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MORPHOMETRIC VARIATION AND JUVENILE STAGES OF *XIPHINEMA DIVERSICAUDATUM* (MICOLETZKY, 1927) THORNE, 1939 AND *X. INDEX* THORNE *ET* ALLEN, 1950 (NEMATODA: DORYLAIMIDA) FROM THE FORMER TERRITORY OF YUGOSLAVIA

by
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Summary. The morphometric variability of adult and juvenile stages of *Xiphinema diversicaudatum* and *X. index* was studied on populations from the former territory of Yugoslavia. Both species presented four juvenile development stages. *X. diversicaudatum* morphometrics generally agree with those previously reported from Yugoslavia, but vary to different extents from those from Germany and Britain. Morphometrics of *X. index* correspond, more or less, with Mediterranean populations.

Xiphinema diversicaudatum and *X. index* are probably the most studied species of the genus. This is due to their almost worldwide distribution and to their importance as vectors of some nepoviruses. *X. diversicaudatum* is a vector of arabis mosaic and strawberry latent ringspot viruses and has a wide host range among woody and herbaceous crops and weeds. *X. index* is the vector of the grapevine fanleaf virus, which causes a serious disease of the grapevine.

Data on the presence and distribution of *X. diversicaudatum* and *X. index* in the former territory of Yugoslavia are scanty (Krnjaić, 1967; 1976; Lamberti *et al.*, 1973; 1976; Hržić, 1978; Krnjaić and Krnjaić, 1987; Barsi, 1989; 1992; 1994; 1996; Barsi and Radišić, 1992; Ivezić and Raspudić, 1998). Morphometric data of *X. diversicaudatum* have been reported by Hržić (1978) from Slovenia, and by Barsi (1989; 1992; 1994) from Montenegro and Vojvodina (Serbia), respectively, and by Barsi and Radišić (1992) from Vojvodina Province. Morphometric data of *X. index* have been reported by Hržić (1978) from Slovenia and by Barsi (1989) from Croatia.

Morphometric variations of *X. diversicaudatum* (Micoletzky, 1927) Thorne, 1939 and *X. index* Thorne *et* Allen, 1950 were studied on populations from the former territory of Yugoslavia.

Materials and methods

Nematodes were extracted using a modified Cobb's decanting and sieving technique. Specimens were killed with 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 for body length which was drawn with a drawing tube and measured with a map measurer.

Measurements and descriptions

XIPHINEMA DIVERSICAUDATUM

(Tables I-III; Figs 1-6)

Female: death posture an open C; body cylindrical, tapering gradually towards the extremities. Lip region frontally flattened, laterally rounded, almost continuous with the rest of the body or separated by a very weak depression. Amphids, odontostyle, odontophore and guiding sheath typical of the genus. Oesophagus dorylaimoid. Gonads paired, symmetrical, pseudo-Z-organ with irregular globular bodies; vulva anterior to mid-body. Tail convex-conoid, dorsally rounded, ventral surface somewhat flattened, with a more or less ventrally situated mammillate peg, rarely without; blind canal present except in pegless specimens; 2-4 pairs of caudal pores.

Male: common, morphologically similar to females, but more coiled in the posterior region. Spicules massive with 15.0-17.5 µm long lateral pieces; adanal pair of supplements plus 3-5 ventromedian supplements. Tail similar to that of female, with or rarely without a mammillate ventral peg; blind canal present except in pegless specimens; 4-6 pairs of caudal pores.

Juveniles: tail conoid, elongated and very gradually tapering towards the extremity in the first and second stages and subdigitate in third and fourth stages. They clearly separate into four groups.

All stages correspond well with juvenile stages described from Franconia (Germany) by Sturhan (1963) with exception of body length, which is slightly longer in fourth stage and slightly longer odontostyle, odontophore and replacement odontostyle in third and fourth stages, respectively (Table III and Fig. 6). Analysing the measurements for odontostyle, replacement odontostyle and length of body given by Goodey *et al.* (1960), juvenile stages from Britain cannot be considered homologous either with the German population as commented on by Sturhan (1963), or with the population from Novi Sad (Vojvodina Province, Serbia). The same author stated that there are several quite considerable differences, but it has to be taken into account that the length of the body and the stylet of the British specimens are generally greater. Furthermore, the formation of the tail in various juvenile stages of the German population corresponded to the illustrations in Goodey *et al.* (1960). Taking into account the presence of intraspecific variability of the tail shape in adults and in juvelile stages, it is obvious that the tail shape of the second juvenile stage (Fig. 1 J in Goodey *et al.*, 1960) from Britain is different from that from Novi Sad (Fig. 3 J).

On a few occasions spindle-shaped structures (Fig. 4B-C, G) or dilated crystalline structures (?) (Fig. 4E) have been observed in the lumen of the tubular portion of the uterus of both freshly dissected reproductive organs in tap water and heat relaxed but unfixed females. Heyns and Coomans (1984) reported the presence of three different types of crystal-like structure in the uterus of the females of *X. diversicaudatum* found for the first time in South Africa.

The morphometrics of populations from Novi Sad, Senta-Adorjan, Bačka Palanka (Vojvodina Province, Serbia) and Morinj (Montenegro) generally agree with those reported earlier by Hržić (1978), Barsi (1989; 1992; 1994) and Barsi and Radišić (1992).

XIPHINEMA INDEX

(Tables IV-VI; Figs 7-10)

Female: death posture an open C; body cylindrical, tapering gradually towards the extremities. Lip region frontally flattened, laterally rounded, almost continuous with the rest of the body or separated by a very weak depression. Amphids, odontostyle, odontophore and guiding sheath typical of the genus. Oesophagus dorylaimoid. Reproductive system amphidelphic, with both genital branches equally devel-

TABLE I - *Morphometric characters of a population of* Xiphinema diversicaudatum *from Novi Sad, Vojvodina.*

Host	*Amorpha fruticosa*					
n	17 females	10 males	3 J1	18 J2	21 J3	12 J4
L mm	4.20±0.30 (3.68-4.64)	4.20±0.29 (3.74-4.73)	0.95±0.08 (0.85-1.00)	1.40±0.09 (1.23-1.57)	1.94±0.19 (1.67-2.34)	2.76±0.26 (2.22-3.05)
a	78.0±5.31 (65.6-88.3)	78.6±4.45 (72.9-86.4)	46.2±1.37 (45.3-47.8)	51.5±2.50 (46.8-56.4)	58.1±2.45 (53.1-63.7)	67.6±4.45 (62.1-75.3)
b	8.9±0.82 (7.6-11.2)	8.7±0.43 (8.1-9.5)	3.8±-0.38 (3.4-4.1)	4.6±0.29 (4.1-5.2)	5.4±0.50 (4.7-6.4)	6.4±0.65 (5.1-7.5)
c	84.8±5.71 (77.2-101.7)	78.3±4.71 (70.2-83.3)	16.9±1.46 (15.5-18.4)	23.3±1.47 (20.2-26.1)	32.7±2.39 (28.6-39.5)	48.2±4.71 (41.4-57.1)
c'	1.18±0.06 (1.04-1.28)	1.22±0.13 (0.98-1.48)	4.11±0.17 (3.93-4.26)	3.00±0.25 (2.55-3.36)	2.26±0.16 (1.84-2.59)	1.69±0.14 (1.53-1.96)
V	42.9±1.50 (40.4-45.2)	–	–	–	–	–
Odontostyle µm	129.8±3.16 (123.7-133.7)	130.4±6.61 (120.0-141.2)	52.5	64.3±2.28 (60.0-68.7)	82.8±4.12 (71.2-91.2)	106.0±3.69 (98.7-113.7)
Odontophore µm	74.5±2.26 (70.0-78.8)	74.0±2.36 (70.0-76.3)	35.0±1.25 (33.8-36.3)	45.4±1.97 (42.5-48.8)	54.3±2.55 (50.0-58.8)	65.0±1.98 (61.3-68.8)
Total stylet µm	204.3±4.26 (196.2-212.5)	204.4±8.0 (195.0-217.5)	87.5±1.25 (86.3-88.8)	109.7±3.04 (103.8-115.0)	137.1±5.54 (123.7-150.0)	171.0±4.64 (163.7-178.7)
Replacement odontostyle µm	–	–	66.7±1.93 (65.0-68.8)	84.8±3.62 (78.8-90.0)	106.0±4.49 (97.5-112.5)	130.3±3.22 (126.0-135.7)
Oral aperture to guiding ring µm	115.1±3.79 (106.9-121.3)	118.1±5.37 (111.9-128.1)	44.2±2.89 (42.5-47.5)	57.0±2.20 (52.5-60.0)	72.2±3.85 (63.8-77.5)	92.6±4.48 (85.0-101.3)
Tail µm	49.7±3.41 (42.8-53.9)	53.8±4.84 (47.1-64.3)	56.3±2.88 (54.3-59.6)	60.1±3.77 (55.7-68.5)	59.5±4.96 (50.0-69.3)	57.6±5.81 (51.8-69.3)
J (hyaline portion of tail) µm	15.7±2.70 (8.1-19.4)	17.2±1.89 (14.4-21.3)	7.1±1.93 (5.0-8.8)	13.2±0.76 (11.9-14.4)	15.8±1.67 (11.3-19.4)	17.0±1.38 (15.0-20.0)
Body diam. at lip region µm	13.6±0.30 (13.1-14.1)	13.7±0.38 (13.1-14.4)	7.7±0.35 (7.5-8.1)	8.9±0.22 (8.4-9.2)	10.0±0.14 (9.7-10.4)	11.6±0.32 (11.3-12.2)
Body diam. at guiding ring µm	38.1±1.07 (36.3-40.0)	38.0±1.38 (35.9-39.7)	16.2±0.23 (15.9-16.3)	21.0±1.06 (19.4-23.4)	25.4±1.17 (23.4-27.5)	30.9±1.08 (28.1-32.2)
Body diam. at base of oesophagus µm	47.8±1.99 (43.8-50.6)	48.1±1.90 (43.4-50.0)	20.3±1.34 (18.8-21.3)	26.5±2.10 (22.5-30.0)	32.4±3.02 (28.0-37.5)	39.5±3.25 (32.8-45.0)
Body diam. at mid-body or vulva µm	54.0±3.53 (47.5-59.7)	53.5±2.37 (47.2-55.0)	20.5±1.58 (18.8-21.9)	27.3±2.61 (23.4-31.9)	33.5±3.86 (28.8-41.3)	41.0±4.10 (32.8-48.8)
Body diam. at anus	42.1±1.59 (38.1-44.1)	44.3±2.17 (41.3-48.3)	13.7±0.75 (12.9-14.4)	20.1±1.96 (17.2-23.8)	26.4±2.44 (22.9-31.3)	34.0±2.05 (28.8-35.9)
Body diam. at beginning of J µm	19.0±2.69 (10.0-21.3)	19.6±3.37 (15.0-25.0)	4.7±0.83 (3.8-5.4)	6.9±0.77 (5.0-7.9)	9.9±0.89 (7.9-11.3)	13.3±1.44 (10.4-15.4)
Spicules µm	–	69.8±2.66 (65.7-72.8)	–	–	–	–

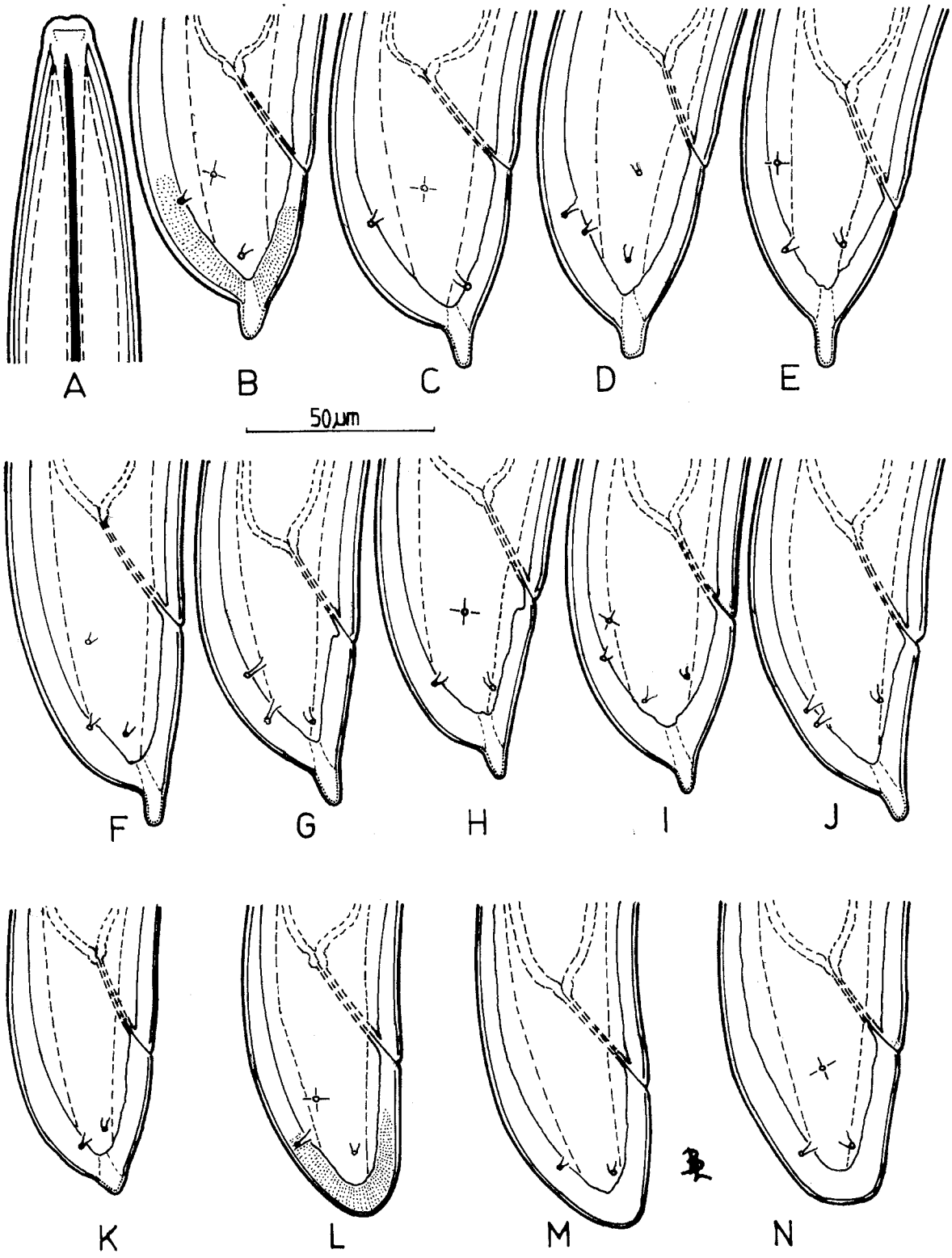

Fig. 1 - *Xiphinema diversicaudatum*: A, female anterior region; B-N, female posterior region.

TABLE II - *Morphometric characters of adult* X. diversicaudatum *from Yugoslavia.*

Locality Host	Morinj *Vitis* sp.		Senta-Adorjan *A. fruticosa*		Bačka Palanka *A. fruticosa*	
n	16 females	11 males	10 females	8 males	10 females	10 males
L mm	3.95±0.21 (3.59-4.34)	3.82±0.30 (3.46-4.31)	4.35±0.26 (3.96-4.79)	4.26±0.32 (3.85-4.83)	4.33±0.37 (3.80-4.90)	4.32±0.37 (3.57-4.90)
a	69.5±4.15 (62.9-75.5)	73.3±6.83 (64.5-89.3)	78.6±3.8 (69.8-84.7)	81.3±5.9 (72.5-89.4)	80.1±4.3 (73.9-89.2)	83.2±3.3 (77.5-88.7)
b	8.4±0.68 (7.6-10.5)	7.8±0.54 (6.8-8.8)	9.7±0.6 (9.0-10.9)	9.3±0.5 (8.7-10.0)	9.0±1.1 (7.8-11.0)	8.8±0.6 (7.7-9.7)
c	84.0±8.25 (70.4-98.0)	78.0±7.44 (66.6-90.7)	91.7±8.7 (75.2-103.0)	90.2±10.5 (76.3-109.0)	91.5±7.8 (79.7-102.2)	91.8±9.2 (82.5-110.9)
c'	1.07±0.09 (0.97-1.26)	1.14±0.10 (0.98-1.28)	1.12±0.09 (0.98-1.35)	1.14±0.11 (1.00-1.37)	1.12±0.07 (1.01-1.24)	1.09±0.09 (0.98-1.30)
V	42.7±1.38 (39.5-44.6)	–	42.5±1.9 (40.2-46.3)	–	44.4±1.5 (41.8-47.1)	–
Odontostyle µm	126.7±3.56 (118.7-133.1)	129.4±4.45 (123.7-136.2)	124.9±9.6 (98.5-134.9)	125.7±4.9 (114.2-131.3)	131.1±4.6 (124.2-138.0)	129.8±2.0 (125.5-133.0)
Odontophore µm	73.4±2.56 (70.0-80.0)	74.0±2.00 (70.0-77.5)	75.5±1.9 (72.8-79.1)	71.8±2.1 (69.0-75.3)	74.6±5.9 (61.5-82.8)	77.0±2.5 (74.0-82.8)
Total stylet µm	200.1±5.10 (190.0-208.1)	203.4±4.78 (197.5-210.0)	200.4±10.2 (172.5-210.2)	197.6±4.4 (189.5-202.0)	205.7±8.7 (193.3-220.8)	206.8±3.8 (200.8-213.3)
Oral aperture to guiding ring µm	121.1±3.55 (116.3-128.1)	123.3±4.34 (118.1-132.5)	119.9±5.4 (109.8-126.7)	118.9±4.9 (107.3-123.0)	120.3±6.1 (111.1-131.1)	117.7±3.9 (112.3-124.2)
Tail µm	47.3±3.89 (41.4-55.0)	49.1±3.75 (44.3-54.3)	47.7±3.2 (42.0-52.7)	47.6±3.5 (43.9-55.2)	47.4±3.4 (41.4-52.7)	47.3±4.5 (43.1-59.0)
J (hyaline portion of tail) µm	16.8±1.53 (15.0-19.7)	17.5±1.57 (15.6-21.3)	16.0±1.6 (12.5-18.2)	16.7±0.8 (15.1-17.6)	16.2±2.2 (13.2-20.1)	17.0±2.1 (13.8-20.7)
Body diam. at lip region µm	13.9±0.41 (13.1-14.7)	13.8±0.12 (13.4-13.8)	13.3±0.2 (13.0-13.5)	13.4±0.6 (12.5-13.8)	13.3±0.2 (13.0-13.5)	13.4±0.4 (12.5-13.8)
Body diam. at guiding ring µm	40.7±1.25 (38.4-42.5)	39.4±0.93 (37.8-40.6)	37.7±0.7 (36.1-38.9)	37.0±0.9 (35.1-38.9)	37.9±1.0 (36.4-39.5)	37.8±0.9 (36.4-38.9)
Body diam. at base of oesophagus µm	49.6±2.20 (45.9-53.8)	48.4±1.87 (45.0-50.9)	48.9±2.0 (45.6-52.7)	47.0±1.5 (43.9-48.9)	47.6±1.8 (44.8-50.2)	47.1±1.9 (43.9-50.2)
Body diam. at mid- body or vulva µm	56.9±2.83 (51.3-61.3)	53.3±2.88 (47.5-56.3)	55.4±2.5 (50.2-59.0)	52.5±2.1 (48.1-55.2)	53.9±2.1 (51.5-57.4)	51.9±3.2 (46.1-57.7)
Body diam. at anus µm	44.1±1.94 (40.9-46.9)	43.0±1.23 (41.3-45.0)	42.6±1.5 (38.9-43.9)	41.8±1.2 (40.2-43.9)	42.2±1.2 (40.2-44.3)	43.3±1.2 (41.4-45.2)
Body diam. at beginning of J µm	25.5±1.90 (21.3-28.4)	23.4±2.25 (20.0-26.3)	23.2±1.5 (19.8-25.1)	22.8±3.0 (16.9-27.6)	21.8±2.3 (17.6-25.7)	22.4±1.8 (19.8-25.0)
Spicules µm	–	72.0±1.68 (70.0-75.0)	–	65.9±2.2 (62.9-68.6)	–	68.2±1.5 (64.3-70.1)

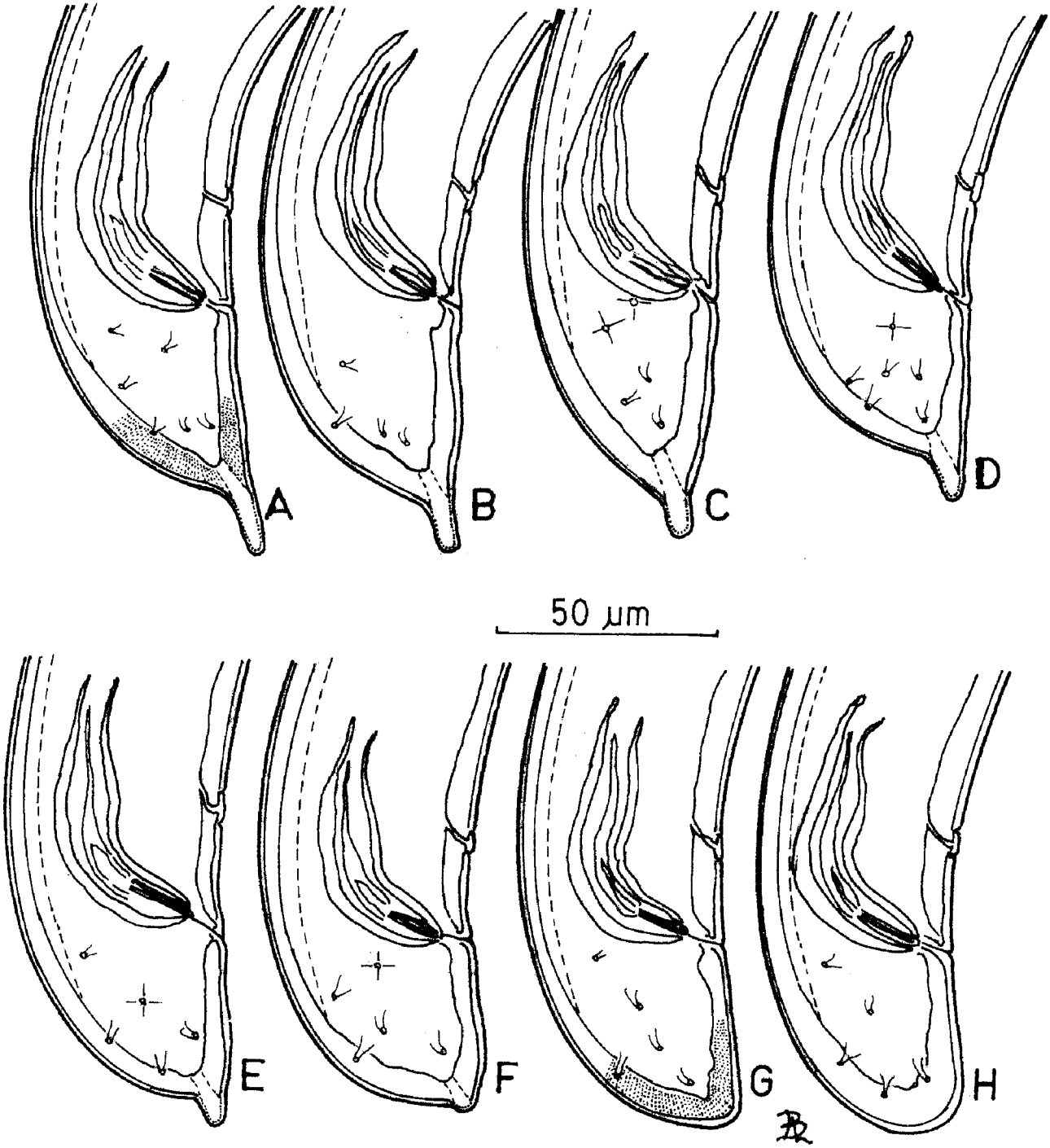

Fig. 2 - *X. diversicaudatum*: A-H, male posterior region.

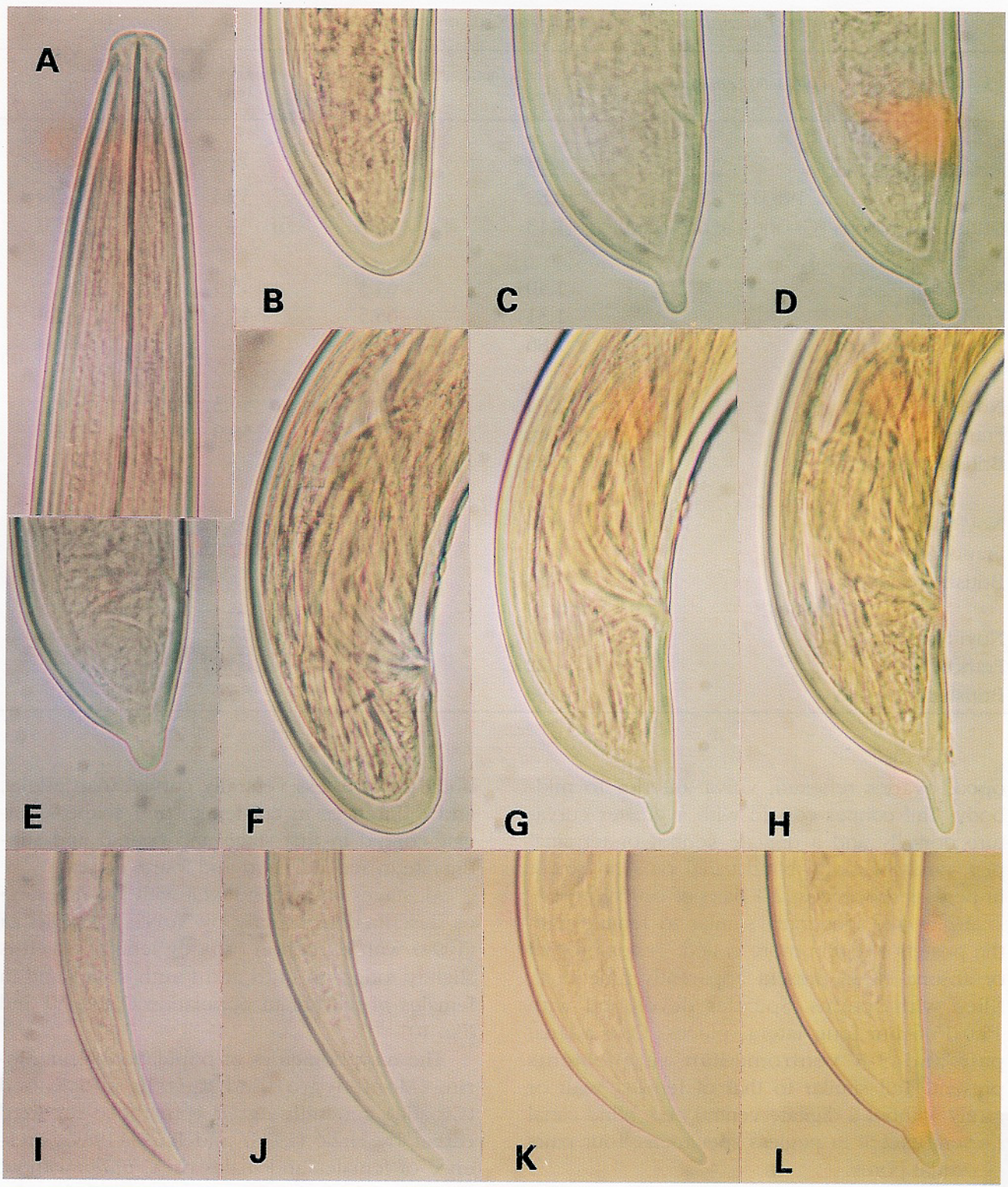

Fig. 3 - Photomicrographs of *X. diversicaudatum*: A, female anterior region; B-E, female posterior region; F-H, male posterior region; tail shape of I, first, J, second, K, third and L, fourth juvenile stage, respectively.

TABLE III - *Morphometrics of juvenile stages and females of* X. diversicaudatum.

Developmental stages and populations	Body length (mm) (mean)	Odontostyle (µm) (mean)	Odontophore (µm) (mean)	Replacement odontostyle (µm) (mean)
J_1				
Novi Sad (original)	0.95	52.5	35.0	66.7
Franconia (Sturhan, 1963)	0.89	52.0	35.5	67.0
British specimens (Goodey *et al.*, 1960)	1.13	56.0	–	73.0
J_2				
Novi Sad	1.40	64.3	45.4	84.8
Franconia	1.31	65.5	47.5	88.8
British specimens	1.86	80.0	–	105.0
J_3				
Novi Sad	1.94	82.8	54.3	106.0
Franconia	2.05	91.0	58.0	112.5
British specimens	2.53	103.0	–	127.0
J_4				
Novi Sad	2.76	106.0	65.0	130.3
Franconia	3.05	114.0	72.0	136.5
British specimens	3.68	123.0	–	151.0
Females				
Novi Sad	4.20	129.8	74.5	–
Franconia	4.22	137.0	83.0	–
British specimens	4.90	143.0	85.0	

oped, ovaries reflexed; vulva anterior to mid-body. Tail convex-conoid with a greater curvature dorsally and a digitate ventral or terminal peg, rarely without; blind canal present except in pegless specimens; 2-4 pairs of caudal pores.

Male: rare, generally similar to female with the posterior region more coiled. Testes present or absent; when present apparently functional, filled with sperms. Spicules developed with 15.0-15.6 µm long lateral pieces. One adanal pair and 3-5 ventromedian supplements present. Tail similar to that of female, with or rarely without a digitate ventral peg; blind canal present except in pegless specimens; four pairs of caudal pores.

Juveniles: clearly separated into four stages. They resemble adults except for smaller size, body posture less ventrally curved than adults, and differences in tail length and shape, elongate-conoid in first stage and conoid and subdigitate in second, third and fourth stages.

All stages correspond well with juvenile stages described from Italy by Vovlas and Larizza (1994) with exception of body length, which is slightly longer in third and fourth stages and in females of the Italian population (Table VI and Fig. 10).

The morphometrics of populations from Morinj (Montenegro) and Kaštelir and Kubed (Croatia) generally agree with those reported earlier by Hržić (1978) and Barsi (1989). Presence of females and males of *X. index* without tail mucro from the former territory of Yugoslavia have been reported by Barsi (1989). Pegless

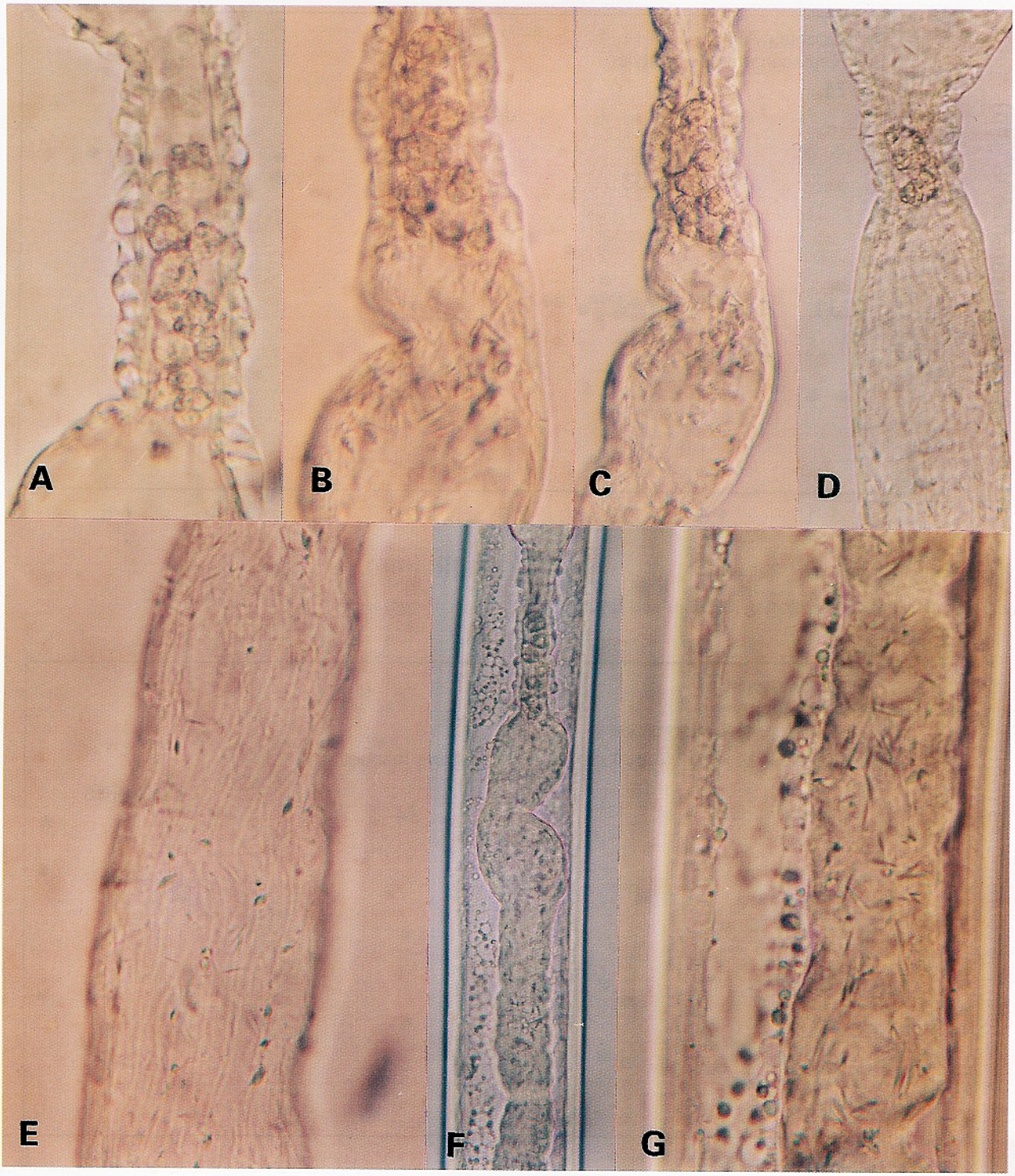

Fig. 4 - Photomicrographs of female genital tract of *X. diversicaudatum*: A-D, pseudo-Z-organ in freshly dissected genital branch; E, tubular part of the freshly dissected uterus with dilated crystalline structure (?); F, part of the uterus with pseudo-Z-organ; G, enlarged detail of the tubular part of the uterus with numerous spindle-shaped structures. (A-E: reproductive system dissected in tap water; F-G: rep. sys. *in situ*, unfixed and unmounted).

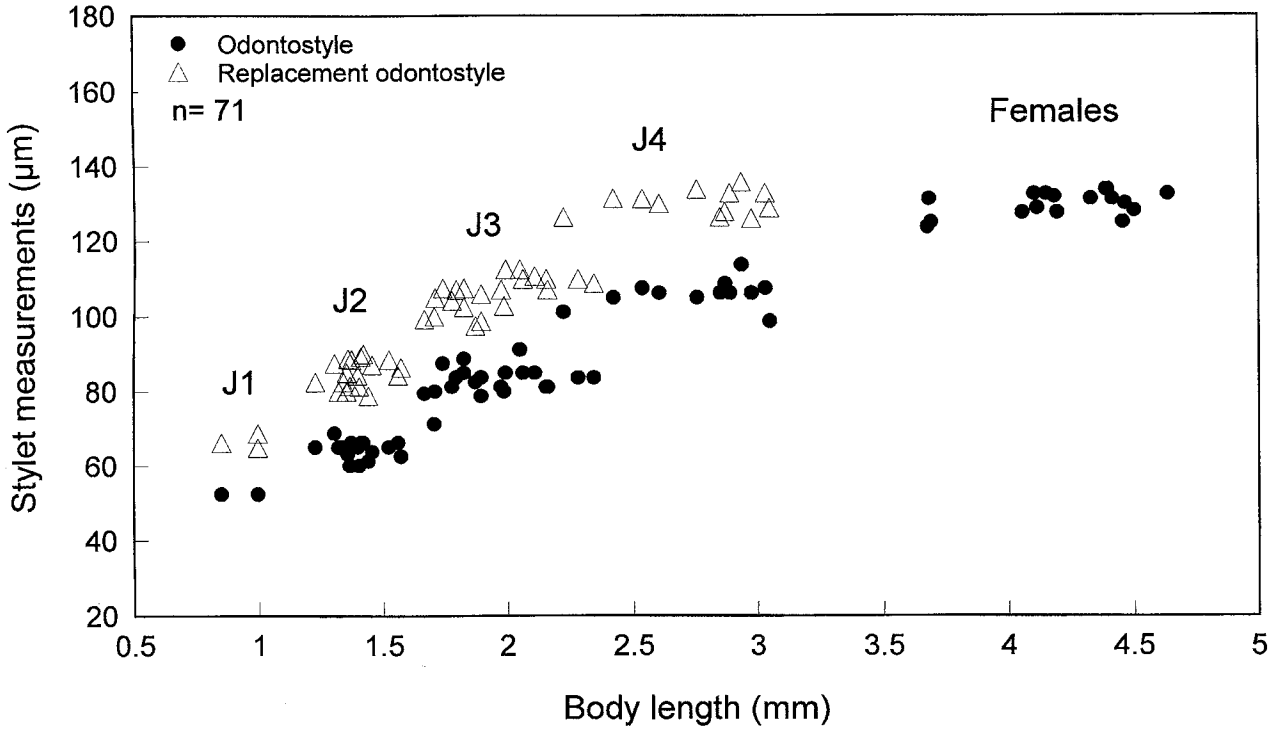

Fig. 5 - Scatter diagram separating juveniles and females of *X. diversicaudatum*.

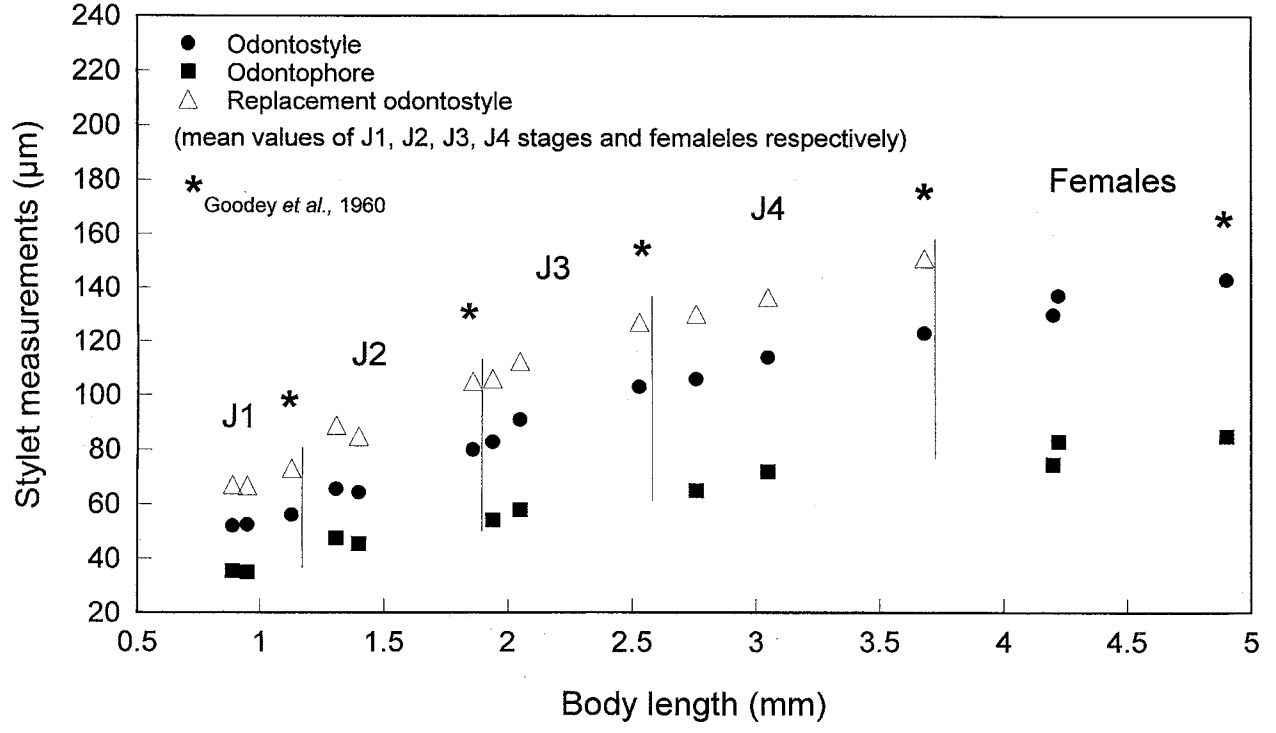

Fig. 6 - Scatter diagram separating juveniles and females of *X. diversicaudatum* from three selected populations (for details see Table III).

TABLE IV - *Morphometric characters of a population of* Xiphinema index *from Morinj, Montenegro.*

Host	*Vitis* sp.					
n	29 females	5 males	15 J1	15 J2	16 J3	12 J4
L mm	3.05±0.19 (2.71-3.49)	3.18±0.23 (2.81-3.41)	0.82±0.05 (0.75-0.88)	1.15±0.09 (1.02-1.28)	1.68±0.14 (1.43-2.03)	2.28±0.14 (2.04-2.50)
a	61.4±2.34 (57.0-67.9)	60.9±1.99 (58.3-63.4)	41.1±1.69 (38.5-44.1)	46.8±1.64 (43.4-49.8)	51.2±1.37 (47.9-53.3)	56.2±1.93 (52.6-59.4)
b	6.4±0.41 (5.8-7.5)	6.8±0.52 (6.1-6.4)	3.6±0.28 (3.1-4.1)	3.9±0.30 (3.2-4.3)	4.5±0.37 (4.1-5.3)	5.4±0.49 (4.8-6.7)
c	71.9±5.97 (61.0-83.5)	69.7±6.39 (62.3-78.2)	18.9±1.22 (17.0-21.3)	24.8±1.23 (23.2-27.2)	33.6±2.55 (29.5-37.5)	48.1±3.62 (40.8-52.2)
c'	1.13±0.08 (0.96-1.25)	1.06±0.05 (0.98-1.11)	3.07±0.20 (2.78-3.50)	2.49±0.13 (2.25-2.68)	1.95±0.14 (1.68-2.17)	1.46±0.08 (1.37-1.60)
V	41.6±0.96 (39.8-43.9)	–	–	–	–	–
Odontostyle µm	127.5±4.38 (118.8-136.3)	129.8±4.46 (122.5-133.8)	49.2±1.31 (47.5-51.2)	64.4±1.88 (62.5-68.8)	87.4±3.12 (83.7-93.7)	107.0±3.60 (100.0-115.0)
Odontophore µm	73.6±2.11 (68.8-77.5)	75.2±2.99 (72.5-80.0)	32.4±1.11 (30.0-33.8)	44.3±2.13 (40.0-47.5)	55.3±1.85 (51.3-58.8)	63.9±3.42 (53.8-67.5)
Total stylet µm	201.1±4.86 (193.8-212.5)	205.0±6.29 (196.2-213.8)	81.6±1.87 (77.5-85.0)	108.7±3.36 (102.5-115.0)	142.7±3.77 (137.5-148.8)	170.9±5.03 (161.9-180)
Replacement odontostyle µm	–	–	63.5±2.60 (58.8-68.2)	85.9±3.42 (78.8-92.1)	108.8±2.58 (105.0-112.5)	128.6±3.06 (124.7-133.5)
Oral aperture to guiding ring µm	116.9±5.19 (108.8-128.8)	120.0±4.97 (112.5-125.6)	39.6±1.63 (36.3-42.5)	56.6±1.99 (53.1-60.0)	76.2±4.29 (68.8-87.5)	95.2±4.28 (87.5-104.4)
Tail µm	42.5±3.06 (35.7-48.6)	45.7±2.08 (43.6-48.6)	43.3±2.57 (40.0-47.8)	46.5±3.03 (42.5-51.4)	50.0±2.72 (46.1-56.0)	47.5±2.05 (44.3-50.0)
J (hyaline portion of tail) µm	15.7±1.77 (12.5-20.0)	16.6±0.84 (15.6-17.5)	7.1±0.55 (6.3-8.1)	8.8±1.11 (7.5-10.6)	11.3±1.11 (9.7-12.5)	12.9±0.75 (11.9-14.4)
Body diam. at lip region µm	13.7±0.25 (13.1-14.2)	13.7±0.37 (13.1-14.1)	7.5 (7.5-7.5)	8.6±0.21 (8.3-8.8)	9.9±0.12 (9.7-10.0)	11.6±0.41 (11.3-12.5)
Body diam. at guiding ring µm	37.6±1.17 (35.0-40.0)	38.7±1.04 (37.2-39.7)	15.4±0.94 (12.5-16.3)	19.6±0.70 (18.4-20.9)	25.7±0.81 (23.8-27.5)	31.7±1.21 (29.4-34.1)
Body diam. at base of oesophagus µm	46.1±2.18 (41.7-51.3)	47.6±1.84 (44.7-48.8)	19.8±1.63 (17.5-21.3)	24.4±2.00 (21.3-26.9)	31.8±1.82 (29.4-37.2)	39.0±1.91 (36.3-42.2)
Body diam. at mid-body or vulva µm	49.6±2.39 (44.4-53.8)	52.2±2.51 (48.1-53.8)	20.2±1.78 (17.5-22.5)	24.7±2.00 (21.3-27.5)	32.8±2.45 (29.4-40.0)	40.5±2.14 (37.2-44.2)
Body diam. at anus µm	37.7±1.89 (32.9-41.3)	43.0±1.56 (40.9-44.7)	14.2±1.02 (12.5-16.3)	18.7±1.48 (16.3-20.9)	25.8±1.87 (23.1-31.3)	32.5±1.43 (31.3-35.6)
Body diam. at beginning of J µm	19.4±1.97 (15.0-23.1)	20.7±2.33 (18.8-24.4)	5.4±0.44 (5.0-6.3)	6.8±0.54 (6.3-7.5)	9.0±0.88 (7.2-10.6)	12.8±1.51 (11.3-16.9)
Spicules µm	–	65.6±1.76 (62.8-67.1)	–	–	–	–

TABLE V - *Morphometric characters of adult* X. index *from Croatia.*

Locality Host	Kaštelir *Vitis* sp.		Kubed *Vitis* sp.
n	19 females	2 males	17 females
L mm	3.33±0.21 (3.04-3.76)	2.82-3.25	3.13±0.18 (2.81-3.53)
a	65.0±3.4 (60.8-74.7)	62.4±61.9	62±2.8 (58.7-67.8)
b	7.0±0.3 (6.4-7.5)	6.3-7.2	6.7±0.5 (6.0-8.1)
c	82.6±5.9 (72.4-93.1)	70.2-76.1	81.4±8.6 (71.0-107.2)
c'	1.09±0.07 (0.95-1.19)	1.02-1.03	1.03±0.08 (0.79-1.12)
V	41.2±0.7 (39.2-42.3)	–	40.3±0.7 (39.5-42.3)
Odontostyle µm	131.1±4.3 (119.4-140.8)	129.5-125.7	129.4±4.4 (124.4-138.3)
Odontophore µm	75.6±2.0 (72.9-80.4)	70.4-74.2	73.9±2.3 (69.1-76.7)
Total stylet µm	206.7±5.4 (193.3-216.2)	199.9-199.9	203.3±6.3 (196.1-214.9)
Oral aperture to guiding ring µm	125.8±4.0 (116.9-132.0)	119.4-124.4	120.0±5.4 (111.2-130.7)
Tail µm	40.7±2.7 (36.4-47.1)	40.2-42.7	38.7±3.5 (28.9-43.1)
J (hyaline portion of tail) µm	16.5±1.7 (12.5-18.8)	16.3-17.6	15.2±2.5 (7.5-18.8)
Body diam. at lip region µm	13.7±0.1 (13.2-13.8)	13.2-13.8	13.7±0.2 (13.2-14.2)
Body diam. at guiding ring µm	38.6±1.1 (37.1-40.8)	35.2-39	37.7±0.9 (36.4-38.9)
Body diam. at base of oesophagus µm	46.9±1.9 (44.0-52.1)	42.1-48.2	46.3±1.4 (43.7-49.0)
Body diam. at mid-body or vulva µm	51.2±2.3 (47.4-57.8)	45.2-52.5	50.8±1.7 (46.9-52.1)
Body diam. at anus µm	37.1±1.7 (34.9-40.6)	39.4-41.5	37.4±1.6 (35.2-40.2)
Body diam. at beginning of J µm	19.1±1.7 (16.3-22.0)	22.6-25.1	19.9±1.2 (17.6-22.0)
Spicules µm	–	63-67	–

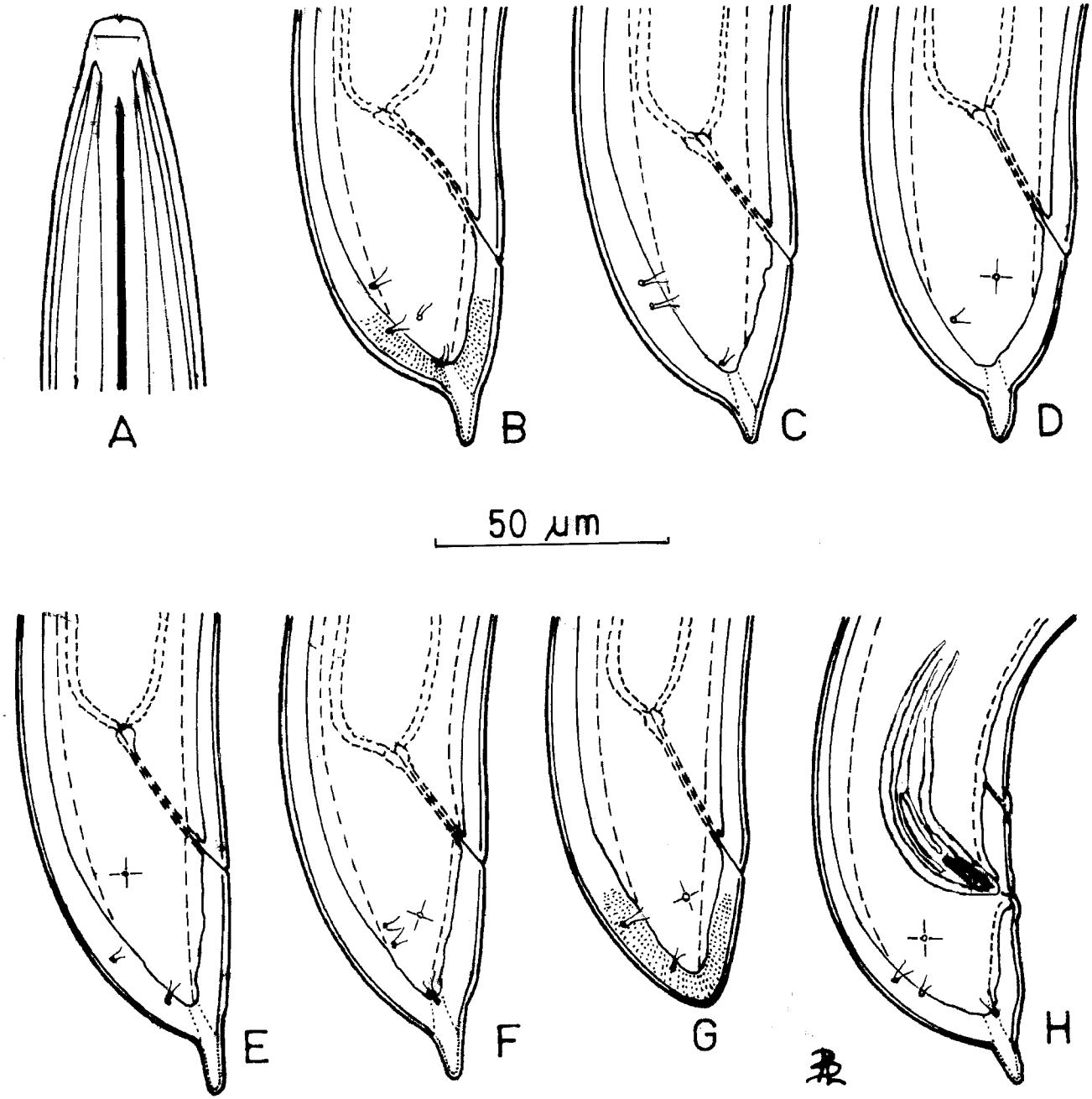

Fig. 7 - *Xiphinema index*: A, female anterior region; B-G female posterior region; H, male posterior region.

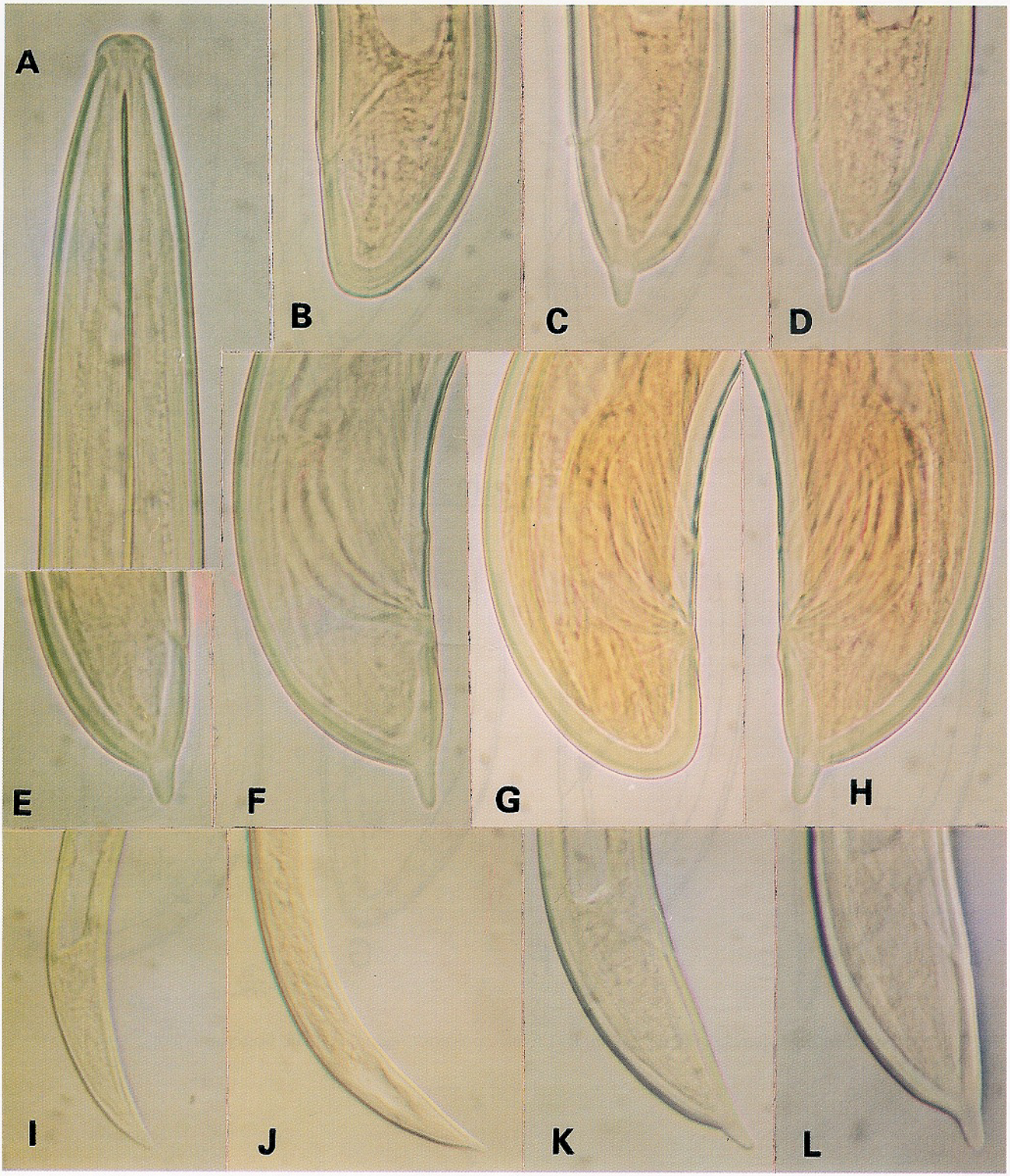

Fig. 8 - Photomicrographs of *X. index*: A, female anterior region; B-E, female posterior region; F-H, male posterior region; tail shape of I, first, J, second, K, third and L, fourth juvenile stage respectively.

TABLE VI - *Morphometrics of juvenile stages and females of* X. index.

Developmental stages and populations	Body length (mm) (mean)	Odontostyle (µm) (mean)	Odontophore (µm) (mean)	Replacement odontostyle (µm) (mean
J_1				
Morinj (original)	0.819	49.2	32.4	49.2
Italy (Vovlas and Larizza, 1994)	0.846	49.3	35.3	49.3
J_2				
Morinj	1.153	64.4	44.3	85.9
Italy	1.194	63.8	43.7	90.0
J_3				
Morinj	1.676	108.8	55.3	87.4
Italy	1.894	108.1	57.3	87.3
J_4				
Morinj	2.277	107.0	63.9	128.6
Italy	2.500	111.6	65.8	135.2
Females				
Morinj	3.047	127.5	73.6	–
Italy	3.153	133.5	76.3	–

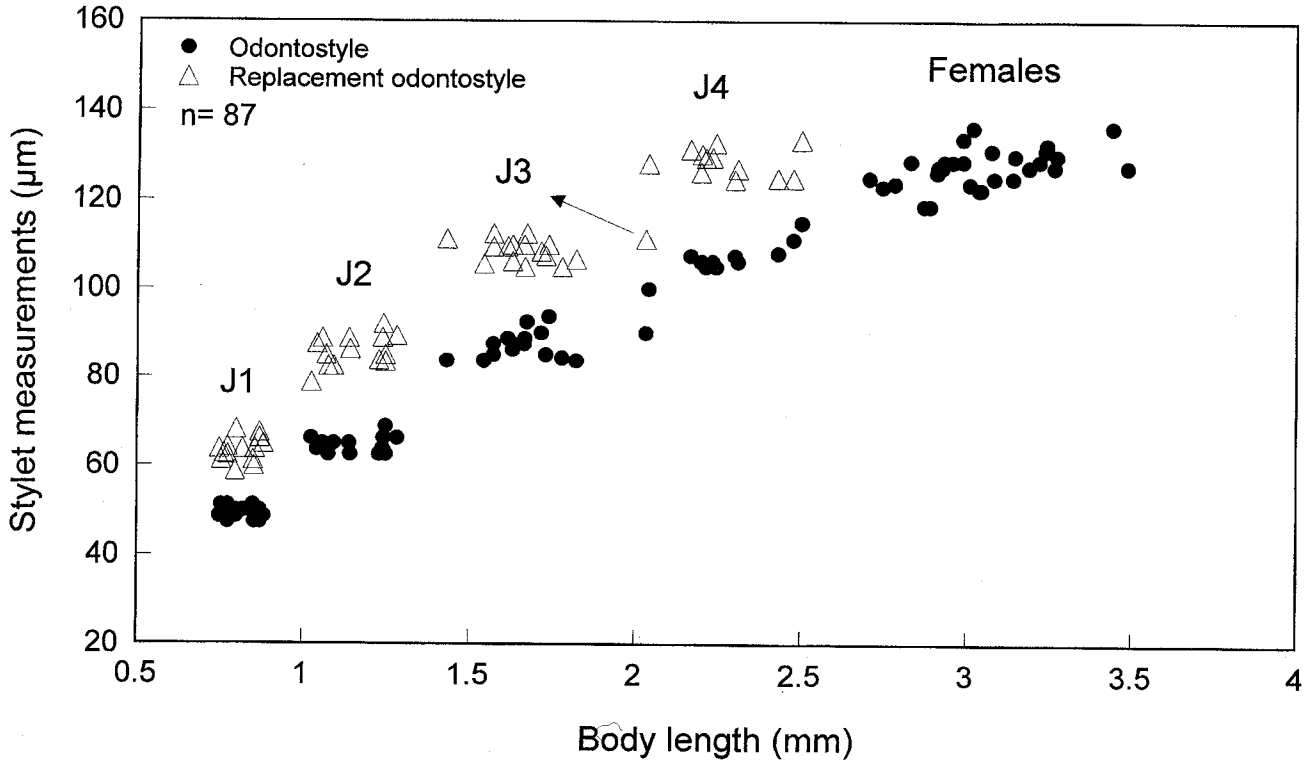

Fig. 9 - Scatter diagram separating juveniles and females of *X. index*.

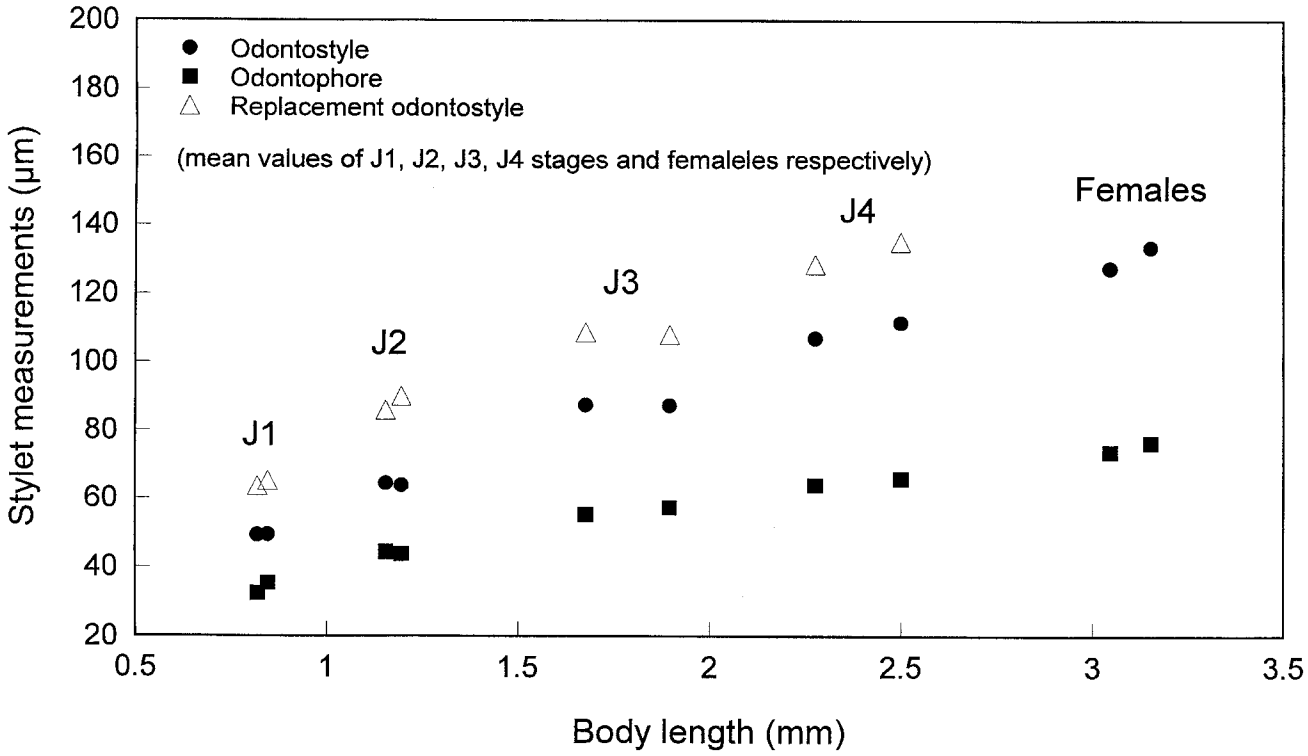

Fig. 10 - Scatter diagram separating juveniles and females of *X. index* from two selected populations (for details see Table VI).

specimens rarely occur in natural populations and it seems that this feature is not inherited (Tzortzakakis and Brown, 1996).

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