisexual species with a body length of 3.1 mm, frontally flattened and laterally rounded lip region, separated from the rest of the body by a depression, odontostyle length of ca 123 µm, vulva about 44%, equally developed genital branches with numerous spiniform structures in the uterus, short tail, mostly convex-conoid, rarely near hemispherical, with ventrally directed conical peg. *X. horvatovicae* sp.n. resembles *X. aequum* Roca *et* Lamberti, 1988, *X. illyricum* sp.n., *X. macedonicum* sp.n and *X. thorneanum* Luc, Loof *et* Coomans, 1986. *X. illyricum* sp.n. was found in the rhizosphere of *Carpinus orientalis* near Danilovgrad in Montenegro. This species is characterized by body length of 2.9 mm, frontally flattened and laterally rounded lip region, separated from the rest of the body by a slight depression, odontostyle length of 130 mm, vulva about 44%, equally developed genital branches with numerous spiniform structures in the uterus, convex-conoid short tail with ventrally directed conical peg, rarely without peg and absence of males. *X. illyricum* sp.n. resembles *X. aequum* Roca *et* Lamberti, 1988, *X. horvatovicae* sp.n., *X. macedonicum* sp.n. and *X. thorneanum* Luc, Loof *et* Coomans, 1986. *X. macedonicum* sp.n. was found in the rhizosphere of *Carpinus orientalis* and *Platanus orientalis* on the bank of the Konska river near Konsko, Macedonia. It is a bisexual species with a body length of 3.54 µm, frontally flattened and laterally rounded lip region, separated from the rest of the body by a weak depression, odontostyle length of 130.5 µm, vulva about 47%, equally developed genital branches with numerous spiniform structures in the uterus, convex-conoid short tail with ventrally directed conical peg. *X. macedonicum* sp.n. resembles *X. aequum* Roca *et* Lamberti, 1988, *X. horvatovicae* sp.n. and *X. illlyricum* sp.n. *Xiphinema* sp.A from Bosnia and Herzegovina and *Xiphinema* sp.B from Slovenia are described but they are not named because only one female and juvenile stages and two females were available, respectively.

Numerous soil samples have been taken in the last ten years from various habitats in the former territory of Yugoslavia. Five *Xiphinema* species were found in the samples which, to the best of our knowledge, are undescribed. They are here named as: *Xiphinema horvatovicae* sp.n. from Croatia, *X. illyricum* sp.n. from Montenegro, *X. macedonicum* sp.n. from Macedonia, *Xiphinema* sp.A from Bosnia and Herzegovina and *Xiphinema* sp.B from Slovenia which are not named because only one female and juvenile stages and two females were available, respectively.

Nematodes were extracted using a modified Cobb's decanting and sieving technique (Flegg, 1967). Specimens were killed in hot FP 4-1, processed to glycerin by Andrássy's (1984) rapid method and mounted on permanent slides in dehydrated glycerin. Measurements were made with an eyepiece scale, except body length, which was drawn with a drawing tube and measured with a map measurer.

HIPHINEMA HORVATOVICAE sp.n.

(Table I; Figs. 1-4)

Holotype female: L=3.26 mm; a=55.6; b=7.1; c=76.3; c'=0.99; V=42.7; odontostyle=122.5 µm; odontophore=74.4 µm; oral aperture to basal guide ring=108.7 µm; tail=42.8 µm; J (hyaline portion of tail)=20 µm; body diameter at lip region=15.9 µm; body diameter at guide ring=40 µm; body diameter at base of oesophagus=51.2 µm; body diameter at vulva=58.7 µm; body diameter at anus=43.4 µm; body diameter at beginning of J=28.4 µm.

Description: female *habitus* almost straight anteriorly, more curved behind the vulva, occasionally C shaped, when killed by heat; body cylindrical, tapering very gradually towards the extremities. Cuticle with very fine transverse striations, 3-4 µm thick at mid-body. Lip region frontally flattened and laterally rounded, separated from the rest of the body by a depression; amphids stirrup-shaped with wide aperture. Odontostyle 1.9-2.4 µm in diameter at its base; odontophore with well developed basal flanges; guiding sheath variable in length, with basal guide ring 4.5-5.5 µm wide. Oesophagus basal portion enlarged, occupying about 1/4 of the total oesophagus length, measuring 94-125 µm long and 23-28 µm wide; oesophageal intestinal valve conical. A 3-9 µm long "mucro" is present in the slender part of the oesophagus. Reproductive system amphidelphic, with both genital branches equally developed and reflexed. Oviduct with a slender part and a *pars dilatata oviductus* separated from the uterus by a conspicuous sphincter; uterus consisting of a distinct and well developed *pars dilatata uteri* containing sperms in several specimens, a tube and an ovijector. Tubular portion of the uterus (n=11) 146 (118-181) µm long, thick-walled, convoluted in several specimens. In the entire lumen there are numerous 4-8.6 µm long and 1-2.5 µm wide spiniform structures (more or less dilated mostly spindle shaped spines), with the same distinct higher concentration at both ends. Uterus generally filled with spermatozoa and some females with one or two 159-233 µm long and 34-44 µm wide eggs. Vulva a transverse slit; vagina perpendicular to long body axis, reaching about half of the corresponding diameter. Prerectum (n=13) about 226-486 µm long; rectum almost as long as the body width in anal region or shorter. Tail short, mostly convex-conoid, rarely nearly hemispherical, with a 1.2-11.9 µm long mostly ventrally directed conical peg; blind canal present; 2-3 pairs of caudal pores.

Male generally similar to female with the posterior region of the body more coiled. Testes well developed, functional, filled with sperms. Spicules well developed with 12.5-17.5 µm long guiding pieces. One adanal pair and 3-5 ventromedian supplements present. Tail similar to that of female, with a similar 2.9-11.2 µm long conical peg; blind canal present; 3-4 pairs of caudal pores.

Juveniles clearly separated into four stages (Fig. 4). They resemble adults except for smaller size, body posture being less ventrally curved than adults, and differences in tail length and shape elongate-conoid in first three stages and conoid with a conical peg in fourth stage (Fig. 1 N-Q; Fig. 3 B, D, F, H). Morphometric data of juveniles in Table I.

Type habitat and locality: rhizosphere of *Pinus nigra* Arn., near Cista Provo, Croatia.

Type material: holotype female, 31 female, 21 male and 58 juvenile paratypes in the collection of the Istituto di Nematologia Agraria, Consiglio Nazionale delle Ricerche, Bari, Italy; 23 female and 19 male paratypes at the Institute of Biology, Novi Sad, Yogoslavia; 5 female and 3 male paratypes in the collection at Rothamsted Experimental Station, Entomology and Nematology Department, Harpenden, United Kingdom; 5 female and 3 male paratypes in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, United States of America.

Diagnosis: *Xiphinema horvatovicae* sp.n. is a bisexual species characterized by body length

TABLE I - *Morphometric characters* of Xiphinema horvatovicae *sp. n.*

	Paratype females	Paratype males	J1	J2	J3	J4
n	64	46	11	16	12	19
L (mm)	3.12±0.21 (2.63-3.92)	3.13±0.17 (2.78-3.49)	0.94±0.06 (0.86-1.08)	1.17±0.08 (1.05-1.34)	1.61±0.09 (1.45-1.79)	2.34±0.21 (1.98-2.77)
a	57.7±2.93 (49.7-67.4)	61.7±3.94 (52.5-71.1)	42.2±1.72 (40.4-46.2)	44.9±1.82 (41.8-49.0)	49.3±2.21 (46.5-54.4)	54.9±2.03 (50.6-59.1)
b	6.9±0.51 (5.7-8.5)	7.0±0.37 (6.2-7.7)	3.9±0.28 (3.5-4.3)	4.0±0.28 (3.6-4.6)	4.6±1.18 (4.3-4.8)	5.5±0.51 (4.6-6.7)
c	75.6±7.17 (60.8-93.5)	69.0±5.48 (59.1-86.3)	18.8±1.58 (16.5-22.4)	22.3±1.47 (20.1-26.0)	31.8±2.14 (28.2-35.6)	48.7±4.21 (42.3-56.7)
c'	1.01±0.09 (0.81-1.24)	1.07±0.09 (0.81-1.28)	3.38±0.20 (3.11-3.70)	2.79±0.24 (2.24-3.23)	1.99±0.17 (1.69-2.28)	1.39±0.12 (1.22-1.65)
V	44.3±1.04 (41.9-46.6)	–	–	–	–	–
Odontostyle µm	123.2±3.91 (113.7-133.7)	123.0±4.18 (112.5-131.2)	53.4±1.28 (51.2-56.2)	62.7±2.25 (57.5-66.2)	79.7±2.79 (75.0-86.2)	100.6±3.50 (92.5-107.5)
Odontophore µm	75.8±2.75 (68.7-83.8)	75.9±2.02 (71.2-81.9)	38.2±1.47 (36.2-41.2)	47.6±1.92 (43.7-51.3)	55.6±2.73 (51.2-60.0)	66.5±3.26 (58.7-71.9)
Total stylet µm	199.0±5.12 (186.2-210)	198.9±5.14 (185-213.1)	91.6±1.79 (88.7-93.77)	110.3±2.86 (103.7-115)	135.3±4.77 (126.2-142.5)	167.1±5.29 (156.2-177.5)
Replacement odontostyle µm	–	–	62.8±2.26 (57.5-66.2)	81.8±2.54 (75.0-85.0)	99.3±4.60 (91.2-108.5)	124.6±5.81 (115.0-136.2)
Oral aperture to basal guide ring µm	114.6±4.75 (103.7-125)	115.4±4.82 (101.2-127.5)	45.4±1.66 (42.5-47.5)	57.1±2.13 (55.0-62.5)	72.3±3.26 66.2-78.1	91.5±4.47 (81.2-98.7)
Tail µm	41.5±3.19 (32.5-48.2)	45.6±3.95 (34.2-56.4)	50.2±3.04 (45.7-57.1)	52.8±3.42 (45.3-57.6)	50.7±2.16 (47.1-55.0)	48.1±2.57) (44.3-55.0)
J (hyaline portion of tail) µm	16.9±2.78 (11.4-30)	15.8±2.91 (9.4-23.7)	7.7±1.10 (6.2-10.0)	11.6±1.16 (9.4-13.7)	13.9±1.17 (11.9-15.6)	15.7±1.82 (11.9-18.7)
Body diam. at lip region µm	15.1±0.33 (14.2-16.2)	15.0±0.31 (14.2-15.6)	8.7±0.22 (8.1-9.1)	9.5±0.18 (9.1-9.7)	10.7±0.37 (10.0-11.2)	12.8±0.44 (11.2-13.4)
Body diam. at guide ring µm	39.4±1.36 (36.2-42.5)	38.7±1.14 (36.2-41.2)	17.7±0.46 (17.5-18.7)	21.5±0.60 (20.6-22.5)	26.2±0.92 (25.0-27.5)	32.8±1.34 (30.0-34.4)
Body diam. at base of oesophagus µm	47.4±2.20 (41.2-51.9)	46.1±1.57 (42.5-50.0)	21.9±0.79 (20.4-23.1)	25.7±1.66 (23.7-29.4)	31.6±2.15 28.4-35.0)	40.2±2.81 (35.0-45.0)
Body diam. at mid-body or vulva µm	54.2±2.89 (45.9-60)	50.9±2.21 (45.6-55.6)	22.3±1.07 (20.4-23.7)	26.2±1.97 (23.7-31.2)	32.7±2.63 (28.7-37.8)	42.7±3.82 (36.2-50.9)
Body diam. at anus µm	41.0±2.12 (36.2-45)	42.7±1.68 (38.7-46.2)	14.9±0.84 (13.4-16.2)	19.0±1.74 (16.7-22.9)	25.7±2.22 (22.5-30.3)	34.7±2.80 (30.0-40.6)
Body diam. at beginning of J µm	24.6±2.88 (16.2-29.2)	23.1±3.42 (15.0-28.7)	4.9±0.45 (3.7-5.6)	6.6±0.72 (5.0-7.8)	10.3±1.39 (7.5-12.5)	16.6±2.53 (11.9-20.4)
Spicules µm	–	68.0±3.98 (60.0-80.0)	–	–	–	–

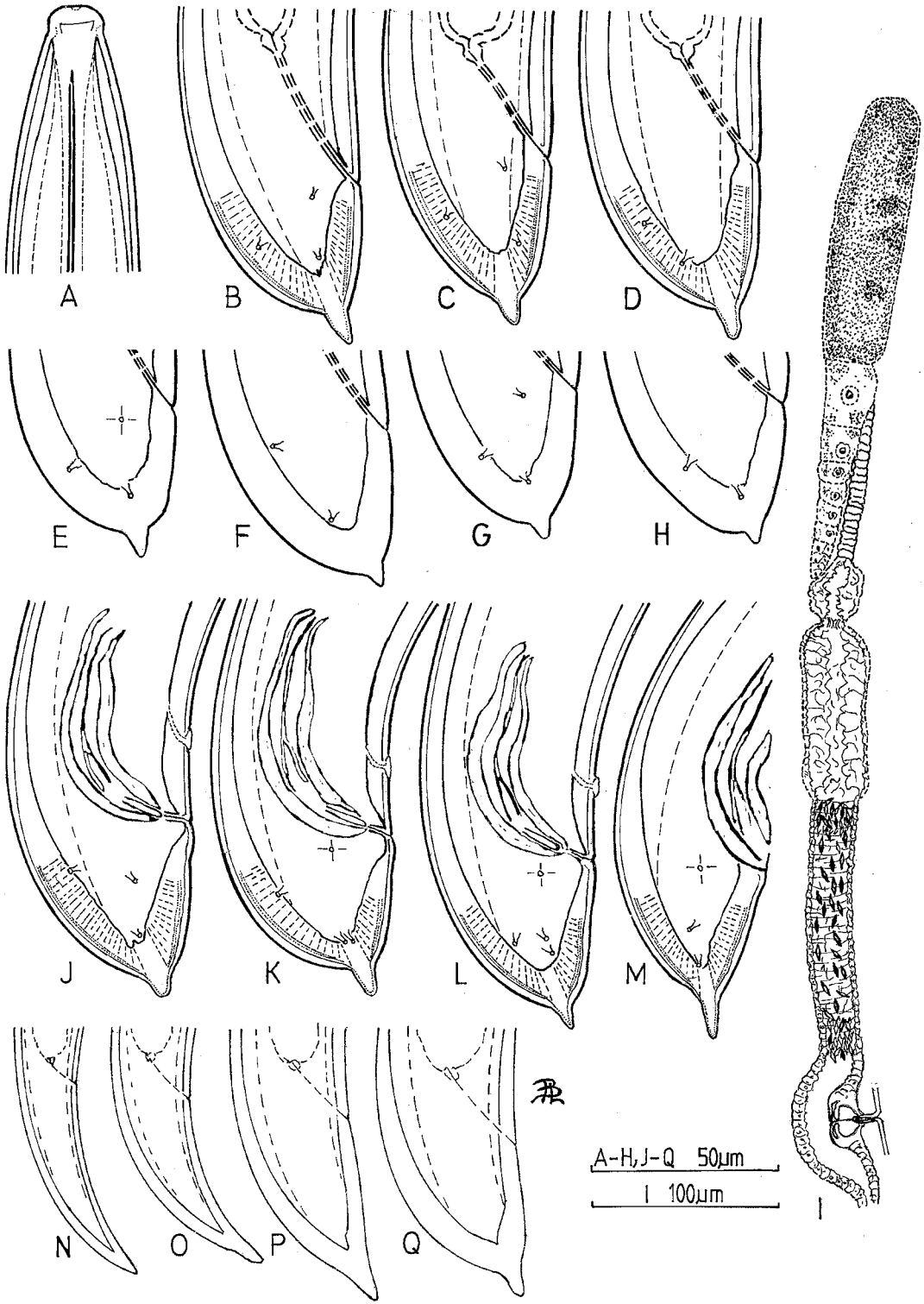

Fig. 1 - *Xiphinema horvatovicae* sp.n.: A, female anterior region; B-H, female posterior region; I, anterior branch of female genital tract; J-M, male posterior region; N-Q, tail of J1, J2, J3 and J4, respectively.

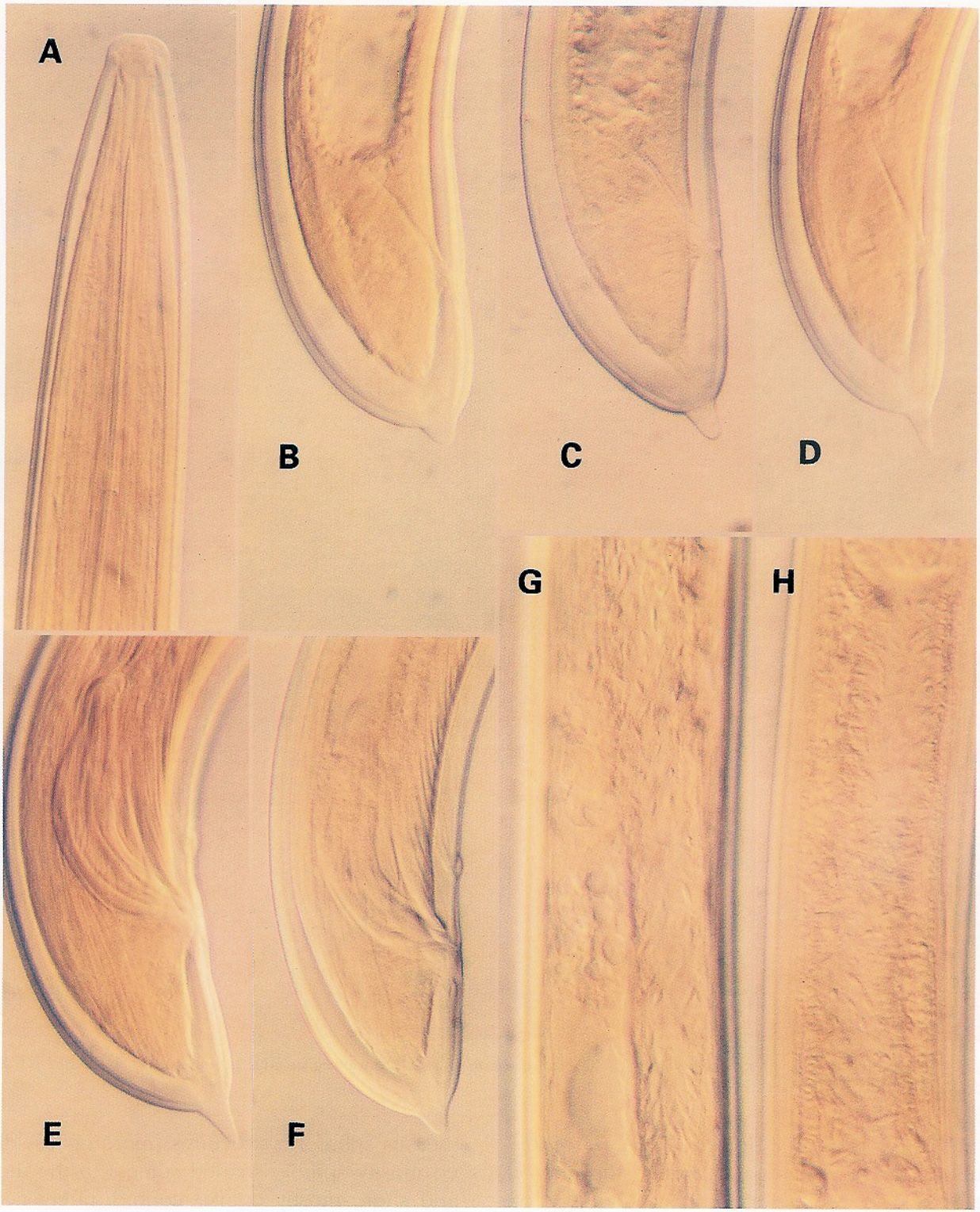

Fig. 2 - Photomicrographs of *X. horvatovicae* sp.n.: A, female anterior region; B-D, female posterior region; E and F, male posterior region; G and H, uterus with spines.

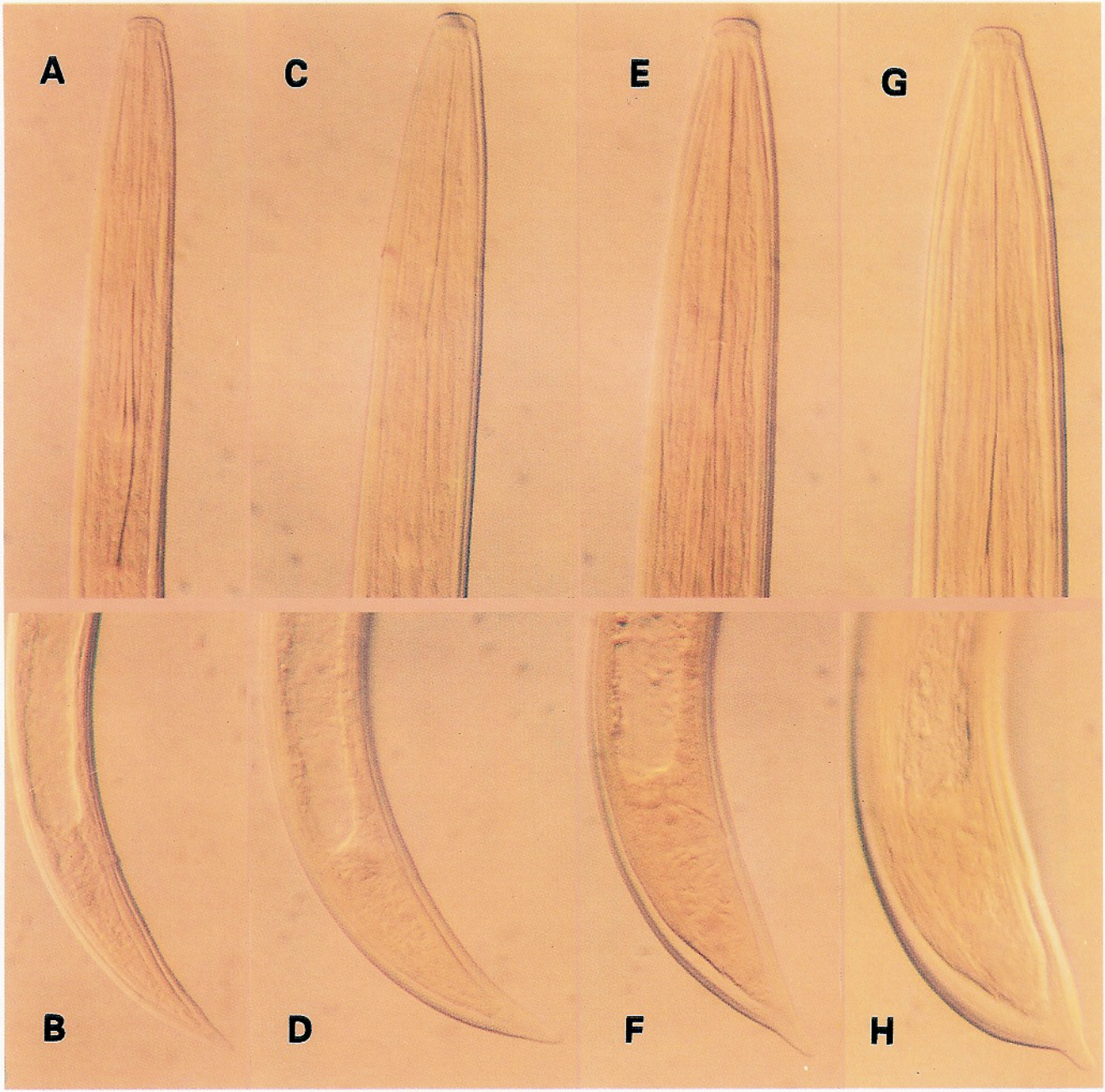

Fig. 3 - Photomicrographs of juvenile stages of X. *horvatovicae* sp.n.: anterior region and tail shape of J1 (A and B); J2 (C and D); J3 (E and F); J4 (G and H).

of 3.1 mm, frontally flattened and laterally rounded lip region, separated from the rest of the body by a depression, odontostyle length of 123 µm, vulva anterior to mid body (V%=44.3), equally developed female genital branches, numerous spiniform structures (more or less dilated mostly spindle shaped spines) in the uterus and short, mostly convex-conoid, rarely nearly hemispherical tail, with a ventrally directed conical peg.

The code for Loof and Luc's (1990, 1993) and Loof *et al.* (1996) polytomous key is: A4, B3, C5a, D56, E45, F34, G23, H2, 13, J5, K2, L2.

Relationships: by the presence of uterine differentiations (spiniform structures or dilated spines) *X. horvatovicae* sp.n. belongs to Loof and Luc's "group 6"; among those species with conical to hemispherical tail with terminal peg it comes close to *X. aequum* Roca *et* Lamberti, 1988, *X. illyricum* sp.n. and *X. macedonicum* sp.n.

It differs from *X. aequum* in having a shorter body (4.1-5.3 mm in *X. aequum*); lower value of c' (1.2-1.5 in *X. aequum*); anterior vulva (44.7-49.8 in *X. aequum*); shorter odontostyle (139.3-150.6 µm in *X. aequum*); smaller distance between basal guide ring and oral opening (110-146 µm in *X. aequum*); shorter tail (46.6-52.0 µm in *X. aequum*); slightly shorter spicules in males (66.6-86.6 µm in *X. aequum*).

It differs from *X. illyricum* sp.n. in the presence of males (males are absent in *X. illyricum* sp.n.); shorter and more muscularized tubular portion of the uterus (thin-walled and 153-187 µm long in *X. illyricum* sp.n.); longer and more dilated spines (spines spindle shaped, 2-6.5 µm long and 0.8-1.5 µm wide with characteristic arrangement before the ovijector in *X. illyricum* sp.n.) and more variable tail shape (tail shape less variable in in *X. illyricum* sp.n.).

It differs from *X. macedonicum* sp.n. in having shorter and more robust body (L=3.36-3.65 mm, value a 69.1-74.8 in *X. macedonicum* sp.n.); anterior vulva (45.8-48.9 in *X. macedonicum* sp.n.); different tail shape (more conical with more or less distinct conical peg in *X. macedonicum* sp.n.); longer spicules in males (59.6-62.8 µm in *X. macedonicum* sp.n.).

X. horvatovicae sp.n. can also be compared with *X. thorneanum* Luc, Loof *et* Coomans, 1986 from Loof and Luc's "group 5". However, it differs from *X. thorneanum* in having a lower a value (66.9-76.6 in *X. thorneanum*); lower c value

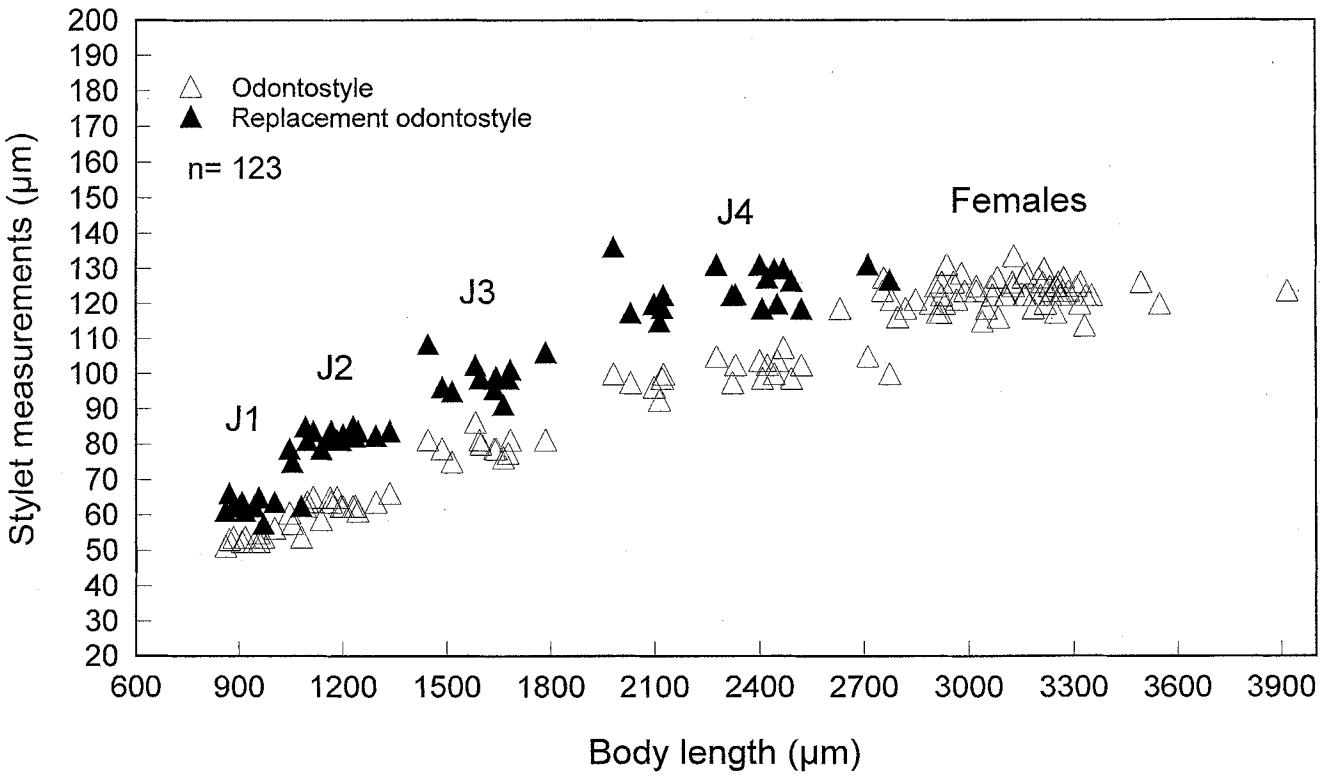

Fig. 4 - Scatter diagram separating juveniles and females of *X. horvatovicae* sp.n.

(91.9-133.6 in *X. thorneanum*); shorter odontostyle and odontophore (89-105 µm and 61-67 µm, respectively, in *X. thorneanum*); longer distance of oral aperture to basal guide ring (73-90 µm in *X. thorneanum*); longer tail (27-36 µm in *X. thorneanum*); absence of pseudo-Z organ (generally present in *X. thorneanum*) and differently shaped and arranged spines (straight, long spines, directed away from vulva in *X. thorneanum*).

The specific name is given in honour of Dr. Andjelka Horvatovic, emeritus professor, Novi Sad, Yugoslavia.

XIPHINEMA ILLYRICUM sp.n.

(Table II; Figs. 5-8)

Holotype female: L=2.89 mm; a=55; b=6.2; c=74.8; c'=1.0; V=44.1; odontostyle=131.2 µm; odontophore=78.8 µm; oral aperture to basal guide ring=120.6 µm; tail=38.6 µm; J (hyaline portion of tail)=16.2 µm; body diameter at lip region=15.9 µm; body diameter at guide ring=40.3 µm; body diameter at base of oesophagus=47.2 µm; body diameter at vulva=52.5 µm; body diameter at anus=38.7 µm; body diameter at beginning of J=22.5 µm.

Description: dead female *habitus* as open C-shape, almost straight anteriorly and more curved behind the vulva; body cylindrical, tapering very gradually towards the anterior extremity. Cuticle apparently smooth, but with very fine transverse striations at the posterior region, 2.8-3.5 µm thick at mid-body. Labial region rounded laterally and flattened frontally, separated from the rest of the body by a slight depression; amphids stirrup-shaped with wide aperture. Odontostyle 1.9-2.2 µm in diameter at its base; odontophore well flanged; guiding "tube" variable in length with basal guide ring 5-5.5 µm wide. Oesophagus dorylaimoid, basal bulb measuring 96-121 µm long and 22-28 µm wide, occupying about 1/4 of the total oesophagus length. A 3-5 µm long "mucro" is present in the tubular part of the oesophagus. Reproductive system amphidelphic, with both genital branches equally developed. Ovaries reflexed; oviduct with a slender part and a *pars dilatata oviductus* separated from the uterus by a conspicuous sphincter; uterus consisting of a long and wide *pars dilatata uteri*, a tubular portion and an ovijector. Tubular portion of the uterus (n=11) 169 (153-187) µm long, thin-walled, convoluted in several specimens. In the entire lumen there are numerous spiniform structures (spindle shaped spines), 2-6.5 µm long and slender, 0.8-1.5 µm in diameter, distributed irregularly, with the same distinct higher concentration just after *pars dilatata* and before the ovijector, where the arrangement of the spines is characteristic (Fig. 5 D). No sperm was seen inside the uteri. Prerectum variable in length. Rectum shorter to longer then the body width in anal region. Tail short conoid, dorsally convex, ventrally slightly convex or almost straight, with a blind canal and a 1.7-10.6 µm long mostly ventrally directed conical peg which is sometimes ventrally bended (exceptionally without a peg), bearing 2-3, seldom one, caudal pores on each side.

Males not found.

Juveniles clearly separated into four stages (Fig. 8). They are morphologically similar to adult females but smaller in size; tail of first and second stage elongate-conoid, and conoid with more or less distinct conical peg in third and fourth stage (Fig. 5 E-H; Fig. 7 B, D, F, H).

Type habitat and locality: rhizosphere of *Carpinus orientalis* Mill. near Danilovgrad, Montenegro, Yugoslavia.

Type material: holotype female, 34 female and 52 juvenile paratypes in the collection of the Istituto di Nematologia Agraria, Consiglio Nazionale delle Ricerche, Bari, Italy; 17 female and 14 juvenile paratypes at Institute of Biology, Novi Sad, Yugoslavia; 5 female paratypes in the collection at Rothamsted Experimental Station, Entomology and Nematology Department, Harpenden, United Kingdom; 5 female paratypes in the Plant Nematology Laboratory Collection, United States Department of Agriculture, Beltsville, Maryland, United States of America.

TABLE II -*Morphometric characters* of Xiphinema illyricum *sp. n.*

	Paratype females	J1	J2	J3	J4
n	61	8	21	16	21
L (mm)	2.92±0.20 (2.43-3.42)	0.92±0.04 (0.86-1.00)	1.15±0.08 (1.04-1.34)	1.61±0.09 (1.43-1.73)	2.18±0.14 (1.95-2.41)
a	54.4±2.00 (50.0-60.1)	36.8±0.55 (35.7-37.4)	40.6±1.34 (38.4-43.1)	43.7±1.08 (42.2-46.1)	48.7±2.67 (43.7-53.9)
b	6.3±0.37 (5.5-7.1)	3.7±0.19 (3.4-3.9)	4.0±0.36 (3.6-4.7)	4.5±0.32 (4.1-5.4)	5.2±0.38 (4.5-6.0)
c	73.0±6.42 (61.0-92.2)	16.4±0.69 (15.5-17.3)	20.2±1.18 (18.2-22.7)	30.2±1.63 (26.5-32.8)	47.1±4.33 (38.5-54.2)
c'	1.03±0.07 (0.85-1.19)	3.4±0.19 (3.0-3.6)	2.76±0.19 (2.33-3.01)	1.97±0.11 (1.79-2.16)	1.35±0.10 (1.18-1.56)
V	44.2±0.95 (41.8-46.7)	–	–	–	–
Odontostyle µm	130.0±2.50 (122.5-136.2)	50.8±0.86 (50.0-52.5)	64.3±2.04 (57.5-67.5)	86.9±2.02 (82.5-91.2)	106.8±2.81 (102.5-112.5)
Odontophore µm	76.0±2.53 (68.7-81.9)	37.9±1.49 (36.2-40.6)	47.3±2.95 (37.5-51.9)	55.5±1.80 (52.8-58.8)	65.6±1.87 (60.0-68.8)
Total stylet µm	206.0±3.55 (197.5-216.2)	88.7±1.60 (86.2-91.8)	111.6±3.78 (101.3-118.1)	142.4±3.42 (135.0-148.7)	172.4±4.07 (165.6-180.0)
Replacement odontostyle µm	–	65.1±1.33 (63.7-67.5)	87.5±3.06 (78.7-92.1)	106.7±3.39 (100.0-112.5)	130.3±3.21 (121.3-134.9)
Oral aperture to basal guide ring µm	121.9±3.75 (114.4-130)	44.1±1.68 (40.6-46.2)	58.7±2.07 (53.8-61.9)	78.1±3.32 (70.0-83.7)	98.1±2.71 (93.7-105.0)
Tail µm	40.1±3.15 (31.8-46.4)	56.3±3.36 (51.4-62.8)	57.1±3.46 (50.0-63.5)	53.5±2.90 (47.5-58.5)	46.5±2.42 (41.1-50.7)
J (hyaline portion of tail) µm	15.0±1.80 (10.0-20.0)	8.9±0.94 (7.5-10.0)	15.6±1.15 (13.7-17.5)	18.3±1.70 (15.0-21.2)	14.4±1.43 (11.9-17.5)
Body diam. at lip region µm	15.1±0.26 (14.4-15.6)	8.7 (8.7-8.7)	9.5±0.23 (9.2-10.0)	11.2±0.17 (10.9-11.3)	12.8±0.39 (12.5-13.8)
Body diam. at guide ring µm	40.2±1.04 (36.2-42.2)	18.5±0.26 (18.1-18.7)	22.7±0.67 (21.7-25.0)	28.6±0.60 (27.2-29.4)	34.8±1.55 (32.5-39.7)
Body diam. at base of oesophagus µm	48.3±2.14 (41.2-52.5)	24.7±0.57 (23.4-25.4)	28.0±2.12 (25.6-33.4)	35.5±1.54 (32.2-37.5)	42.6±2.48 (38.7-46.9)
Body diam. at mid-body or vulva µm	53.6±3.14 (44.7-59.7)	25.1±0.83 (23.7-26.9)	28.4±2.44 (25.6-35.0)	37.0±1.99 (32.5-39.7)	44.8±3.59 (38.7-50.6)
Body diam. at anus µm	38.8±1.82 (33.3-42.5)	16.7±0.46 (16.2-17.5)	20.7±1.49 (19.2-25.4)	27.2±1.14 (23.7-28.4)	34.6±1.46 (31.7-36.9)
Body diam. at beginning of J µm	20.2±1.77 (13.7-24.4)	5.1±0.42 (4.4-5.6)	7.4±0.63 (6.2-8.7)	10.9±1.06 (9.2-12.5)	14.0±1.30 (12.2-17.5)

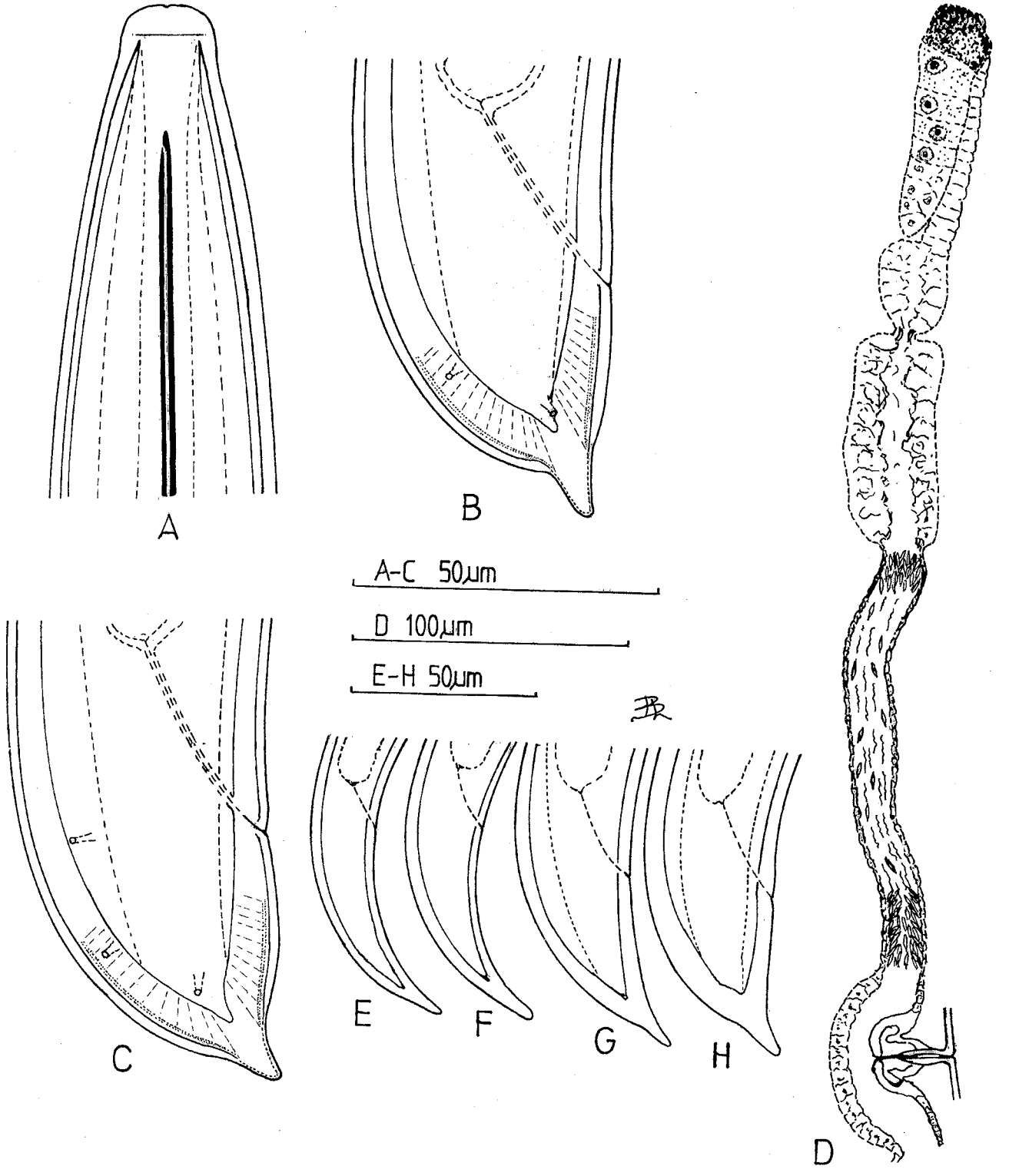

Fig. 5 - *Xiphinema illyricum* sp.n.: A, female anterior region; B and C, female posterior region; D, anterior branch of female genital tract; E-H, tail of J1, J2, J3 and J4, respectively.

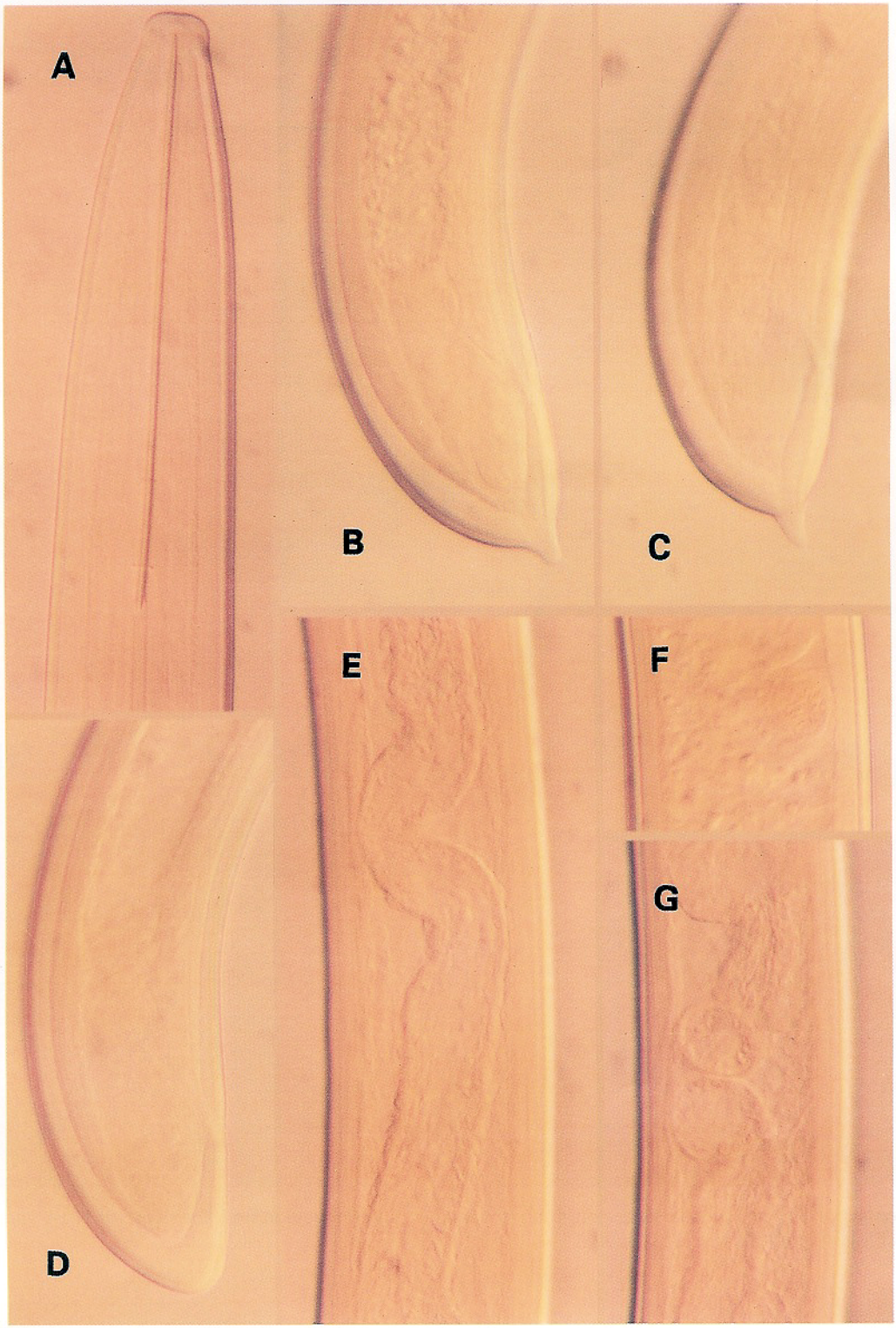

Fig. 6 - Photomicrographs of *X. illyricum* sp.n.: A, female anterior region; B-D, female posterior region; E-G, uterus with spines.

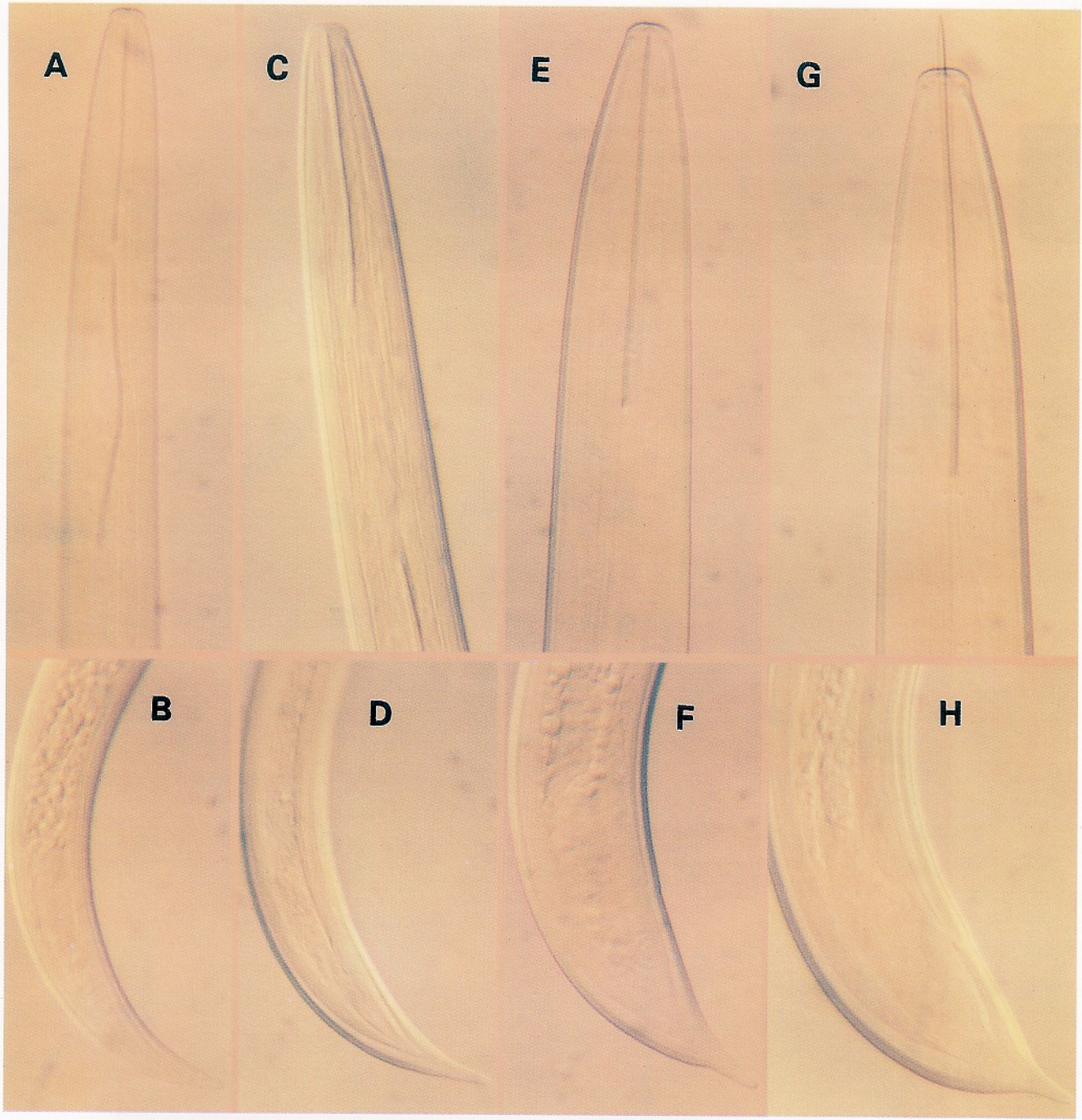

Fig. 7 - Photomicrographs of juvenile stages of *X. illyricum* sp.n.: anterior region and tail shape of J1 (A and B); J2 (C and D); J3 (E and F); J4 (G and H).

3.65 mm, value a 69.1-75.8 in *X. macedonicum* sp.n.); anterior vulva (45.8-48.9 in *X. macedonicum* sp.n.); different tail shape (more conical in *X. macedonicum* sp.n.) and absence of males (males are present in *X. macedonicum* sp.n.).

X. illyricum sp.n. can also be compared with *X. thorneanum* Luc, Loof *et* Coomans, 1986 from Loof and Luc's "group 5". However, it differs from *X. thorneanum* in having a lower a value (66.9-76-6 in *X. thorneanum*); lower c value (91,9-133.6 in *X. thorneanum*); shorter odontostyle and odontophore (89-105 µm and 61-67 µm, respectively, in *X. thorneanum*); longer distance of oral aperture to basal guide ring (73-90 µm in *X. thorneanum*); longer tail (27-36 µm in *X. thorneanum*); absence of pseudo-Z organ (generally present in *X. thorneanum*), differently shaped and arranged spines (straight, long spines, directed away from vulva in *X. thorneanum*) and absence of males (males are present in *X. thorneanum*).

XIPHINEMA MACEDONICUM sp.n.

(Table III; Figs. 9-10)

Description: dead female *habitus* hook- or open C-shaped, almost straight anteriorly and more curved behind the vulva; body cylindrical, tapering very gradually towards the extremities. Cuticle very fine transversely striated, 2.5-3 µm thick at mid body. Lip region frontally flattened and rounded laterally, separated from the rest of the body by a weak depression. Amphidial pouches stirrup-shaped. Odontostyle 1.8-2 µm in diameter in its base; flanges of odontophore 11.6-13.6 µm wide. Oesophagus dorylaimoid, basal bulb measuring 110-120 µm long and 23-24 µm wide, occupying ca. 1/4 of the total oesophagus length. Reproductive system amphidelphic, with both genital branches equally developed. Each branch composed of an ovary, an oviduct, a sphincter, a *pars dilatata uteri*, a long tubular portion with 3-4.5 µm long and 0.8-1.3 µm wide spiniform structures and an ovijector. Spiniform structures are distributed over the entire length of the tubular part of the uterus with higher concentration at both ends. Vulva a transverse slit, situated slightly anterior to mid body. Rectum shorter than anal body width. Tail convex-conoid, with a ventrally directed 4.4-10 µm long conical peg; blind canal present; two caudal pores on each side.

Male generally similar to female with the posterior region of the body more coiled. Testes well developed, functional, filled with sperms. Spicules well developed with 13.7-15.0 µm long guiding pieces. One adanal and 3-4 ventromedian supplements present. Tail similar to that of female but slightly more convex dorsally, with a ventral 6.2-8.4 µm long conical peg; blind canal present; 4-5 pairs of caudal pores.

Type habitat and locality: rhizosphere of *Carpinus orientalis* Mill. and *Platanus orientalis* L. on the bank of the Konska river near Konsko, Macedonia.

Type material: holotype female, 3 female and 2 male paratypes in the collection at the Istituto di Nematologia Agraria, Consiglio Nazionale delle Ricerche, Bari, Italy; 2 female and 1 male paratypes in the collection at Rothamsted Experimental Station, Entomology and Nematology Department, Harpenden, United Kingdom.

Diagnosis: *Xiphinema macedonicum* sp.n. is a bisexual species characterized by body length of 3.54 mm, frontally flattened and laterally rounded lip region separated from the rest of the body by a weak depression, odontostyle length of 130.5 µm, vulva anterior to mid body (V%=47.4), equally developed female genital branches, spiniform structures in the uterus and convex-conoid tail with ventrally directed conical peg.

The code in the polytomous key (Loof and luc, 1990) is: A4, B3, C5a, D56, E5, F34, G3, H2, I3, J?, K?, L2.

Relationships: by the presence of uterine differentiations (spiniform structures or dilated spines) *X. macedonicum* sp.n. belongs to Loof and Luc's "group 6"; among those species with conical to hemispherical tail with terminal peg it

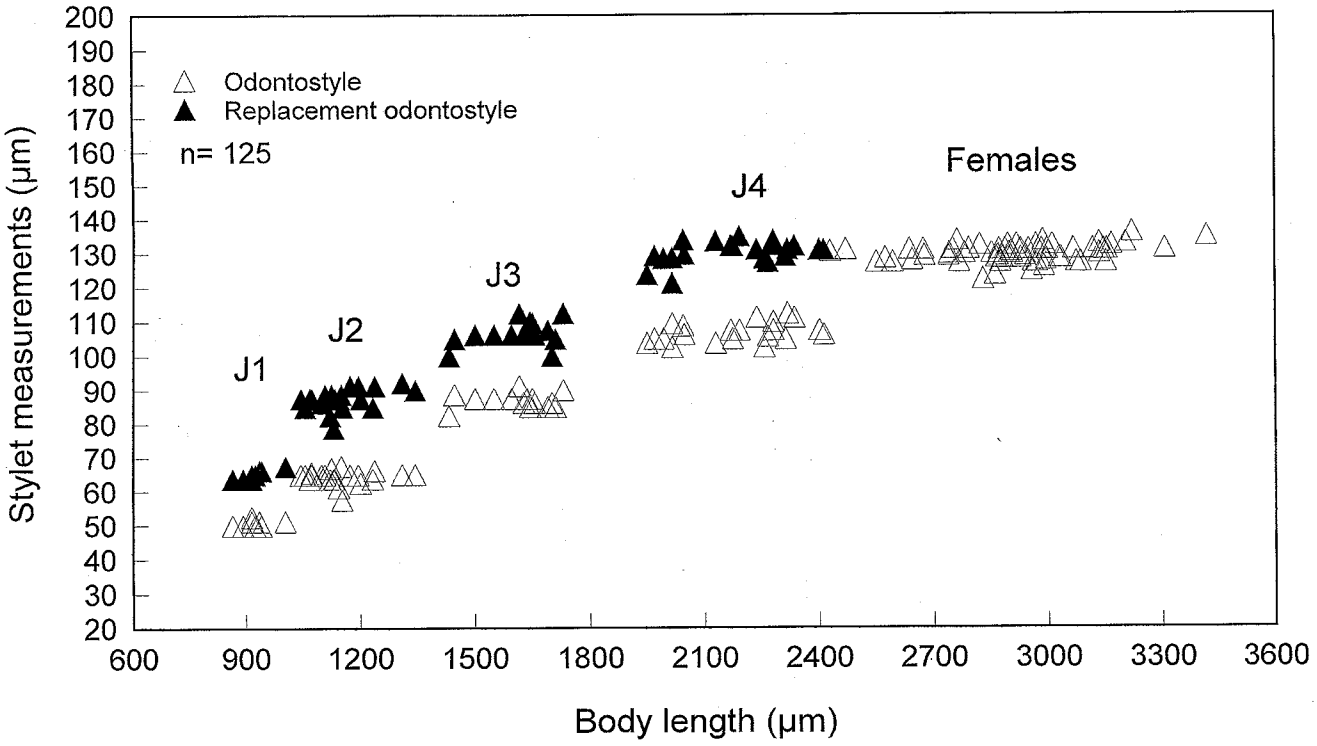

Fig. 8 - Scatter diagram separating juveniles and females of *X. illyricum* sp.n.

Diagnosis: *Xiphinema illyricum* sp.n. is a monosexual species characterized by body length of 2.92 mm, frontally flattened and laterally rounded lip region, separated from the rest of the body by a slight depression, odontostyle length of 130 µm, vulva anterior to mid body (V%=44.2), equally developed female genital branches, numerous spiniform structures in the uterus and convex-conoid tail with ventrally directed conical peg, exceptionally without a peg.

The code for Loof and Luc's (1990, 1993) and Loof *et al.* (1996) polytomous key is: A4, B3, C5a7b, D56, E45, F23, G23, H2, I3, J5, K2, L1.

Relationships: by the presence of uterine differentiations (spiniform structures or dilated spines) *X. illyricum* sp.n. belongs to Loof and Luc's "-group 6"; among those species with conical to hemispherical tail with terminal peg it comes close to *X. aequum* Roca *et* Lamberti, 1988, *X. horvatovicae* sp.n. and *X. macedonicum* sp.n.

It differs from *X. aequum* in having a shorter body (4.1-5.3 mm in *X. aequum*); lower value of c' (1.2-1.5 in *X. aequum*); anterior vulva (44.7-49.8 in *X. aequum*); shorter odontostyle (139.3-150.6 µm in *X. aequum*); shorter tail (46.6-52.0 µm in *X. aequum*) and absence of males (males are present in *X. aequum*).

It differs from *X. horvatovicae* sp.n. in absence of males (males are present in *X. horvatovicae* sp.n.); longer and less muscularized tubular portion of the uterus (thick-walled and 118-181 µm long in *X. horvatovicae* sp.n.); shorter and more slender spines with characteristic arrangement before the ovijector (more or less dilated mostly spindle shaped spines, 4-8.6 µm long and 1-2.5 µm wide in *X. horvatovicae* sp.n.) and less variable tail shape (tail shape more variable in *X. horvatovicae* sp.n.).

It differs from *X. macedonicum* sp.n. in having a shorter and more robust body (L=3.36-

TABLE III - *Morphometric characters* of Xiphinema macedonicum *sp. n.*

	Holotype female	Paratype females	Paratype males
n		5	3
L (mm)	3.41	3.54±0.10 (3.36-3.65)	3.56±0.09 (3.49-3.70)
a	74.7	73.0±2.19 (69.1-75.8)	77.8±1.80 (75.6-80.0)
b	7.7	7.6±0.37 (7.1-8.1)	7.4±0.28 (7.0-7.6)
c	91.8	81.2±10.3 (68.5-99.0)	83.7±3.76 (78.4-86.7)
c'	1.11	1.19±0.16 (0.92-1.41)	1.15±0.05 (1.11-1.22)
V	48.5	47.4±1.24 (45.8-48.9)	–
Odontostyle µm	130.0	130.5±7.37 (118.7-140.0)	132.5±2.04 (130.0-135.0)
Odontophore µm	73.7	77.2±3.39 (72.5-82.5)	74.4±3.87 (70.0-79.4)
Total stylet µm	203.7	207.7±6.48 (201.2-218.7)	206.9±5.90 (200.0-214.4)
Oral aperture to basal guide ring µm	118.1	120.0±4.05 (115.6-126.9)	122.1±2.29 (119.4-125.0)
Tail µm	37.1	44.2±5.69 (35.3-52.3)	42.7±3.12 (40.3-47.1)
J (hyaline portion of tail) µm	7.2	15.4±2.51 (13.4-20.0)	14.8±1.51 (13.7-16.9)
Body diam. at lip region µm	14.7	14.6±0.22 (14.4-15.0)	14.5±0.14 (14.4-14.7)
Body diam. at guide ring µm	35.6	36.1±1.21 (34.4-37.5)	36.3±0.83 (35.6-37.5)
Body diam. at base of oesophagus µm	41.9	44.2±2.05 (41.2-47.5)	43.0±0.79 (41.9-43.7)
Body diam. at mid-body or vulva µm	45.6	48.5±0.64 (47.5-49.4)	45.8±0.57 (45.0-46.2)
Body diam. at anus µm	33.4	36.1±1.83 (32.5-37.5)	37.0±1.18 (36.2-38.7)
Body diam. at beginning of J µm	13.4	18.5±2.53 (15.6-22.5)	21.4±0.79 (20.6-22.5)
Spicules µm	–	–	61.0±1.33 (59.6-62.8)

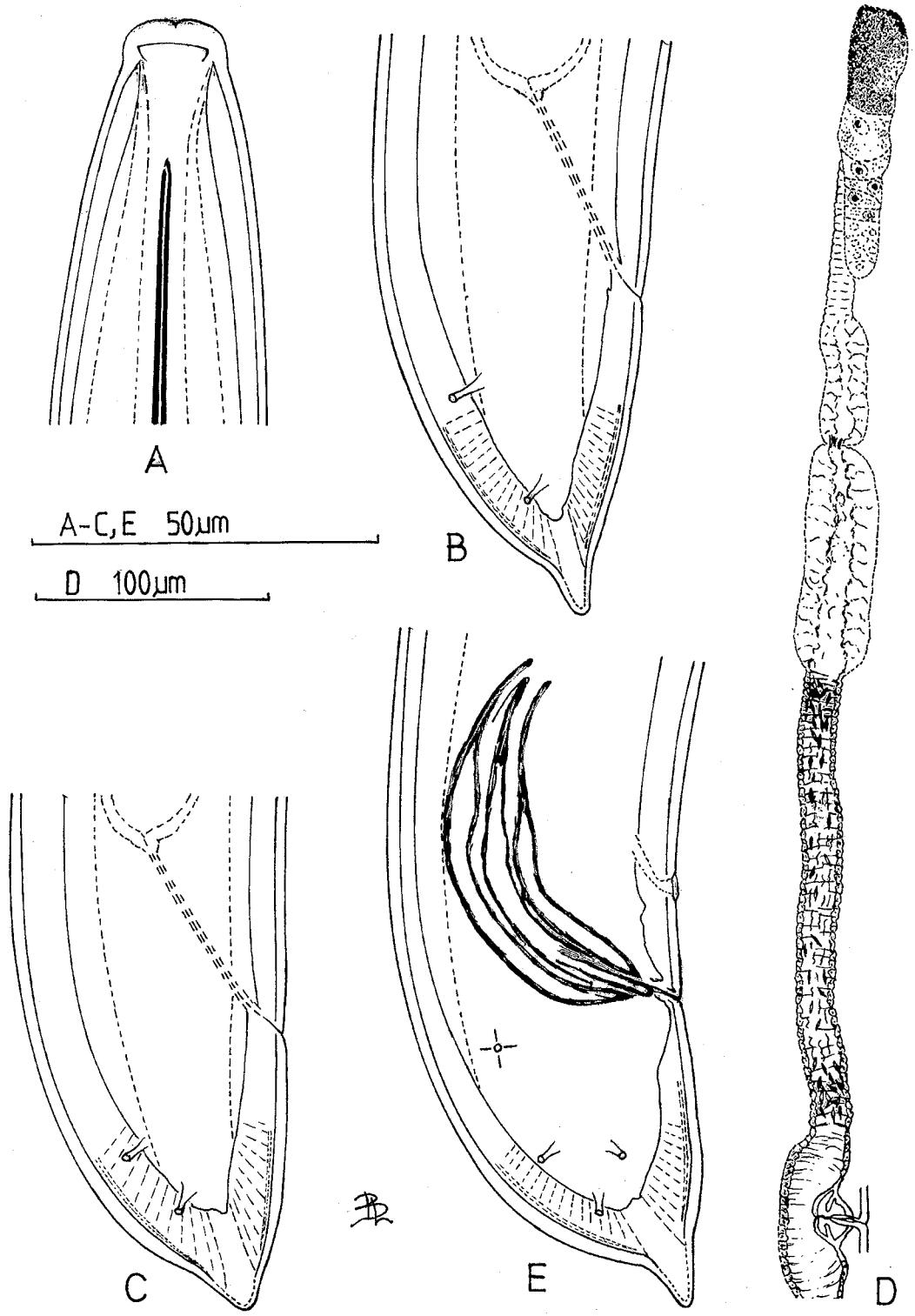

Fig. 9 - *Xiphinema macedonicum* sp.n.: A, female anterior region; B and C, female posterior region; D, anterior branch of female genital tract; E, male posterior region.

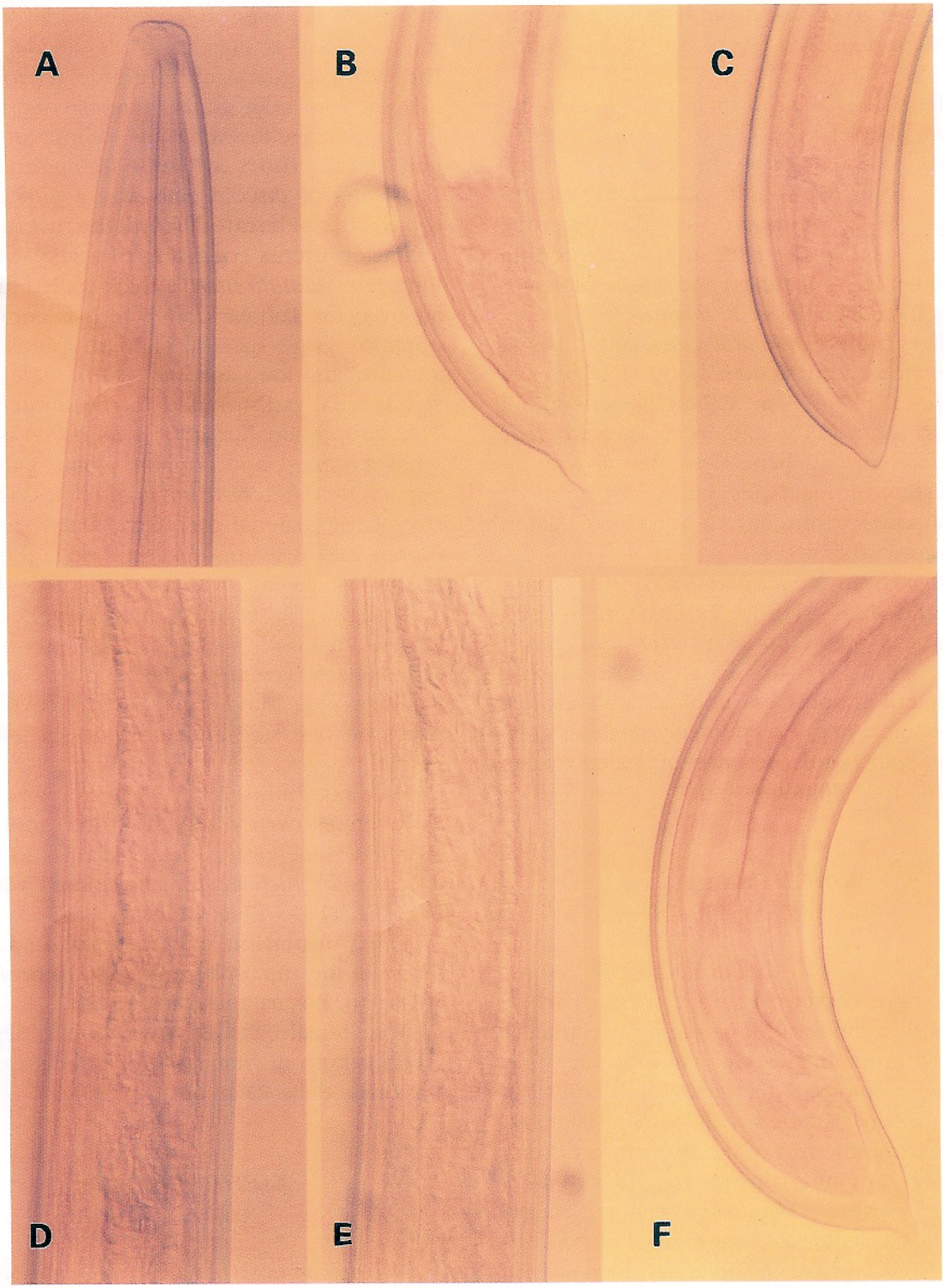

Fig. 10 - Photomicrographs of *X. macedonicum* sp.n.: A, female anterior region; B and C, female posterior region; D and E, uterus with spines; F, male posterior region.

comes close to *X. aequum* Roca *et* Lamberti, 1988, *X. horvatovicae* sp.n. and *X. illyricum* sp.n.

It differs from *X. aequum* in having a shorter and more slender body (L=4.1-5.3 mm, value a 76.0-109.6 in *X. aequum*); lower c' value (1.2-1.5 in *X. aequum*); shorter odontostyle (139.3-150.6 µm in *X. aequum*); smaller distance between basal guide ring and oral opening (110-146 µm in *X. aequum*) and shorter spicules in males (66.6-86.6 µm in *X. aequum*).

It differs from *X. horvatovicae* sp.n. in having a longer and more slender body (L=2.63-3.92 mm, value a 49.7-67.4 in *X. horvatovicae* sp.n.); posterior vulva (41.9-46.6 in *X. horvatovicae* sp.n.); different tail shape (less conical with always distinct conical peg in *X. horvatovicae* sp.n.); shorter spicules in males (60.0-80.0 µm in *X. horvatovicae* sp.n.).

It differs from *X. illyricum* sp.n. in having a longer and more slender body (L=2.43-3.42 mm, value a 50.0-60.1 in *X. illyricum* sp.n.); posterior vulva (41.8-46.7 in *X. illyricum* sp.n.); different tail shape (less conical with always distinct conical peg, exceptionally pegless, in *X. illyricum* sp.n.) and presence of males (males are absent in *X. illyricum* sp.n.).

XIPHINEMA sp.A

(Table IV; Figs. 11-13)

Description: female *habitus* anteriorly almost straight, more curved behind the vulva, when killed; body cylindrical, tapering very gradually towards the extremities. Cuticle with very fine transverse striations, 5 µm thick at mid body. Lip region frontally flattened and rounded laterally, separated from the rest of the body by a distinct depression; amphids stirrup-shaped with 12.5 µm wide aperture. Odontostyle robust, 2.5 µm in diameter at its base, basal flanges of odontophore 17.7 µm wide. Oesophagus dorylaimoid, with basal portion enlarged, occupying more than 1/4 of the total oesophagus length, measuring 134 µm long and 26 µm wide. A 6.3 µm long "mucro" is present in the slender part of the oesophagus. Amphidelphic reproductive system, with both genital branches equally developed and reflexed. Ovary without any particular characteristic; oviduct with a slender part consisting of discoid cells and a *pars dilatata oviductus* separated from the uterus by a sphincter. Uterus consisting of a very wide and long *pars dilatata uteri*, a thick-walled tube and an ovijector. Tubular part, which is convoluted, contains large spindle shaped spines (about 12.6-16.7 µm long and 1.8-2.3 µm wide), which seem equally distributed in the entire lumen. Tubular portion just after *pars dilata* is somewhat widened and contains some inclusions, apparently different from large spines. The scarcity of the material (only one female has been found) makes it impossible to judge the nature of these inclusions. Vulva a transverse slit, situated slightly anterior to mid body. Rectum as long as anal body width. Tail short conoid, dorsally convex, ventrally slightly convex with a 15 µm long peg; blind canal present; two caudal pores on one side and three on the other are visible.

Male not found.

Juveniles clearly separated into four stages (Fig. 13). General appearance similar to female, except tail which is elongate conoid without a peg (Fig. 11 D-G; Fig. 12 D-G).

The population of *Xiphinema* sp.A was found in the rhizosphere of *Corylus avellana* L. at Duvno, Bosnia and Herzegovina.

Note: female and 24 juveniles are deposited at the Istituto di Nematologia Agraria, Consiglio Nazionale delle Ricerche, Bari, Italy.

XIPHINEMA sp.B

(Figs. 14-15)

Measurements: (females, n=2). L=3.49-3.67 mm; a=68.1-70; b=7.4-7.1; c=99.7-91.9; c'=0.83-0.89; V=46.1-46.9; odontostyle=148.1-

TABLE IV - *Morphometric characters* of Xiphinema *sp. A.*

	Female	J1	J2	J3	J4
n	1	4	9	8	3
L (mm)	4.44	1.40±0.02 (1.37-1.42)	1.78±0.09 (1.62-1.93)	2.46±0.09 (2.33-2.60)	3.21±0.06 (3.15-3.29)
a	69.7	47.0±1.45 (45.5-49.4)	50.1±2.30 (45.9-53.2)	51.6±2.58 (47.2-54.6)	57.6±1.46 (55.5-58.6)
b	7.4	4.5±0.08 (4.4-4.6)	4.6±0.24 (4.2-5.0)	5.4±0.32 (5.1-6.1)	6.0±0.08 (5.9-6.1)
c	81.8	18.0±0.52 (17.6-18.9)	22.5±0.80 (21.4-23.9)	35.2±1.18 (32.7-36.2)	52.5±2.97 (49.6-56.6)
c'	1.17	3.66±0.12 (3.54-3.83)	3.02±0.09 (2.91±3.16)	2.13±0.10 (1.94-2.29)	1.60±0.08 (1.52-1.71)
V	46.9	–	–	–	–
Odontostyle µm	158.8	75.9±1.34 (73.8-77.5)	88.3±1.09 (86.9-90.0)	111.9±2.42 (107.5-115.0)	133.7±2.68 (130.0-136.2)
Odontophore µm	93.7	50.9±1.03 (50.0-52.5)	62.9±1.15 (61.2-65.0)	73.2±1.52 (70.6-75.0)	81.7±3.12 (77.5-85.0)
Total stylet µm	252.5	126.8±1.88 (125.0-130.0)	151.2±1.70 (149.4-155.0)	185.1±2.79 (180.0-188.7)	215.4±5.61 (207.5-220.0)
Replacement odontostyle µm	–	88.0±1.22 (86.2-89.4)	113.4±1.82 (110.0-115.7)	136.6±1.81 (133.5-139.2)	160.4±1.79 (158.5-162.8)
Oral aperture to basal guide ring µm	146.9	67.9±3.11 (63.7-71.2)	83.4±4.34 (76.2-93.1)	104.0±2.59 (101.2-107.5)	123.1±4.84 (116.9-128.7)
Tail µm	54.3	77.8±1.81 (75.0-80.0)	79.0±2.40 (75.0-82.8)	69.9±2.62 (64.3-73.2)	61.3±2.24 (58.2-63.5)
J (hyaline portion of tail) µm	27.5	17.8±1.38 (16.2-20.0)	23.0±1.95 (20.0-25.6)	24.8±1.04 (23.1-26.5)	20.8±1.58 (18.7-22.5)
Body diam. at lip region µm	17.5	9.7±0.00 (9.7-9.7)	11.1±0.15 (10.9-11.2)	13.0±0.27 (12.5-13.4)	15.3±0.25 (15.0-15.6)
Body diam. at guide ring µm	44.4	23.3±0.49 (22.5-23.7)	27.6±0.48 (26.7-28.4)	34.5±0.97 (33.1-36.2)	41.2±0.45 (40.6-41.7)
Body diam. at base of oesophagus µm	54.4	28.8±0.37 (28.4-29.4)	34.3±1.75 (30.6-36.2)	44.0±1.35 (42.8-47.2)	52.3±1.28 (50.6-53.7)
Body diam. at mid-body or vulva µm	63.7	29.8±0.92 (28.7-31.2)	35.6±2.57 (30.9-38.7)	47.7±2.18 (45.0-52.5)	55.8±1.58 (53.7-57.5)
Body diam. at anus µm	46.2	21.3±0.78 (20.3-22.5)	26.2±0.89 (24.7-27.5)	32.9±0.99 (31.2-35.0)	38.3±0.82 (37.2-39.2)
Body diam. at beginning of J µm	28.1	8.8±0.29 (8.4-9.2)	11.3±0.65 (10.4-12.8)	15.1±0.73 (13.7-16.2)	17.5±2.33 (14.7-20.4)

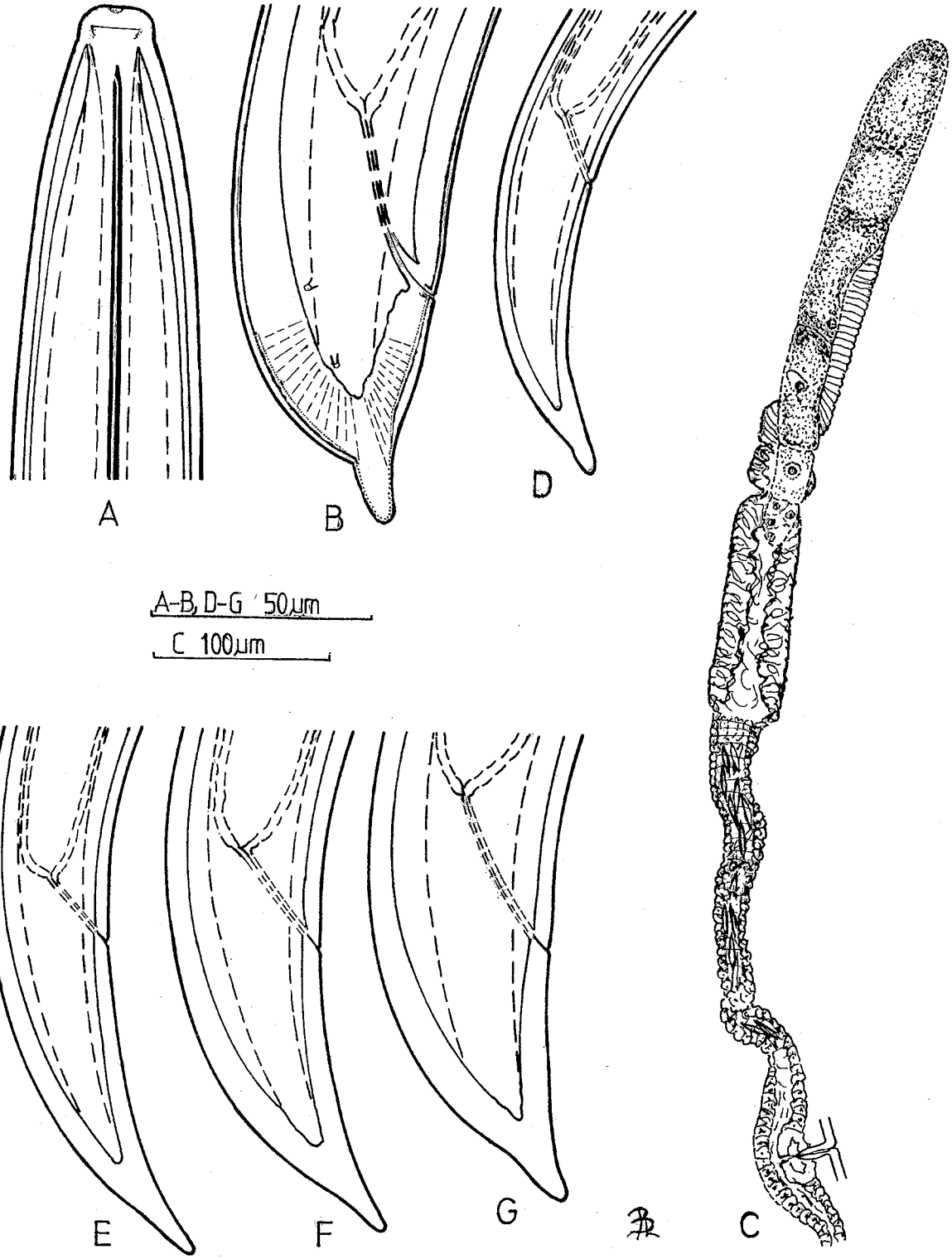

Fig. 11 - *Xiphinema* sp.A: A, female anterior region; B, female posterior region; C, anterior branch of female genital tract; D-G, tail of J1, J2, J3 and J4, respectively.

Fig. 12 - Photomicrographs of *Xiphinema* sp.A: A, female anterior region; B, female posterior region; C, uterus with spines; D-G, tail of J1, J2, J3 and J4, respectively.

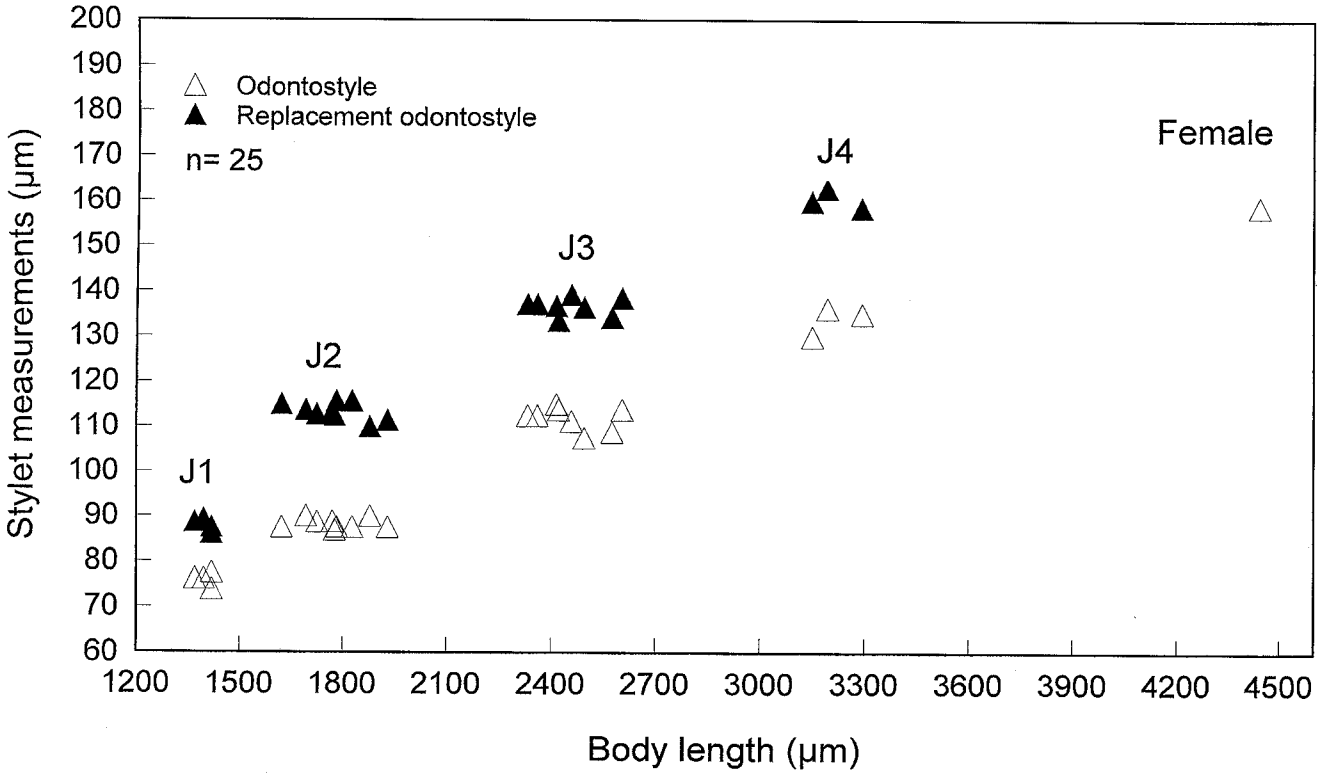

Fig. 13 - Scatter diagram separating juveniles and female of *Xiphinema* sp.A.

148.7 µm; odontophore=87.5-90 µm; oral aperture to basal guide ring=140-138.7 µm; tail length=35-40 µm; J (hyaline portion of tail)=14.4-13.1 µm; body diam at lip region=15.0-15.2 µm; body diam at guide ring=41.2-42.5 µm; body diam at base of oesophagus =47.9-50 µm; body diam at vulva=51.2-52.5 µm; body diam. at anus=41.9-45 µm; body diam at beginning of J=30-28.7 µm.

Description: female *habitus* anteriorly almost straight, more curved behind the vulva, when killed; body cylindrical, tapering very gradually towards the extremities. Cuticle with very fine transverse striations, 3.5 µm thick at mid body. Lip region having somewhat cylindrical appearance, frontally flattened and laterally rounded, separated from the rest of the body by a depression; amphids stirrup-shaped. Odontostyle typical, 2.3-2.4 µm at its base; basal flanges of odontophore 14.6-16.2 µm wide. Oesophagus dorylaimoid with the anterior portion tubular; basal enlarged portion occupying more than 1/4 of the total oesophagus length and measuring 106-114 µm long and 23-24 µm wide. Reproductive system amphidelphic, with equally developed branches and reflexed ovaries; oviduct consisting of a cylindrical part and a *pars dilatata oviductus* separated from the uterus by a sphincter. Uterus consisting of a relatively long *pars dilatata uteri*, a thin-walled tube containing spiniform structures distributed over the entire length with distinct concentration at both ends of the tubular portion, and an ovijector. Vulva slit-like situated slightly anterior to mid body. Rectum extending less or more than the body width at anus. Tail short, hemispherical with a 5.4-5.6 µm long peg, situated nearer to ventral side; blind canal present; 2-3 caudal pores on each side.

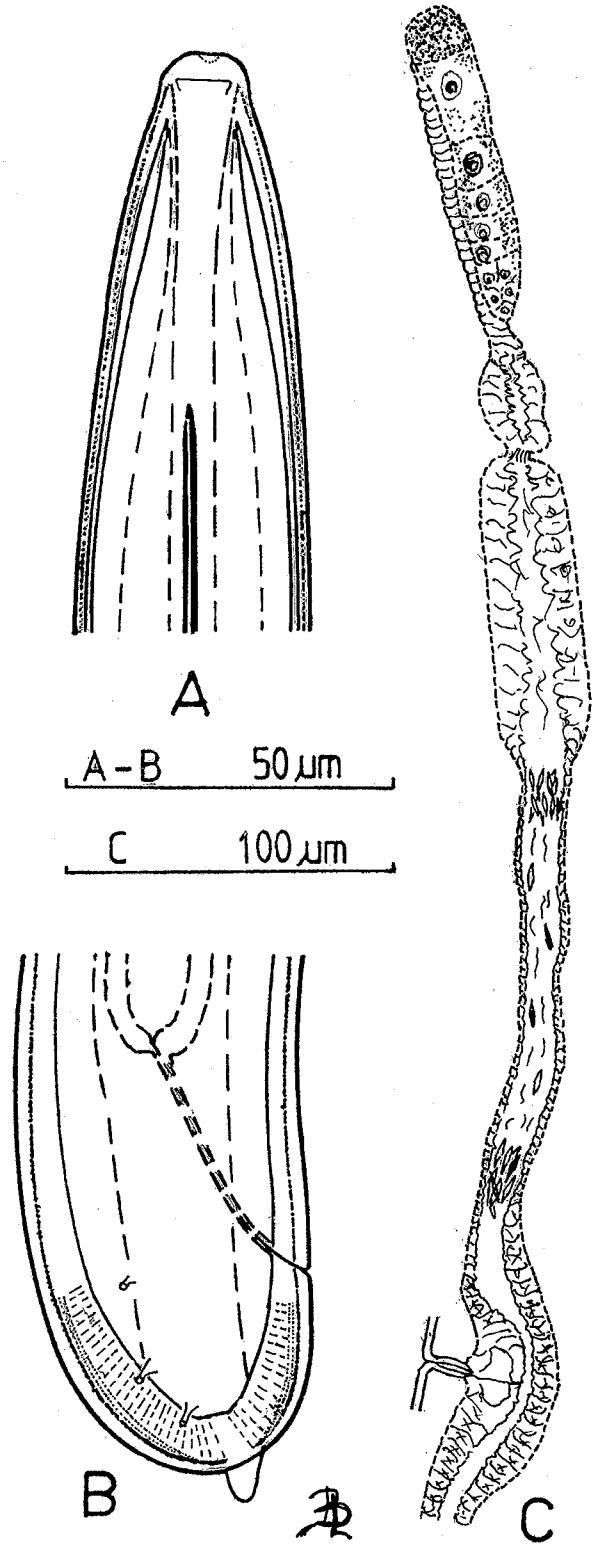

Fig. 14 - *Xiphinema* sp.B: A, female anterior region; B, female posterior region; C, anterior branch of female genital tract.

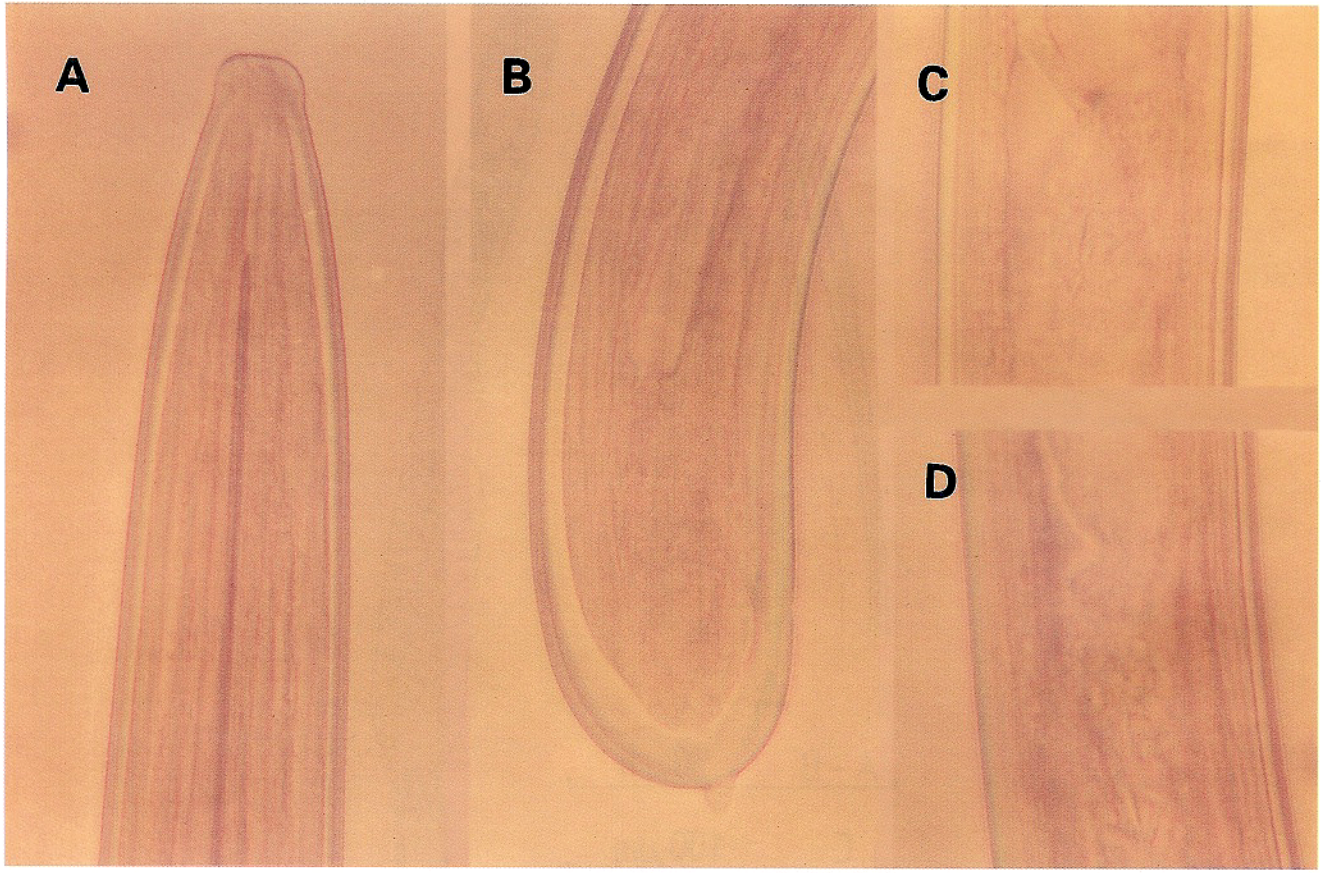

Fig. 15 - Photomicrographs of *Xiphinema* sp.B: A, female anterior region; B, female posterior region; C and D, uterus with spines.

Male and juveniles not found.

The two females were found in the rhizosphere of *Vitis vinifera* L. at Kubed, Slovenia.

Note: Specimens are deposited at the Istituto di Nematologia Agraria, Consiglio Nazionale delle Ricerche, Bari, Italy.

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