

Original paper

Contribution to the knowledge of *Xiphinema paradentatum* Barsi, Fanelli & De Luca, 2017 (Nematoda: Dorylaimida)

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Summary. Identification of a population of *Xiphinema paradentatum* on Mt. Durmitor in Montenegro, is the first after its description from Mt. Tara in Serbia. This population is described, illustrated and morphometric data of females and four juvenile developmental stages are presented. It is very similar to the type population from Serbia and minor differences in morphometric data are considered to be intraspecific variability.

Keywords: Durmitor, intraspecific variability, Longidoridae, Montenegro, nematodes.

INTRODUCTION

During a survey of longidorid nematodes in 2000 on Durmitor Mountain in Montenegro, a population of a *Xiphinema* species with rounded and pegless female tails was found. Although similar to *X. dentatum* Sturhan, 1978, this population showed some subtle differences in the morphology and morphometrics of adults and juvenile developmental stages, and has not been reported to date. *Xiphinema dentatum* was originally described from Germany (Sturhan, 1978). It has also been recorded from Serbia (Barsi and Horvatić 1986; Barsi 1989, 1996; Radivojević and Baujard 1998), the Slovak Republic (Lišková 1994; Lišková et al. 1995; Lišková and Brown 1999, 2003; Lišková and Liška 2000), Poland (Prior et al. 2008), and the Czech Republic (Kumari and Decraemer 2008; Kumari 2009). The current published and unpublished information on morphological variability indicates that *X. dentatum* might be actually a complex of similar species. Barsi et al. in 2017 described a new *Xiphinema* species from Serbia with rather similar morphology to *X. dentatum*, and named it *X. paradentatum*. Comparison of the population from Montenegro with type population *X. paradentatum* from Mt. Tara in Serbia revealed that they were conspecific.

The aim of this paper was to describe, illustrate and present morphometric data of females and four juvenile developmental stages of a population of *X. paradentatum* from Montenegro, in order to contribute to the knowledge of the intraspecific variability of this species.

MATERIALS AND METHODS

Soil samples containing specimens of *X. paradentatum* were collected from the rhizosphere of European beech – *Fagus sylvatica* L. in the canyon of Sušica river (UTM CN38) in May 2000. Subsequently, in August 2002 additional soil samples were collected to obtain enough material for more detailed study.

Nematodes were extracted by Cobb's wet sieving technique, killed and fixed with hot FP 4:1, transferred to glycerin by the slow evaporation method and mounted on permanent microscope slides. Measurements were made with an eyepiece scale, except for body length, which was measured with the aid of a drawing tube and map measurer. Photographs were taken using a Zeiss Axio Imager A1 compound microscope equipped with a digital camera AxioCam MRC

5. Final images of Z-differentiation were made using Helicon focus stacking software.

Terminology and location of pharyngeal gland nuclei are given according to Andrásy (1998).

DESCRIPTION

Xiphinema paradentatum Barsi, Fanelli & De Luca, 2017
(Figs 1-6)

Measurements

See Table 1.

Female. Habitus as open C when killed, body cylindrical, tapering very gradually towards the extremities. Cuticle with very fine transverse striations. Lip region frontally almost flattened and laterally rounded, separated from the rest of the body by a weak depression. Amphidial fovea stirrup-shaped, with a conspicuous slit-like aperture, about 69 ± 3.0 (65-73)% of head width, located just anterior to the demarcation line. Odontostyle long, 1.6 ± 0.1 (1.5-1.8) times longer than the odontophore; the latter with well-developed flanges 17.2 ± 0.9 (15-19.2) μm wide. Guiding sheath variable in length, with guiding ring 7.0 ± 0.6 (6.7-8.9) μm wide. Pharynx dorylaimoid with basal bulb, 129 ± 4.1 (121-141) \times 33 ± 1.4 (30-35) μm , occupying 22.9 ± 1.0 (21.5-27)% of total length and provided with three gland nuclei. In almost every specimen studied, a 7.5-9 μm long mucron is present in the anterior region of the slender part of the pharynx at various distances [43 ± 18.3 (14-79) μm] posterior to the odontophore base. Reproductive system didelphic-amphidelphic with equally developed genital branches. Ovaries reflexed, oviduct with a slender part and a *pars dilatata oviductus* separated from the uterus by a conspicuous sphincter muscle. Uterus tripartite, consisting of a long and wide *pars dilatata uteri* continuing into a narrower, muscular tube-like portion including a Z-differentiation (pseudo Z-organ) with moderately thick wall and containing several irregular, angular sclerotized bodies – aphophyses, which are apparently solid and porous (Fig. 2). Rarely, in some specimens ring like porous sclerotized bodies are present. No sperm was seen inside the uteri. Ovejector with inner epithelium characteristically covered with numerous tuft-like protrusions toward the lumen. Vulva pre-equatorial transverse slit; vagina extending inwards for 57 ± 3.5 (48-66)% of the corresponding body diameter. Prerectum 495 ± 62.7 (333-594) μm long or 9 ± 1.1 (6.2-10.8) times the anal body width. Rectum 49 ± 3.7 (40-57) μm long, more or less as the body width at the anus. Tail broadly and symmetrically rounded with 2-3 caudal pores on each side.

Male. Not found.

Juvenile stages (J1-J4). Juveniles clearly separated into four stages; morphologically similar to females but smaller.

Tail shape in J1 elongate conoid with long cuticular extension, slightly curved ventrally; in J2 dorsally convex conoid with relatively long cuticular extension, slightly curved ventrally in posterior region; in J3 and J4 conoid with broadly rounded tip, without cuticular extension.

DISCUSSION

Although some intraspecific variability exists, the population of *X. paradentatum* from Montenegro is very similar to the type population from Serbia (Barsi et al. 2017). The differences between these populations worth to mention are as follows. In females: slightly shorter odontostyle [152 (142-158) vs. 157 (147-166) μm], longer tail [40 (30-50) vs. 34 (23-40) μm], lower c value [107.7 (88.4-136.9) vs. 132.6 (105.4-167.9)], and higher c' value [0.73 (0.55-0.89) vs. 0.63 (0.49-0.74)]. In juvenile developmental stages: longer tail in J3 and J4 [47 (42-53), 43 (39-50) vs. 41 (36-46), 36 (29-41) μm], lower c value [J1 12.3 (11.3-13.5) vs. 12.7 (11.6-13.5), J2 20.2 (16.7-22.9) vs. 21.7 (19.8-25.6), J3 46.0 (40.5-51.0) vs. 53.3 (41.3-62.2), J4 73.4 (62.9-83.7) vs. 90.3 (73.6-112.8)], higher c' value [J2 2.81 (2.42-3.19) vs. 2.74 (2.37-3.0), J3 1.29 (1.16-1.50) vs. 1.15 (1.01-1.48), J4 0.90 (0.81-1.09) vs. 0.77 (0.62-0.89)].

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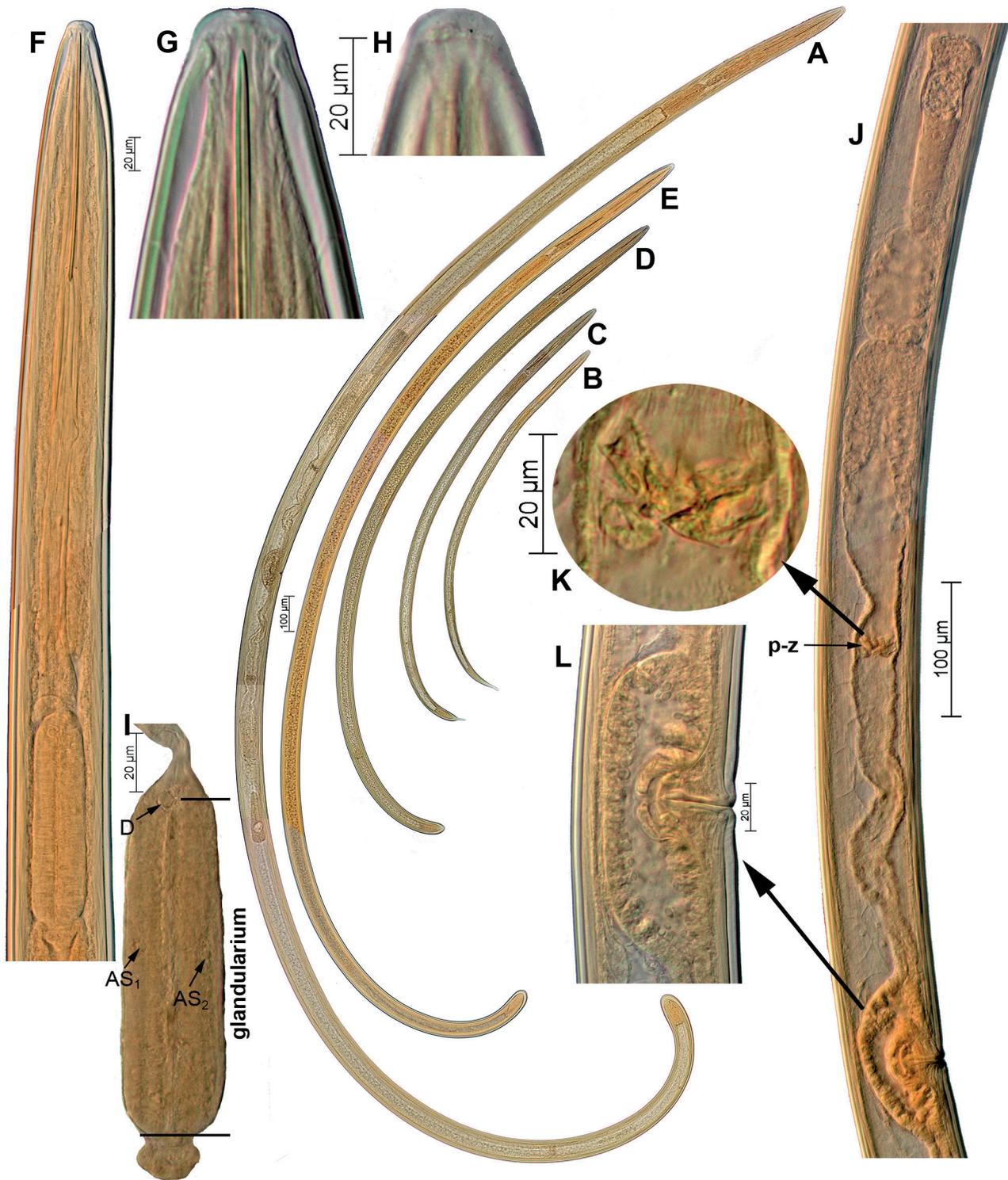


Fig. 1. *Xiphinema paradentatum*, Montenegro. **A:** Entire body, female; **B-E:** Entire body, juveniles from J1 to J4, respectively; **F:** Anterior region of a female in lateral optical view; **G:** Female lip region; **H:** Amphid; **I:** Cylindrical basal bulb (*cylindrus*) of the pharynx showing nuclei of dorsal and subventral glands (D = dorsal nucleus; glandularium = distance between the dorsal nucleus and posterior margin of *cylindrus* – signified by two horizontal black lines; AS₁ = first anterior subventral nucleus; AS₂ = second anterior subventral nucleus); **J:** Female anterior genital branch (pz = pseudo-Z-organ); **K:** Pseudo-Z-organ (enlarged); **L:** Vulval region. (Scale bars: A-E = 100 µm; F = 20 µm; G, H = 20 µm; I = 20 µm; J = 100 µm; K = 20 µm; L = 20 µm.)

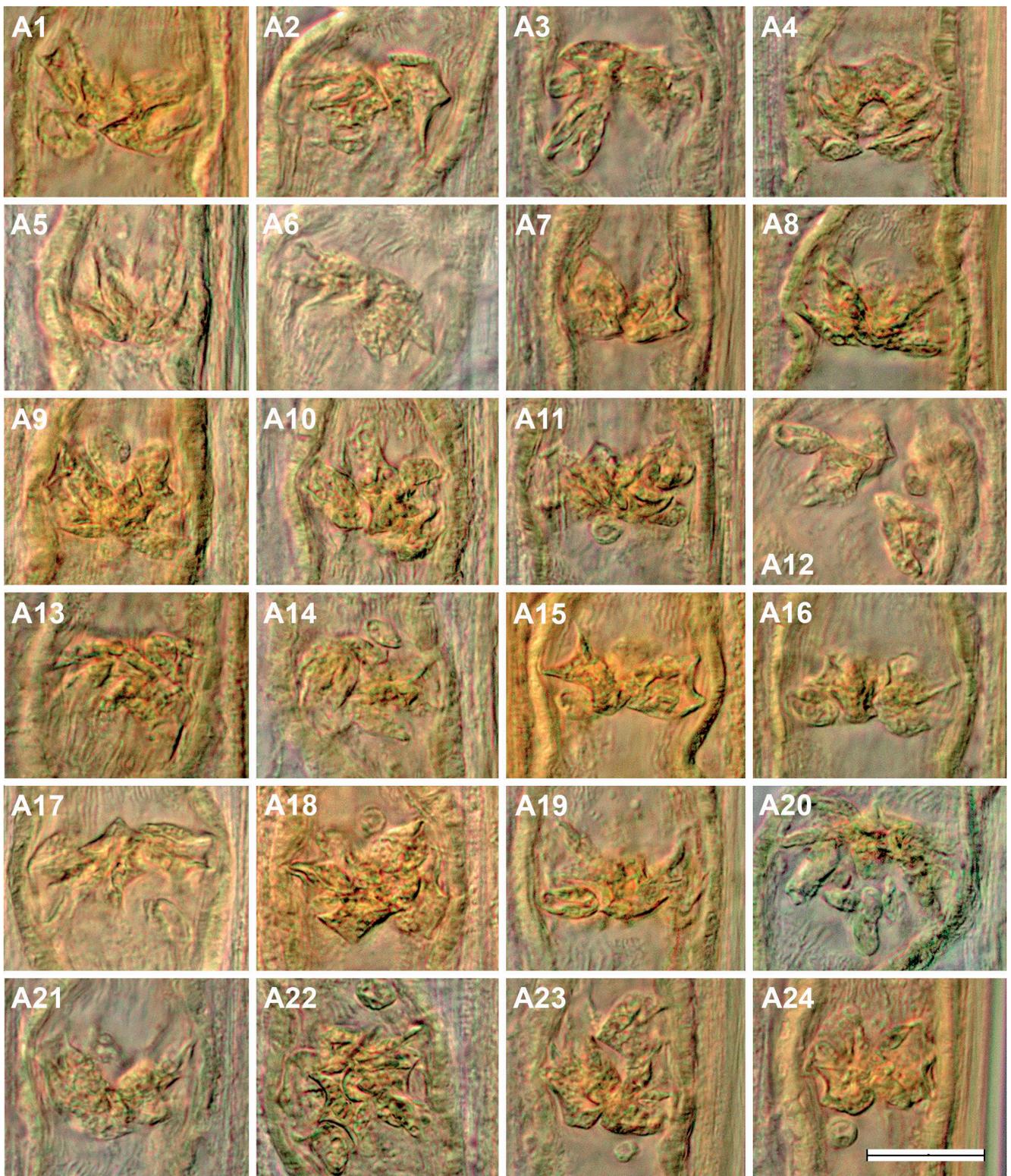


Fig. 2. *Xiphinema parudentatum*, Montenegro. **A1-A24:** Pseudo-Z-organ in detail. (Scale bar = 20 μm .)

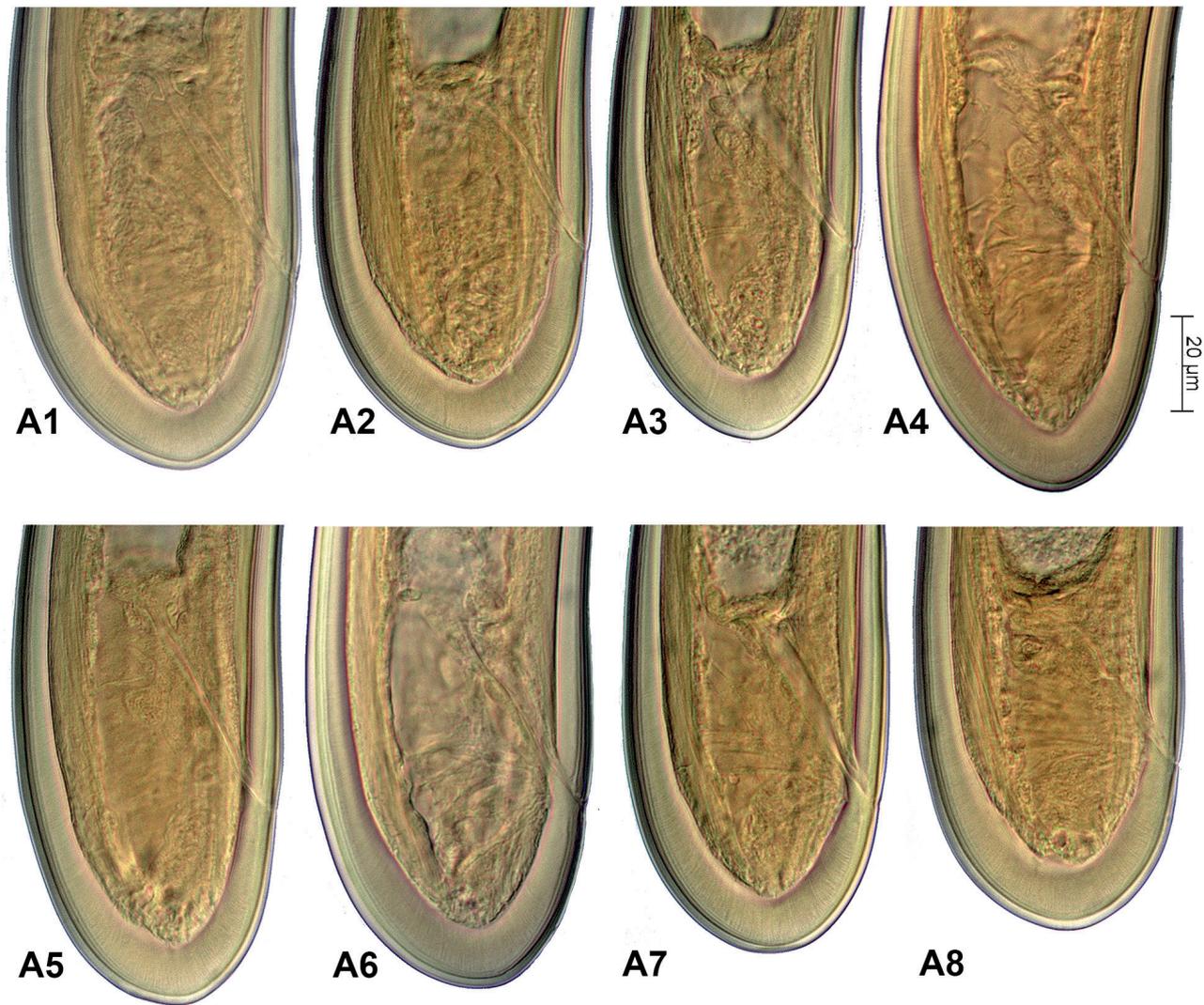


Fig. 3. *Xiphinema parudentatum*, Montenegro. **A1-A8:** Female tail region. (Scale bar = 20 μ m.)

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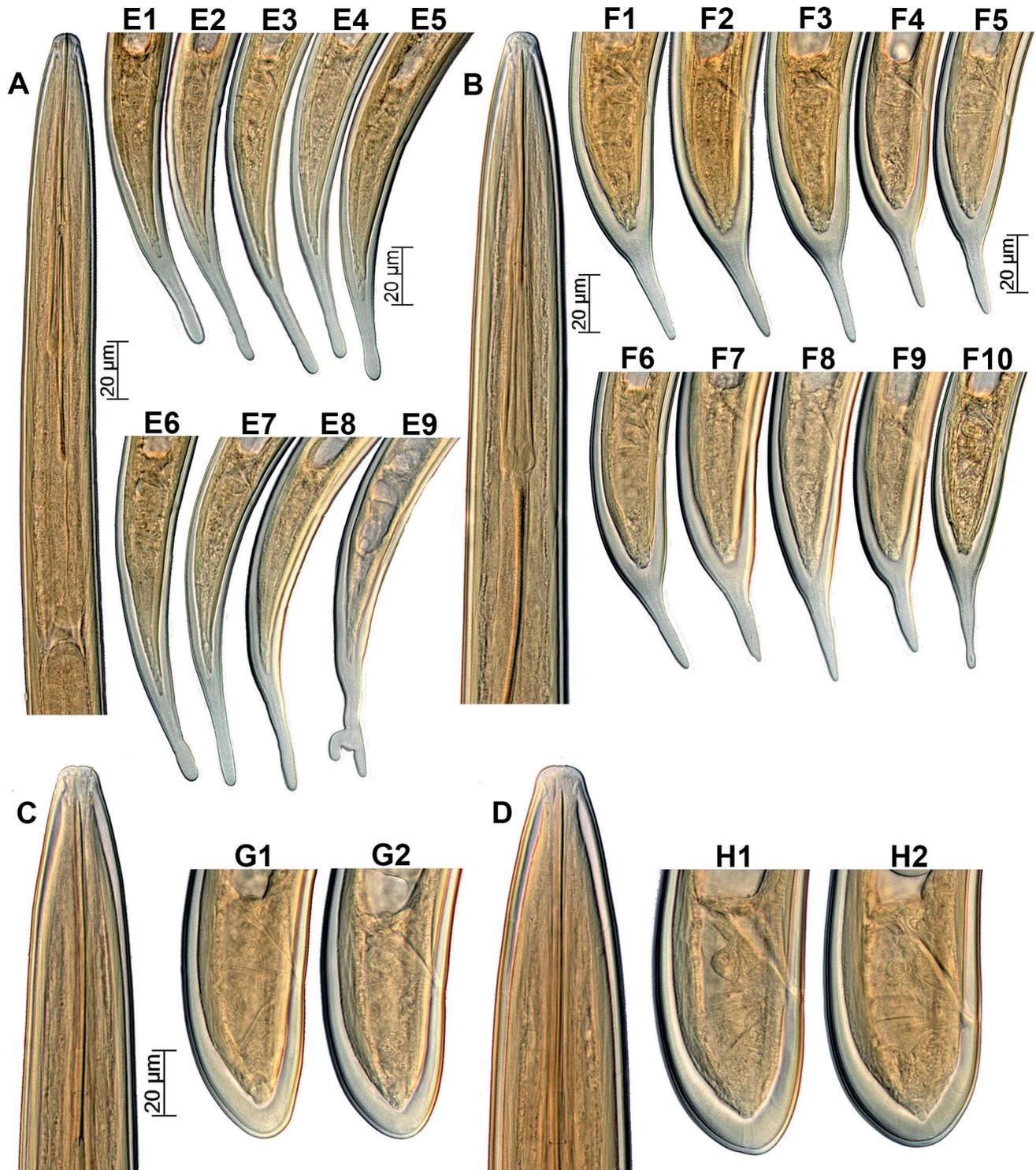


Fig. 4. *Xiphinema parudentatum*, Montenegro. Juvenile stages J1-J4. Anterior body region of J1 (A), J2 (B), J3 (C) and J4 (D); Tail region of J1 (E1-E9; E9 with anomaly of the hyaline portion), J2 (F1-F10), J3 (G1, G2) and J4 (H1, H2). (Scale bars: A, B, E1-E9, F1-F10 = 20 µm; C, D, G1, G2, H1, H2 = 20 µm.)

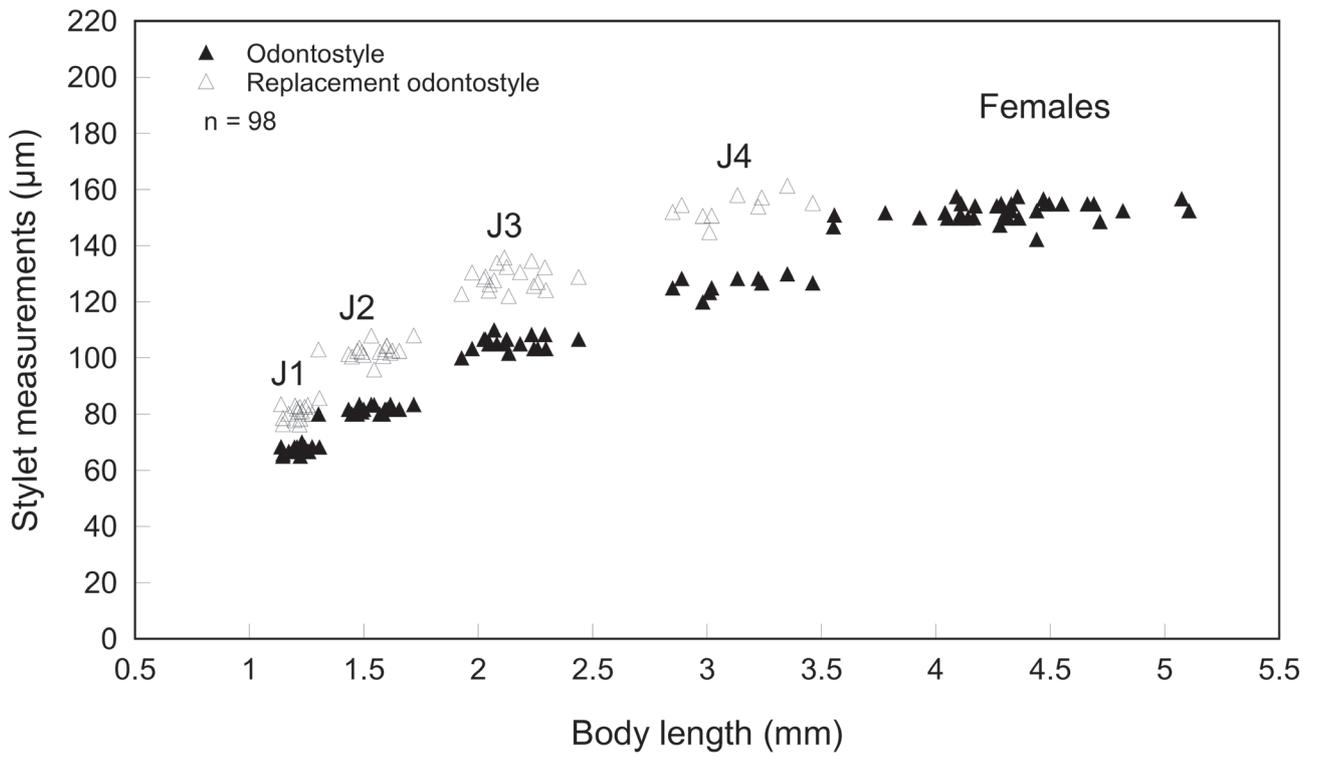


Fig. 5. Scatter diagram separating juveniles (J1-J4) and females of *Xiphinema paradenatum* from Canyon of Sušica river, Mt. Durmitor, Montenegro.

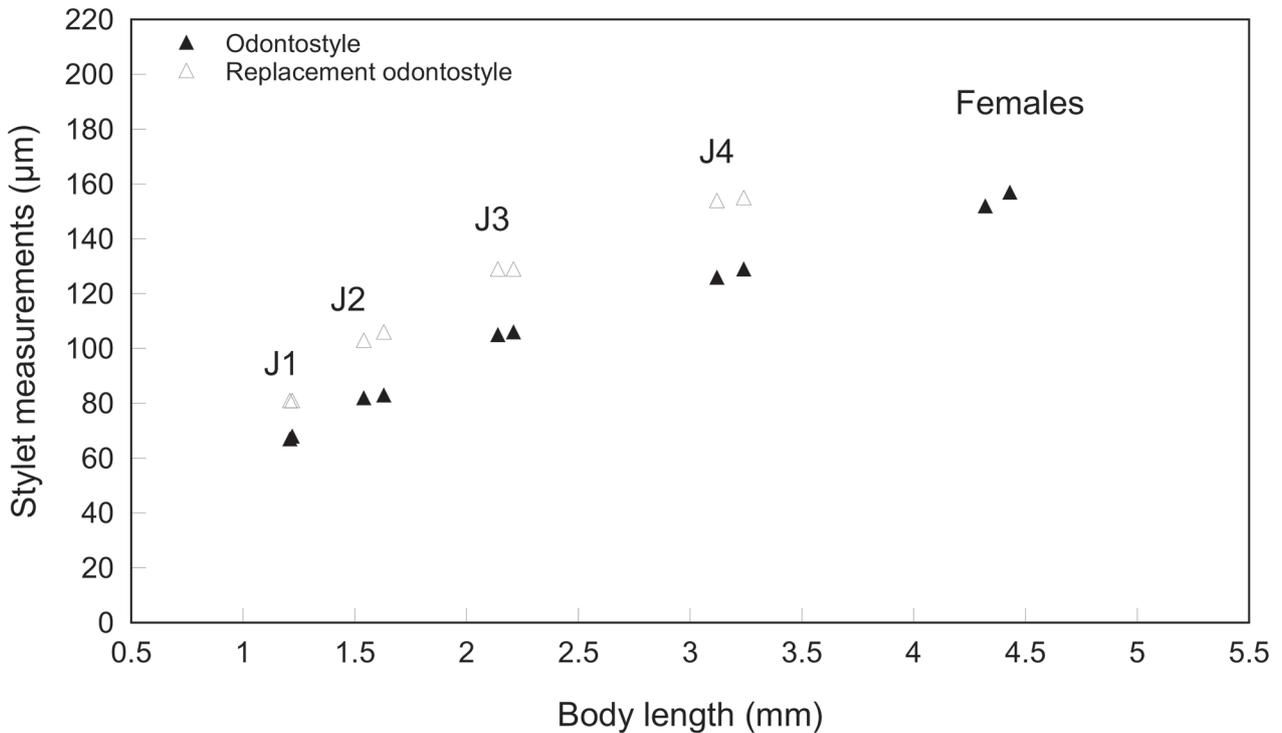


Fig. 6. Scatter diagram separating juveniles (J1-J4) and females of *Xiphinema paradenatum* from Serbia and Montenegro.

Table 1. Morphometrics of adult and juvenile *Xiphinema parudentatum* from Montenegro. All measurements in μm (except for L) and in the form: mean \pm standard deviation (range).

Locality:	Canyon of Sušica river, Mt. Durmitor, Montenegro					
Host:	Fagus sylvatica					
	J1	J2	J3	J4	Female	Female
N	17	18	18	10	34	1
L (mm)	1.21 \pm 0.05 (1.14-1.31)	1.54 \pm 0.10 (1.30-1.72)	2.14 \pm 0.13 (1.93-2.44)	3.12 \pm 0.20 (2.85-3.46)	4.32 \pm 0.35 (3.55-5.11)	4.11
a	39.6 \pm 2.8 (34.3-43.6)	41.5 \pm 3.9 (35.3-47.0)	49.2 \pm 3.3 (42.1-52.9)	56.0 \pm 4.2 (48.6-63.7)	62.4 \pm 3.8 (53.9-69.8)	55.2
b	4.1 \pm 0.2 (3.6-4.4)	4.2 \pm 0.3 (3.8-4.7)	5.0 \pm 0.4 (4.3-5.7)	6.0 \pm 0.5 (5.5-7.0)	7.7 \pm 0.7 (6.3-8.9)	7.5
c	12.3 \pm 0.6 (11.3-13.5)	20.2 \pm 1.6 (16.7-22.9)	46.0 \pm 3.1 (40.5-51.0)	73.4 \pm 5.7 (62.9-83.7)	107.7 \pm 11.0 (88.4-136.9)	99.2
c'	4.86 \pm 0.33 (4.37-5.50)	2.81 \pm 0.20 (2.42-3.19)	1.29 \pm 0.09 (1.16-1.50)	0.90 \pm 0.08 (0.81-1.09)	0.73 \pm 0.7 (0.55-0.89)	0.81
d	5.92 \pm 0.19 (5.58-6.33)	6.68 \pm 0.26 (6.13-7.10)	7.49 \pm 0.20 (7.08-7.77)	7.72 \pm 0.22 (7.33-7.95)	8.38 \pm 0.21 (7.88-8.80)	8.57
d'	2.33 \pm 0.05 (2.22-2.42)	2.59 \pm 0.15 (2.35-2.90)	2.75 \pm 0.09 (2.63-2.93)	2.90 \pm 0.06 (2.80-3.00)	3.00 \pm 0.08 (2.83-3.18)	3.05
J'	4.22 \pm 0.26 (3.60-4.65)	2.20 \pm 0.27 (1.64-2.66)	0.40 \pm 0.03 (0.36-0.45)	0.31 \pm 0.03 (0.27-0.39)	0.32 \pm 0.02 (0.28-0.37)	0.54
V	-	-	-	-	46.7 \pm 1.3 (43.8-49.1)	43.2
Odontostyle	67 \pm 1.3 (65-70)	82 \pm 1.3 (80-83)	105 \pm 2.5 (100-110)	126 \pm 2.9 (120-130)	152 \pm 3.3 (142-158)	151
Odontophore	49 \pm 1.7 (47-53)	60 \pm 1.7 (57-63)	74 \pm 2.0 (70-78)	85 \pm 2.8 (81-89)	93 \pm 2.9 (86-98)	91
Total stylet	117 \pm 2.2 (113-122)	142 \pm 2.2 (137-147)	179 \pm 4.0 (172-186)	212 \pm 5.3 (203-218)	245 \pm 4.8 (236-254)	242
Replacement odontostyle	81 \pm 2.6 (76-86)	103 \pm 2.7 (96-108)	129 \pm 4.1 (122-136)	154 \pm 4.6 (145-161)	-	-
Oral aperture to guide ring	59 \pm 1.9 (56-63)	76 \pm 3.4 (67-82)	98 \pm 3.0 (94-103)	117 \pm 3.4 (110-122)	144 \pm 3.0 (138-150)	142
Tail	99 \pm 4.8 (90-106)	77 \pm 4.8 (71-86)	47 \pm 3.4 (42-53)	43 \pm 3.7 (39-50)	40 \pm 4.3 (30-50)	41
J (hyaline portion of tail)	37.6 \pm 3.2 (31.7-42.5)	36.2 \pm 2.9 (30.8-40.6)	9.3 \pm 0.7 (8.3-10.4)	9.5 \pm 1.0 (7.9-11.1)	12.2 \pm 0.7 (10.6-13.8)	16.9*
Body diam. at lip region	10.0 \pm 0.0 (10.0-10.0)	11.3 \pm 0.3 (10.8-11.7)	13.1 \pm 0.3 (12.8-13.6)	15.1 \pm 0.4 (15.0-16.1)	17.2 \pm 0.4 (16.3-17.9)	16.6
Body diam. at guide ring	23.3 \pm 0.5 (22.2-24.2)	29.3 \pm 1.9 (27.1-32.8)	35.9 \pm 1.2 (34.6-38.8)	44.0 \pm 0.9 (42.9-45.6)	51.7 \pm 1.1 (49.6-54.2)	50.6
Body diam. at base of pharynx	29.8 \pm 1.9 (27.5-33.3)	36.4 \pm 4.2 (30.8-43.3)	42.2 \pm 3.4 (36.3- 48.3)	53.7 \pm 3.0 (46.7-56.7)	62.1 \pm 2.8 (56.3-67.9)	64.2
Body diam. at mid-body or vulva	30.8 \pm 2.5 (27.5-35.3)	37.6 \pm 4.8 (31.7-45.3)	43.7 \pm 3.6 (38.3-50.0)	55.8 \pm 3.7 (49.2-61.3)	69.2 \pm 3.4 (62.9-76.7)	74.4
Body diam. at anus	20.4 \pm 0.8 (18.8-21.9)	27.4 \pm 1.6 (25.0-30.0)	36.2 \pm 1.5 (33.6-38.9)	47.2 \pm 1.5 (45.0-49.7)	55.2 \pm 1.7 (51.1-58.3)	51.3
Body diam. at beginning of J	8.9 \pm 0.5 (8.3-10.0)	16.6 \pm 1.4 (13.8-18.8)	23.1 \pm 1.2 (21.3-25.0)	30.8 \pm 1.7 (28.6-33.3)	38.5 \pm 1.9 (34.7-44.3)	31.3

d, anterior to guide-ring/body width at lip region (Brown et al. 1994). d', body width at guide ring/body width at lip region (Brown et al. 1994). J', length of the hyaline region of the tail/hyaline width (Lišková et al. 1997).

*tail with a 6.3 μm long peg.