Morphometric variation and juvenile stages of *Longidorus piceicola* Liskova *et al*., 1997 (Nematoda: Longidoridae) from the former territory of Yugoslavia

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Summary. Longidorus piceicola is reported for the first time from the former territory of Yugoslavia. Morphometric variability of females, males and four juvenile stages are presented. Key words: distribution, Longidorus piceicola, morphometrics.

Lišková *et al.* (1995) reported the occurrence and distribution of Longidoridae and Trichodoridae from the Slovak Republic, and subsequently Lišková *et al.* (1997) reported three new Longidorus species occurring in the country, including L. piceicola.

During the 1990s, several soil samples collected as part of a nematode survey in the former territory of Yugoslavia contained populations of a *Longidorus* species that is identified here as L. *piceicola* Liskova *et al.*, 1997. Morphometrics of specimens from these populations are reported here to provide information on the natural variability of females, males and the four juvenile stages of L. *piceicola*.

MATERIAL AND METHODS

Samples were collected in April 1990 from the rhizosphere of *Picea excelsa* (Lam) Lk. at Partizansko Polje (UTM:CP38), Kupres (UTM:XJ87), Podromanija (UTM:CP26) and Bugojno-Poriče (UTM:XJ98) in Bosnia and Herzegovina; in July 1996 from the rhizosphere of *Fagus sylvatica* L. at Brezovica (UTM:EM07) and in June 1998 from the same host at Samokovska reka (UTM:DN89) in Serbia; and in June 1997 from the rhizosphere of *F. sylvatica* at Zminje jezero (UTM:CN47) and in May 2000 from the rhizosphere of *Abies alba* Mill. at Crno jezero, near Žabljak (UTM:CN47) in Montenegro.

Nematodes were extracted by Cobb's wet sieving technique. Specimens were killed by hot FP 4-1 and processed and mounted on permanent slides in dehydrated glycerin. Measurements were made with an eyepiece graticule, except body length, which was determined with the aid of drawing tube and map measurer.

DESCRIPTION Longidorus piceicola Liskova, Robbins & Brown, 1997 (Figs. 1-4)

Measurements: Tables 1-4

Female. Body from J-shape to spiral, tapering gradually anteriorly. Cuticle finely transversally striated. Lip region frontally broadly rounded or almost flattened, laterally rounded. Amphidial pouch mostly indistinct, when visible it appears pocket shaped, shallowly symmetrically bilobed at the base. Odontostyle long and very slender, approximately 2 to 2.4 µm wide at base; odontophore and guide ring typical of the genus. Oesophagus dorylaimoid; the basal bulb measures 115 to 146 µm long and 20 to 30 µm wide. Vulva more or less equatorial, slit like; vagina occupying slightly more than 1/2 of the corresponding body diameter. Reproductive system amphidelphic with equally developed genital branches; uterus short, 1 to 2 body widths in length, separated by a sphincter from the oviduct; ovaries opposed, reflexed. Sperm not ob-



Fig. 1. Photomicrographs of *Longidorus piceicola*. A & B: Female anterior region; C & D: Female amphidial pouch; E: Junction of the odontostyle with the odontophore; F: Vulva region and anterior uterus; G-J: Female tail; K: Male tail. Scale bar - $50 \mu m$.



Fig. 2. Photomicrographs of juvenile stages of *L. piceicola*. A-D: Anterior region of J1, J2, J3 and J4 stage; E-H: Tail of J1, J2, J3 and J4 stage. Scale bar - $50 \mu m$.

served in uteri. Pre-rectum as long as 5 to 15 times the anal body width; rectum as long as about 3/4 the anal body width. Tail dorsally convex, conoid with rounded terminus, bearing two caudal pores on each side.

Male. Morphologically similar to females, with the posterior region of the body more coiled. Tes-

tes fully developed, apparently functional, with sperms inside. Spicules robust, guiding pieces mostly inconspicuous (*ca.* 14 μ m long in one male). The adanal pair of supplements is preceded by a row of 9-11 ventromedian supplements. Tail dorsally convex and ventrally slightly concave, conoid with rounded terminus, bearing two caudal pores on each side.



Fig. 3. Scatter diagram separating juveniles and females of L. piceicola.



Fig. 4. Scatter diagram separating juveniles and females of *L. piceicola* from two selected populations (for details see Table 4).

Juveniles. Clearly separated into four stages. They resemble adults except for smaller size, with some overlapping in body length between fourth juvenile stage and adults. Their posture varies from J to an open C. Tail elongate-conoid in first stage and progressively less conoid in second, third, and fourth stage.

All stages correspond well with juvenile stages described from Slovakia by Lišková *et al.* (1997) with exception of body length, odontostyle, and replacement odontostyle length. Body length is longer in third and fourth stages and in females of the population from Crno jezero, near Žabljak (Table 4 and Fig. 4). Odontostyle and replacement odontostyle is generally longer in all juvenile stages and in females of this population.

The original description of L. piceicola was based on specimens associated with Norway spruce [(Picea abies (L.) Karst] growing in the Muranska Planina Mountains near the village of Cervena Skala, Slovakia (Lišková *et al.*, 1997). Subsequently, other populations of this species have been found in several localities in Slovakia (Lišková, pers. comm.). To the best of our knowledge this is the first record of this species out of this country. The morphology of our populations

Locality	Crno jezero, near Žabljak					
Host	Abies alba					
n	17 QQ	17 J1	20 J2	16 J3	12 J4	
	5.95±0.76	1.56 ± 0.10	2.30±0.21	3.32±0.22	4.70 ± 0.46	
L (mm)	(4.42-7.99)	(1.44-1.86)	(1.99-2.75)	(2.89-3.71)	(3.84-5.46)	
а	104±11 (92-128)	66±2.9 (63-73)	72±3.3 (67-80)	81±4.8 (70-86)	91±4.6 (81-99)	
b	10.0±1.4 (8.0-13.1)	4.2±0.4 (3.8-5.0)	5.3±0.5 (4.5-6.6)	6.7±0.7 (5.4-8.0)	8.1±1.1 (6.1-10.7)	
с .	153±19.9 (119-205)	31±1.8 (29-35)	48±5.9 (38-64)	71±6.2 (63-86)	112±16.9 (76-137)	
c'	1.0±0.1 (0.8-1.1)	2.8±0.1 (2.7-3.1)	2.0±0.2 (1.6-2.4)	1.5±0.1 (1.3-1.7)	1.1±0.1 (1.0-1.4)	
d*	2.5±0.2 (2.1-2.8)	2.6±0.1 (2.5-2.8)	2.7±0.1 (2.4-2.9)	2.8±0.2 (2.5-3.1)	2.6±0.2 (2.4-2.9)	
d'**	1.7±0.1 (1.5-1.8)	1.7±0.1 (1.6-1.8)	1.7±0.1 (1.6-1.8)	1.7±0.1 (1.6-1.8)	1.7±0.1 (1.7-1.8)	
J,	0.5±0.04 (0.4-0.6)	1.3±0.1 (1.0-1.6)	0.9±0.1 (0.7-1.2)	0.6±0.1 (0.5-0.7)	0.5±0.1 (0.4-0.6)	
V%	49±2.1 (45-54)	-	-	-	-	
Odontostyle µm	178±5.1 (168-188)	109±4.1 (104-116)	121±3.4 (115-128)	141±5.5 (132-151)	160±5.1 (150-165)	
Odontophore µm	82±9.6 (65-96)	51±2.1 (48-55)	60±3.7 (53-68)	69±4.8 (60-76)	79±6.3 (66-89)	
Total stylet µm	261±12.7 (236-280)	160±5.4 (153-170)	181±4.9 (173-189)	210±9.1 (193-226)	238±9.7 (221-249)	
Replacement odontostyle µm	-	118±4.3 (113-125)	137±5.0 (126-146)	158±6.5 (144-166)	178±6.6 (166-191)	
Oral aperture to guiding ring µm	41±3.1 (34-45)	25±0.8 (23-26)	30±1.1 (27-31)	35±1.9 (32-38)	39±2.1 (36-43)	
Tail µm	39±3.2 (34-46)	50±3.0 (46-54)	49±3.3 (43-56)	47±3.7 (40-52)	43±3.6 (37-51)	
J (hyaline portion of tail) μm	12 ± 0.9 (10-13)	9.3 ± 1.2 (6.9-11.9)	10.3 ± 1.1 (8.1-11.9)	10.9 ± 0.8 (9.4-12.2)	10.7 ± 0.9 (8.4-12.2)	
Body diam. at lip region μm	16.5±0.7 (15-18)	9.3±0.2 (8.8-9.6)	11±0.4 (10-12)	13±0.4 (12-13)	15±0.6 (14-16)	
Body diam. at guiding ring μm	28±1.6 (23-30)	16±0.5 (15-16)	18±0.6 (17-19)	22±0.9 (20-23)	26±0.8 (25-27)	
Body diam. at base of oesophagus µm	50±2.8 (44-54)	24±1.4 (23-29)	31±2.3 (28-36)	38±1.9 (34-41)	46±2.2 (42-49)	
Body diam. at mid- body or vulva µm	57±4.9 (48-65)	23±1.9 (21-30)	32±3.6 (27-40)	41±2.8 (36-46)	51±4.0 (45-59)	
Body diam. at anus µm	41±2.2 (38-44)	18±0.9 (16-20)	24±1.8 (23-28)	32±2.1 (28-34)	39±2.0 (35-41)	
Body diam. at beginning of J μm	26±1.3 (24-29)	7.3±0.5 (6.3-8.1)	11.5±1.2 (9.4-13)	17±1.4 (15-19)	23±2.1 (20-26)	

Table 1. Morphometric characters of a population of Longidorus piceicola from Montenegro.

d* - anterior to guide-ring/body width at lip region;

d'** - body width at guiding-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).

were similar to those reported in the original description of the species and to the specimens kindly sent for comparison by Dr. M. Lišková. An abrupt tapering of the anterior region observed in some specimens from Slovakia (Lišková, pers. comm.) occurred also in a few specimens of almost all our populations (Fig. 1B).

Compared to the type population (Lišková *et al.*, 1997) *L. piceicola* from the former territory of Yugoslavia has a longer body (4.4-8 vs 4.2-6 mm), higher "a" value (90-140 vs 73-104), longer odontostyle (145-188 vs 151-169 μ m) and longer odontophore (65-96 vs 75-87 μ m). However, longer specimens have also been observed in other populations of *L. piceicola* from Slovakia (unpublished data, Lišková, pers. comm.).

Two males found in the population from the rhizosphere of *P. excelsa* at Partizansko Polje are generally similar to the male from the type popu-

lation except for the slightly shorter odontostyle (155-160 vs 166 μ m), longer odonophore (76-80 vs 61 μ m), shorter distance from oral aperture to guiding ring (39 vs 47 μ m) and slightly longer tail (49-50 vs 44 μ m).

Taking into consideration the existing intraspecific variability of this species, the identification code for *L. piceicola* in the polytomous key of Chen *et al.* (1997) should be modified as: A67-B23-C34-D2-E2-F234-G123-H12-I12.

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Locality	Partizansko Polje		Kupres	Podromanija
Host	Picea excelsa		P. excelsa	P. excelsa
n	24 QQ	2 ඊඊ	6 QQ	8 QQ
L (mm)	6.23±0.67 (5.21-7.88)	4.80, 4.97	6.33±0.54 (5.89-7.32)	6.32±0.45 (5.92-7.38)
a	111±8.0 (99-140)	95, 103	113±7.2 (103-123)	111±6.4 (103-124)
b	10.6±0.8 (9.5-12.8)	10.4, 9.3	10.3±0.5 (9.6-11.2)	10.4±0.9 (8.9-12.1)
с	137±17.5 (102-171)	98, 100	149±7.8 (138-159)	146±6.7 (138-156)
c'	1.1±0.1 (0.9-1.4)	1.15, 1.2	0.96±0.05 (0.9-1.0)	0.99±0.03 (0.9-1.0)
d	2.7±0.1 (2.5-3.0)	2.5, 2.5	2.7±0.2 (2.4-3.1)	2.8±0.2 (2.4-3.2)
d'	1.8±0.04 (1.7-1.9)	1.7, 1.6	1.8±0.1 (1.7-1.9)	1.8±0.1 (1.7-2.0)
V%	46±0.8 (45-48)	-	48±0.9 (46-49)	48±0.8 (46-49)
Odontostyle µm	169±8.5 (145-183)	160, 155	170±5.6 (165-180)	169±5.0 (164-180)
Odontophore µm	85±4.7 (76-95)	76, 80	88±3.7 (84-95)	89±1.8 (87-92)
Total stylet µm	254±8.9 (236-273)	236, 235	258±7.4 (249-268)	258±5.3 (252-267)
Oral aperture to guiding ring µm	43±2.3 (39-48)	39, 39	43±2.9 (40-48)	43±2.4 (40-48)
Tail µm	46±5.0 (35-56)	49, 50	42±3.0 (39-46)	43±2.6 (39-48)
J (hyaline portion of tail) μm	13±1.2 (11-16)	12, 15	14±2.3 (10-16)	14±1.6 (11-16)
Body diam. at lip region μm	16±0.6 (14-17)	16, 16	16±0.7 (15-17)	16±0.6 (15-17)
Body diam. at guiding ring µm	28±1.1 (26-31)	27, 26	29±1.4 (28-31)	28±1.4 (26-31)
Body diam. at base of oesophagus µm	49±2.6 (44-54)	44, 44	50±3.6 (46-57)	49±2.0 (47-53)
Body diam. at mid-body or vulva µm	56±4.2 (47-65)	50, 48	56±3.9 (51-61)	57±2.1 (54-60)
Body diam. at anus µm	42±3.0 (35-49)	43, 42	44±2.2 (40-47)	44±2.0 (40-46)
Body diam. at beginning of J µm	26±2.0 (21-29)	23, 21	29±3.0 (24-33)	29±2.7 (24-31)
Spicules µm	-	58, 51	_	-

Table 2. Morphometric characters of adults from populations of L. piceicola from Bosnia and Herzegovina.

Table 3. Morphometric characters of adults from populations of L. piceicola from Bosnia and Herzegovina, Montenegro and Serbia.

Locality	Bugojno-Poriće	Zminje jezero	Samokovska reka	Brezovica
Host	P. excelsa	Fagus sylvatica	F. sylvatica	F. sylvatica
n	6 QQ	10 QQ	3 QQ	12 QQ
L (mm)	6.17±0.34	6.01±0.42	5.49±0.46	6.16 ± 0.51
	(5.73-6.73)	(5.07-6.51)	(5.03-5.95)	(5.22-6.88)
а	109 ± 3.3 (104-112)	99±6.1 (90-112)	98±1.9 (96-100)	112±7.1 (98-124)
b	9.9 ± 0.8 (8.2-10.6)	9.8±0.6 (9.2-11.1)	9.4±0.3 (9.1-9.7)	11.5±1.0 (9.8-12.7)
c	156±10.8 (144-169)	141±9.5 (120-156)	129±5.9 (122-134)	146±13.7 (123-165)
c'	0.95±0.1 (0.8-1.0)	1.0 ± 0.1 (0.96-1.2)	1.1±0.1 (0.97-1.1)	1.1±0.1 (1.0-1.2)
d	2.6±0.1 (2.5-2.8)	2.7±0.1 (2.5-3.0)	2.6±0.1 (2.5-2.8)	2.5±0.2 (2.2-2.7)
d'	1.8±0.04 (1.7-1.8)	1.8±0.1 (1.7-1.9)	1.8±0.0 (1.8-1.8)	1.8±0.1 (1.7-1.9)
V%	47±0.8 (46-48)	49±1.9 (46-51)	50±1.2 (49-51)	49±1.1 (47-51)
Odontostyle µm	178±4.8 (172-183)	175±4.8 (168-183)	167±1.4 (165-168)	174±6.0 (165-183)
Odontophore µm	90±2.5 (86-94)	89±2.9 (85-93)	78±9.2 (68-85)	87±5.4 (79-94)
Total stylet µm	268±4.9 (263-274)	264±6.0 (254-274)	245±8.3 (235-250)	261±10.3 (245-275)
Oral aperture to guiding ring μm	+ 42±1.8 (40−44)	45±1.5 (43-48)	44±1.3 (43-46)	40±2.1 (36-43)
Tail µm	40±3.0 (34-42)	43±2.0 (39-45)	43±2.7 (41-46)	42±3.7 (38-50)
J (hyaline portion of tail) μm	13±0.7 (13-14)	11±0.8 (10-13)	13±0.7 (13-14)	12±1.0 (10-13)
Body diam. at lip region µm	16±0.6 (15-17)	17±0.6 (16-18)	17±0.5 (16-17)	16±0.7 (15-17)
Body diam. at guiding ring μm	28±1.0 (27-30)	30±1.6 (28-33)	30±0.8 (29-30)	29±1.4 (27-31)
Body diam. at base of oesophagus µm	49±2.0 (47-52)	53±2.0 (50-56)	50±3.1 (47-53)	49±2.0 (45-53)
Body diam. at mid-body or vulva µm	56±2.6 (54-59)	61±3.3 (56-68)	56±3.6 (52-59)	55±3.4 (48-59)
Body diam. at anus µm	42±0.7 (41-43)	41±2.4 (38-46)	40±1.9 (39-43)	39±2.3 (36-43)
Body diam. at beginning of J μm	28±1.1 (27-29)	24±2.0 (19-26)	27±1.4 (26-28)	24±1.7 (20-26)

 Table 4. Morphometrics of juvenile stages and females of the L. piceicola populations from Slovakia and Montenegro.

Developmental stages and populations	Body length (mm) (mean)	Odontostyle (µm) (mean)	Odontophore (µm) (mean)	Replacement odontostyle (µm) (mean)
J ₁				
Muranska Planina Mountains, Cervena Skala, Slovakia (Lišková <i>et al.</i> , 1997)	1.50	92	47	99
Crno jezero, near Žabljak, Montenegro (original)	1.56	109	51	118
J ₂				
Muranska Planina Mountains, Cervena Skala, Slovakia	2.36	99	60	122
Crno jezero, near Žabljak, Montenegro	2.30	121	60	137
J ₃				
Muranska Planina Mountains, Cervena Skala, Slovakia	3.00	119	67	138
Crno jezero, near Žabljak, Montenegro	3.32	141	69	158
J4				
Muranska Planina Mountains, Cervena Skala, Slovakia	3.75	133	75	158
Crno jezero, near Žabljak, Montenegro	4.70	160	79	178
Females				
Muranska Planina Mountains, Cervena Skala, Slovakia	5.19	160	81	-
Crno jezero, near Žabljak, Montenegro	5.95	178	82	-

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Barsi L., Lamberti F. Морфологическая изменчивость и личиночные стадии Longidorus piceicola Liskova et al., 1997 (Nematoda: Longidoridae) с территории бывшей Югославии.

Резюме. Впервые сообщается об обнаружении Longidorus piceicola на территории бывшей Югославии. Дается анализ морфологической изменчивости самок, самцов и четырех личиночных стадий.