

***Longidorus poessneckensis* Altherr, 1974 and *L. piceicola* Lišková, Robbins & Brown, 1997 (Nematoda: Longidoridae): new records from Poland and the first description of the *L. poessneckensis* male and a bivulval female**

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Abstract *Longidorus poessneckensis* Altherr, 1974 and *L. piceicola* Lišková, Robbins & Brown, 1997 (Nematoda: Longidoridae) represent new records from Poland. These two species are described and illustrated together with a male and bivulval female of *L. poessneckensis*. In its general morphology and morphometrics, the male of *L. poessneckensis* is similar to the females, but has a spicule 100 µm long and one adanal pair, two double and a row of six single ventromedian supplements. Comments on the differential diagnosis of *L. poessneckensis* and two morphologically related species, *L. uroshis* Krnjaić, Lamberti, Krnjaić, Agostinelli & Radicci, 2000 and *L. macrosoma* Hooper, 1961 are given.

Introduction

Twelve species of *Longidorus* Micoletzky, 1922 have previously been reported from Poland. The most

common species associated both with cultivated and wild growing plants are *L. elongatus* (de Man, 1876) Thorne & Swanger, 1936, *L. attenuatus* Hooper, 1961, *L. euonymus* Mali & Hooper, 1973 and *L. leptocephalus* Hooper, 1961 (Brzeski, 1963; Szczygieł, 1974; Brzeski, 1985; Szczygieł & Brzeski, 1985). Other, less frequently occurring species are: *L. balticus* Brzeski, Peneva & Brown, 2000, known only from Poland, *L. caespiticola* Hooper, 1961 and *L. goodeyi* Hooper, 1961 (see Szczygieł & Brzeski, 1985), *L. cylindricaudatus* Kozłowska & Seinhorst, 1979 (see Brzeski & Winiszewska-Ślipińska, 1996), *L. intermedius* Kozłowska & Seinhorst 1979 and *L. macrosoma* Hooper, 1961 (see Brzeski, 1985). More recent records include *L. distinctus* Lamberti, Choleva & Agostinelli, 1983 and *L. picens* Roca, Lamberti & Da Costa, 1961 (see Szczygieł & Zepp, 2004). No data on the morphology and morphometrics of the Polish populations of several species (*L. caespiticola*, *L. goodeyi*, *L. cylindricaudatus*, *L. distinctus*, *L. macrosoma* and *L. picens*) are available in the above-mentioned references. During a recent survey of the family Longidoridae Thorne, 1935 in Poland, two previously unrecorded species were found: *L. poessneckensis* Altherr, 1974 and *L. piceicola* Lišková, Robbins & Brown, 1997. Among the females of the former, an as yet undescribed male and a bivulval female were found. Data on morphology and morphometrics of both species are presented below.

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Materials and methods

Soil samples containing specimens of *Longidorus* were collected using a soil auger of 4 cm diameter. Nematodes were extracted from soil by the sieving and decanting method, heat-killed and preserved in cold TAF, with exception of the specimens of *L. poessneckensis* from the arboretum in Rogów, which were fixed in DESS (Yoder et al., 2006). Specimens were transferred to anhydrous glycerine using the Seinhorst method (Seinhorst, 1959). Identification and measurements were made using a Zeiss Axioskop 2 plus microscope. Measurements were taken with an eye graticule, except for body length which was measured using a map measurer. Photographs were taken using an Olympus BX 51 equipped with a digital camera.

In the description of the morphometrics, the ratios d (anterior to guide ring/body width at lip region) and d' (body width at guide ring/body width at lip region) proposed by Brown et al. (1994) are used. Additionally, in the description of the bivulval female, ratios $a1$ and $a2$ are used; these were calculated using body width measured at the anterior and posterior vulva, respectively. All measurements are in micrometres.

Longidorus poessneckensis Altherr, 1974

Locality data: Material was collected from three localities in Poland (geographical coordinates in parentheses): near Górzycza (52.28264°N; 14.36871°E), population associated with *Quercus robur* L. and grasses; near Ustrzyki Dolne (49.25694°N; 22.30157°E), population associated with *Carpinus betulus* L. and *Rubus* sp.; the arboretum in Rogów (51.83360°N; 19.92320°E), where single specimens were found in sites close to each other but associated with different plants: *Acer rubrum* L. and cover plants; *Betula alleghaniensis* Britton and cover plants; and *C. betulus* (no cover plants). The specimens from Rogów are considered to represent a single population.

Description (Figs. 1, 2; Tables 1, 2)

Female (Fig. 1A–D)

Body open C to spiral in shape, with posterior third to half of body more curved. Lip region 6 high, continuous with rest of body. Cuticle 6 thick at guide

Fig. 1 Morphology of *Longidorus poessneckensis*. A. female, anterior end; B. female, anterior end with focus on amphidial fovea; C. female, vulval region; D. female, tail; E. male, posterior end; F. male, spicule; G. male, anterior end; H. bivulval female, vulval region; I. J3 juvenile, abnormal position of guide ring; J–M. tails of J1–J4 juveniles, respectively. Scale-bars: A–D,G,I,J–M, 20 μ m; E,F,H, 50 μ m

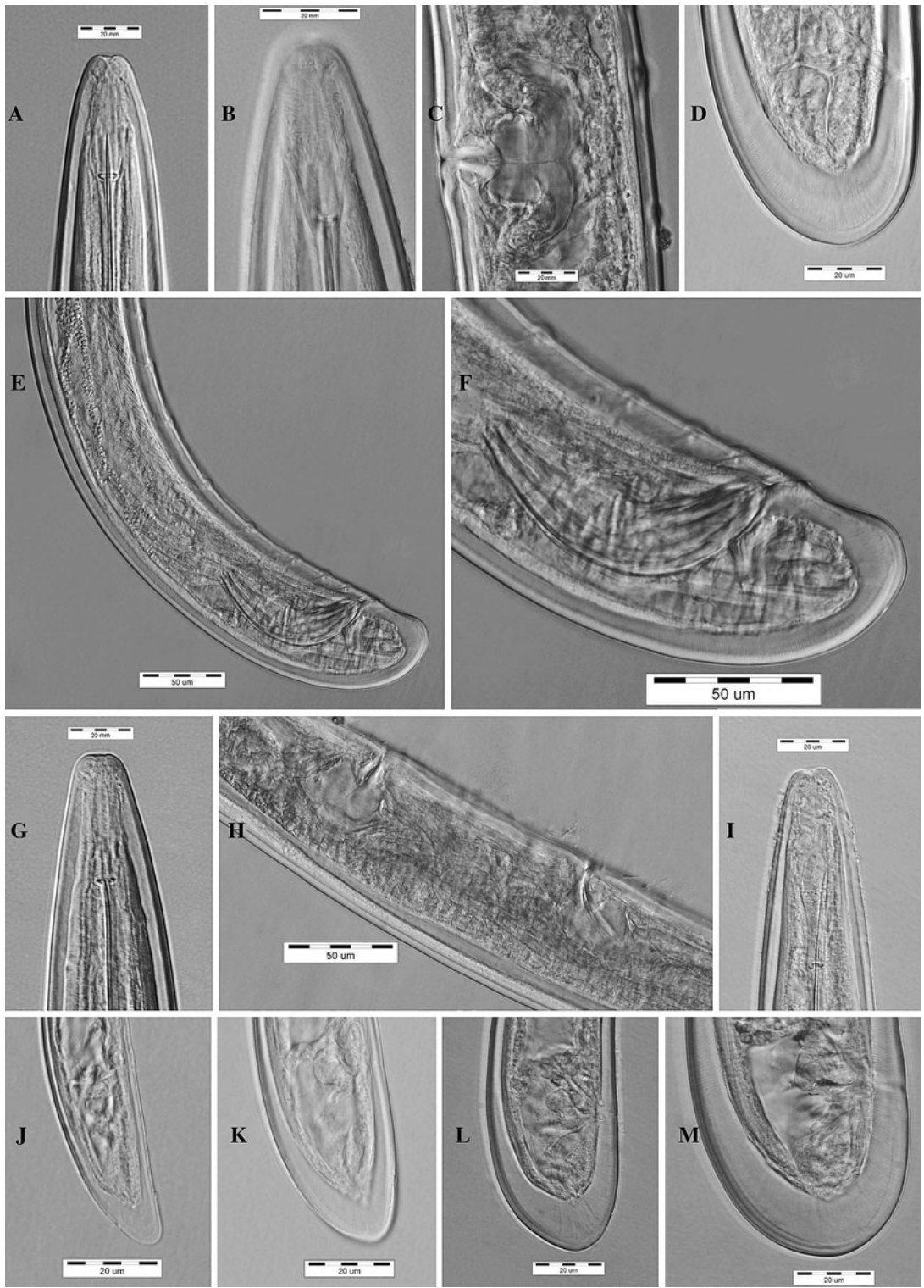
ring, 5 at mid-body and 9–14 on tail posterior to anus. Fine transverse cuticular striations present along entire body, 1.5–2 striations per 1 μ m. Amphids with pouch-like fovea, 11–13 wide in widest part and visibly longer than wide; posterior limit indistinct (according to terminology proposed by Decraemer & Coomans, 2007, following Chen et al., 1997, it is elongate-funnel shaped, i.e. code E4). Basal bulb occupies 25 (21–33)% of total pharynx length. Three gland nuclei present: 1 dorsal nucleus at 35 (27–42)% ($n = 13$) of pharyngeal bulb length and 2 ventro-sublateral nuclei at 57 (49–67)% ($n = 31$) and 58 (49–68)% ($n = 31$). Vagina occupies 60–70% of corresponding body width; *pars distalis vaginae* and *pars proximalis vaginae* 22.4 (14–26) and 23.7 (20–28) long, respectively. Reproductive system amphidelphic, with equally developed genital branches. No sperm observed in genital tract. Tail almost hemispherical (majority of specimens) to bluntly conoidal, always visibly shorter than anal body width. Two caudal pores present on each side of body.

Male (Fig. 1E–G)

Morphology of anterior end similar to that of female; caudal region more strongly coiled ventrally. Tail short, rounded, with somewhat flattened tip. Cuticle 10–11 and 8 thick on dorsal and ventral part of tail, respectively. One adanal pair, two double and row of six single ventromedian supplements. Supplements arranged as follows: distance from anus to 1st pair, 17; 1st to 2nd pair, 16; 2nd to 3rd pair, 18; 3rd pair to 1st single, 35; between single ventral supplements as follows: 1st to 2nd, 39; 2nd to 3rd, 48; 3rd to 4th, 38; 4th to 5th, 34; 5th to 6th, 41. Supplements extend $c.2$ from body contour.

Bivulval female (Fig. 1H)

Anomalous female found associated with *Betula alleghaniensis*. Morphometrics of bivulval female: $L = 8,815$; $a1 = 114.5$; $a2 = 117.5$; $b = 16.7$; $c = 220.4$; $c' = 0.63$; $d = 2.1$; $d' = 1.8$; $V1 = 52.2\%$;



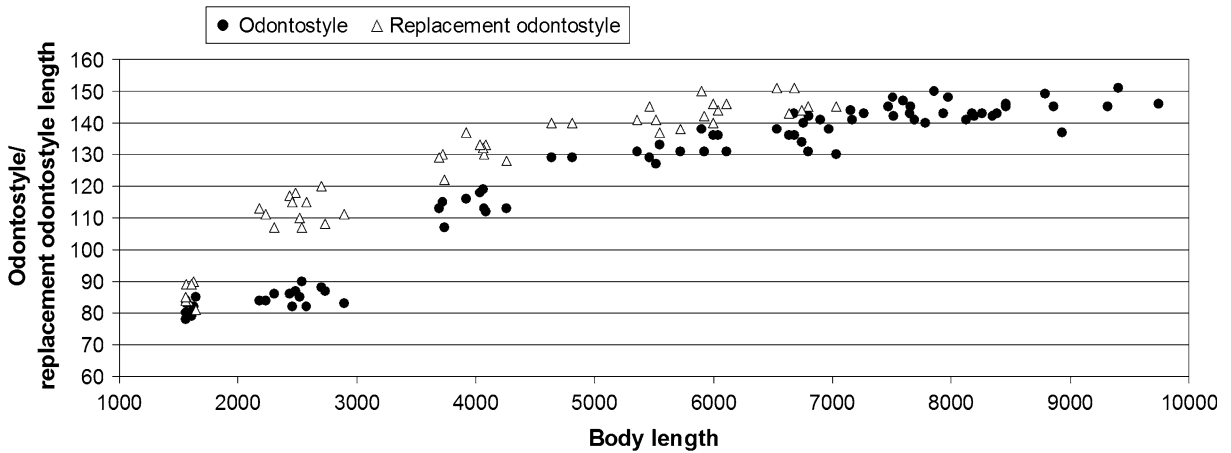


Fig. 2 Scatter plot of the functional and replacement odontostyle in relation to juvenile and females body length in a *Longidorus poessneckensis* population from Górzycza

Table 1 Morphometrics of adult *Longidorus poessneckensis* females from Poland

Locality	Górzycza		Ustrzyki Dolne	Rogów
	Females n = 33	Male n = 1	Females n = 10	Females n = 4
Length	7,932 ± 790.6 (6,673–9,743)	9,379	7,484 ± 756.3 (6,381–8,363)	7,770 (7,009–8,815)
a	104.3 ± 7.7 (93.9–119.5)	125.0	97.8 ± 7.6 (84.2–106.1)	97.0 (86.9–114.5)
b	12.6 ± 1.0 (11.0–15.5)	13.4	11.6 ± 1.2 (9.4–12.8)	15.2 (13.1–16.7)
c	215.8 ± 16.9 (179.1–256.4)	228.7	180.7 ± 22.9 (153.9–237.2)	185.8 (164.2–220.4)
c'	0.64 ± 0.04 (0.56–0.70)	0.67	0.73 ± 0.06 (0.61–0.80)	0.70 (0.63–0.76)
d	2.5 ± 0.13 (2.2–2.7)	2.6	2.5 ± 1.90 (2.0–2.6)	2.2 (2.1–2.4)
d'	2.1 ± 0.12 (1.8–2.3)	2.1	1.9 ± 0.1 (1.67–2.06)	1.92 (1.8–2.1)
V/spicule	53.2 ± 0.97 (51.1–59.2)	100	55.5 ± 1.35 (53.5–57.6)	52.9 (52.2–54.7)
Odontostyle	143.7 ± 3.25 (137–151)	143	142.8 ± 5.6 (135–151)	139.0 (136–145)
Odontophore	92.2 ± 6.1 (81–105)	102	81.2 ± 4.9 (71–86)	96 n = 1
Total stylet	235.9 ± 5.7 (219–250)	245	224.0 ± 5.8 (216–237)	232 n = 1

Table 1 continued

Locality	Górzycza		Ustrzyki Dolne	Rogów
	Females n = 33	Male n = 1	Females n = 10	Females n = 4
Pharyngeal bulb length	157.6 ± 11.4 (135–178) n = 30	177	150.8 ± 13.1 (137–175) n = 8	139, 155 n = 2
Pharyngeal bulb width	28.9 ± 1.85 (26–33) n = 30	33	28.8 ± 2.5 (25–31) n = 8	29, 29 n = 2
Anterior end to guide ring	39.9 ± 1.3 (37–42)	42	41.5 ± 2.6 (36–45)	36.5 (34–39)
Tail	36.8 ± 2.8 (31–43)	41	41.7 ± 4.4 (34–47)	42.0 (40–45)
Hyaline tip	17.9 ± 1.6 (14–21)	17	17.7 ± 1.5 (15–20)	15.0 (8–19)
Body width at				
Lip region	15.8 ± 0.8 (14–18)	16	16.6 ± 0.8 (16–18)	16.3 (16–17)
Guide ring	32.5 ± 1.5 (30–35)	33	32.3 ± 1.25 (30–34)	31.3 (29–33)
Base of pharynx	63.3 ± 3.6 (58–71)	64	61.8 ± 4.3 (55–70)	60.5 (57–63)
Vulva or mid-body	76.1 ± 5.3 (65–86)	75	76.5 ± 4.5 (71–84)	80.5 (76–85)
Anus	57.8 ± 2.9 (54–67)	61	57.2 ± 2.5 (55–62)	60.3 (58–63)

Measurements (μm) and ratios are in the form: mean \pm standard deviation (range). The value of 'n' below the measurements indicates the number of specimens measured if different from that indicated in the heading. The standard deviation is not given when there are <5 measurements

V2 = 53.5%. Odontostyle, 138; anterior end to guide ring, 34; tail, 40; hyaline tip, 8; body width at: lip region, 16; guide ring, 9; base of pharynx, 62; vulva 1, 77; vulva 2, 75; anus, 63; distance from vulva 1 to vulva 2, 118 μm . Detailed description of genital tract is not possible due to poor preservation of specimen; however, both vulvae appear unconnected. Additionally, two ovaries as well as two other structures resembling ovaries were observed. Remaining morphology similar to normal females from same population.

Juveniles (Figs. 1J–M, 2; Table 2)

General morphology similar to adult females, with differences mainly in body habitus and tail shape: J1 in form of a widely open C, tail elongate, bluntly conoidal (Fig. 1J); J2 with shape of open C, tail

elongate, almost cylindrical (Fig. 1K); J3 and J4 adopting a J- to C-shape, tail of J3 similar to that of adults but more frequently bluntly conoidal (Fig. 1L), tail of J4 as in adults, hemispherical (Fig. 1M).

Single specimen (Fig. 1I) of J3 found with guide ring at 60 from anterior end; however, remaining morphometrics within ranges of normal J3. This specimen was not included in morphometrics of juveniles presented in Table 2.

Remarks

Longidorus poessneckensis, in addition to its type-locality in Germany (Altherr, 1974), has been reported from several other localities in Germany (Sturhan & Loof, 2001), Slovakia (e.g. Lišková &

Table 2 Morphometrics of *Longidorus poessneckensis* juveniles from Górzycza, Poland

Juvenile stage	J1 n = 7	J2 n = 12	J3 n = 9	J4 n = 19
Length	1,592 ± 34.1 (1,553–1,643)	2,503 ± 207.6 (2,178–2,891)	3,954 ± 197.9 (3,695–4,257)	5,968 ± 662.4 (4,640–7,034)
a	67.6 ± 2.2 (64.7–70.9)	73.1 ± 6.1 (61.9–81.8)	86.9 ± 3.7 (81.2 ± 92.5)	100.9 ± 6.5 (88.5 ± 111.8)
b	4.5 ± 0.1 (4.4–4.7)	5.9 ± 0.4 (5.4–6.7)	7.4 ± 0.3 (6.9–7.8)	9.8 ± 0.9 (7.6 ± 11.1)
c	40.9 ± 3.2 (36.7–46.0)	60.2 ± 4.7 (54.0–67.5)	98.6 ± 7.4 (88.9–109.2)	148.4 ± 16.4 (116.0 ± 184.3)
c'	2.11 ± 0.21 (1.84–2.39)	1.42 ± 0.11 (1.28–1.63)	0.95 ± 0.07 (0.83–1.03)	0.77 ± 0.06 (0.64 ± 0.89)
d	2.5 ± 0.18 (2.3–2.8)	2.7 ± 0.1 (2.5–2.8)	2.5 ± 0.3 (2.1–2.7)	2.5 ± 0.1 (2.3 ± 2.8)
d'	1.8 ± 0.2 (1.7–2.0)	2.1 ± 0.11 (2.0–2.3)	1.9 ± 0.2 (1.7–2.3)	2.0 ± 0.1 (1.87 ± 2.20)
Odontostyle	81.0 ± 2.45 (79–85)	85.3 ± 2.5 (80–92)	114.0 ± 3.6 (107–119)	132.7 ± 3.4 (127–138)
Replacement odontostyle	86.0 ± 3.4 (81–90)	112.7 ± 4.4 (107–120)	130.4 ± 4.2 (122–137)	143.6 ± 4.1 (137–151)
Odontophore	57, 57 n = 2	66.3 ± 1.9 (64–69) n = 6	76.6 ± 6.5 (66–84) n = 5	84.0 ± 5.0 (76–91) n = 16
Total stylet	136, 137 n = 2	152.5 ± 3.3 (148–158) n = 6	190.8 ± 5.9 (181–196) n = 5	216.7 ± 6.4 (205–225) n = 16
Pharyngeal bulb length	85.6 ± 2.2 (82–88) n = 5	104.2 ± 5.9 (95–114) n = 11	124.1 ± 3.4 (119–127) n = 8	145.6 ± 8.9 (129–160) n = 17
Pharyngeal bulb width	14.8 ± 0.8 (14–16) n = 5	18.6 ± 1.3 (17–21) n = 11	22 ± 1.5 (20–24) n = 8	26.7 ± 1.7 (22–30) n = 17
Anterior end to guide ring	21.1 ± 0.4 (21–22)	25.2 ± 0.4 (25–26)	29.3 ± 1.2 (27–31)	35.2 ± 1.4 (32–38)
Genital primordium length	20.5 ± 2.7 (18–25) n = 6	27 ± 1.5 (25–30) n = 10	42 ± 3.1 (38–46); n = 5	69.1 ± 8.8 (53–79) n = 9
Tail	39.1 ± 2.8 (35–43)	41.7 ± 3.2 (37–47)	40.2 ± 2.6 (38–46)	40.3 ± 3.1 (35–46)
Hyaline tip	8.1 ± 0.7 (7–9)	9.3 ± 1.1 (7–11)	12.7 ± 1.3 (11–15)	15.8 ± 1.6 (14–19)
Body width at				
Lip region	8.4 ± 0.5 (8–9)	9.5 ± 0.5 (9–10)	11.9 ± 0.9 (11–13)	14.1 ± 0.7 (13–15)
Guide ring	15.4 ± 0.5 (15–16)	19.8 ± 0.6 (19–21)	23.3 ± 1.2 (22–25)	28.4 ± 1.6 (26–33)

Table 2 continued

Juvenile stage	J1n = 7	J2n = 12	J3n = 9	J4n = 19
Base of pharynx	25.1 ± 0.7 (24–26)	35.2 ± 2.6 (31–40)	45.6 ± 2.3 (42–49)	56.1 ± 4.9 (46–65)
Mid-body	23.6 ± 1.0 (22–25)	34.5 ± 4.3 (29–41)	45.6 ± 2.5 (42–50)	59.4 ± 7.3 (46–72)
Anus	18.6 ± 0.5 (18–19)	29.4 ± 2.6 (25–34)	42.4 ± 2.6 (39–47)	52.3 ± 3.8 (45–57)

Measurements (μm) and ratios are in the form: mean \pm standard deviation (range). The value of ‘n’ below the measurements indicates the number of specimens measured if different from that indicated in the heading. The standard deviation is not given when there are <5 measurements

Sturhan, 2000; Lišková & Kumari, 2010), Austria (Tiefenbrunner & Tiefenbrunner, 2004) and the Czech Republic (Kumari et al., 2009).

Morphometrically, populations from Poland are similar to each other, exhibiting only small difference in tail length (means 36.8 μm in a population from Górzycza vs 41.7 and 42.2 μm in populations from Ustrzyki Dolne and Rogów, respectively) and ratios based on tail length: c (mean 215.8 vs 180.7 and 185.8) and c' (mean 0.64 vs 0.73 and 0.70).

The morphology of normal females is close to that given in the re-description given by Sturhan & Loof (2001). In comparison with populations from other countries, those from Poland are most similar to populations from Germany (Sturhan & Loof, 2001), the main difference being the odontostyle length (mean 133 μm in German populations vs 143.7, 142.8 and 139.0 μm in populations from Poland). Material from Poland is also similar to that from the Czech Republic (Kumari et al., 2009), but females are longer (means 7,932, 7,484 and 7,770 vs 6,851 μm), more slender ($a = 104.3, 97.8$ and 97.0 vs $a = 85.5$) and have longer odontostyles (means 143.7, 142.8 and 139.0 μm vs 128 μm). Moreover, the population from Górzycza has a higher c index (mean 215.8 vs 177.3). Similarly, in comparison with populations from Austria (Tiefenbrunner & Tiefenbrunner, 2004), and Slovakia (Lišková & Sturhan, 2000; Lišková & Kumari, 2010), specimens from Poland are longer (means 7,932, 7,484 and 7,770 μm vs 7,160, 6,500 and 6,690 μm), more slender (means $a = 104.3, 97.8$ and 97.0 vs $a = 818, 90.8$ and 78), have longer odontostyles (means 143.7, 142.8 and 139.0 μm vs 130, 140.2 and 127 μm) and higher c values (215.8, 180.7 and 185.8 vs 170.97, 154 and 158.6).

Sturhan & Loof (2001) observed a slight increase in the tail length of subsequent juvenile stages. In Polish populations such a tendency has not been observed, tail length being about the same in all stages, similar to the results obtained by Kumari et al. (2009) from the Czech Republic.

The absence versus presence of males was used by Sturhan & Loof (2001) as one of the morphological characters distinguishing *L. poessneckensis* from *L. macrosoma* Hooper, 1961. Because of the existence of the *L. poessneckensis* male, this ‘trait’ can no longer be used. However, the other traits proposed by those authors as differentiating these species, i.e. the shape of the lip region (rounded in *L. poessneckensis* vs truncate in *L. macrosoma*), the structure of the cuticle on the tail (with thick, distinct median layers in *L. macrosoma*) and the shape of the J1 tail (conoidal vs subdigitate) are valid. Another species similar to *L. poessneckensis*, the differential diagnosis of which requires changes after the finding of the male, is *L. uroshis* Krnjaić, Lamberti, Krnjaić, Agostinelli & Radicci, 2000. In the original description, Krnjaić et al. (2000) did not compare these two species. Later, Lišková & Sturhan (2002) distinguished them mainly on the basis of the presence and absence of males, respectively. This ‘trait’ can no longer be used, but these two species can be distinguished on the basis of spicule length—means 65.5 and 72 μm (Krnjajac et al., 2000; Lišková & Sturhan, 2002) in *L. uroshis* vs 100 μm in *L. poessneckensis*, the tail shape of the first-stage juvenile—subdigitate in *L. uroshis* vs bluntly conoidal in *L. poessneckensis*, and the amphidial fovea—bilobed at the base in *L. uroshis* vs not bilobed in *L. poessneckensis*. For a discussion of other closely related species, as well as information on

relationships based on molecular analyses, see Kumari et al. (2009).

The identification codes of the polytomous key published by Chen et al. (1997), based on the present data and other sources (Lišková & Sturhan, 2000; Sturhan & Loof, 2001; Tiefenbrunner & Tiefenbrunner, 2004; Kumari et al., 2009; Lišková & Kumari, 2010), are: A56 B1234 C34 D3 E4 F345 G12 H1 I12.

Anomalies in the female genital organs among *Longidorus* spp. are rather rare, although the phenomenon of bivulval female has been reported for other species of the genus, e.g. *L. euonymus* Mali & Hooper, 1973 (see Barsi, 1994) and *L. juvenilis* Dalmasso, 1969 (see Širca et al., 2007).

According to the literature, *L. poessneckensis* occurs in moist to wet soils, particularly often associated with lowland riparian vegetation but also in wet woodlands in Germany, Slovakia, Austria and

the Czech Republic (Sturhan & Loof, 2001; Lišková & Sturhan, 2000; Lišková, 2001; Tiefenbrunner & Tiefenbrunner, 2004; for more references see Lišková & Kumari, 2010). Our data are in general agreement with these observations; we have found populations in the same types of habitats, i.e. riparian and wet woodlands, but not in hilltop forests as reported by Lišková & Kumari (2010).

Longidorus piceicola Lišková, Robbins & Brown, 1997

Locality data: Specimens were collected from Rogów, Poland (51.83360°N; 19.92320°E), c.500 m from the site where *L. poessneckensis* occurred; the sample was taken from the soil around *Carpinus betulus* L. and no cover plants were present.

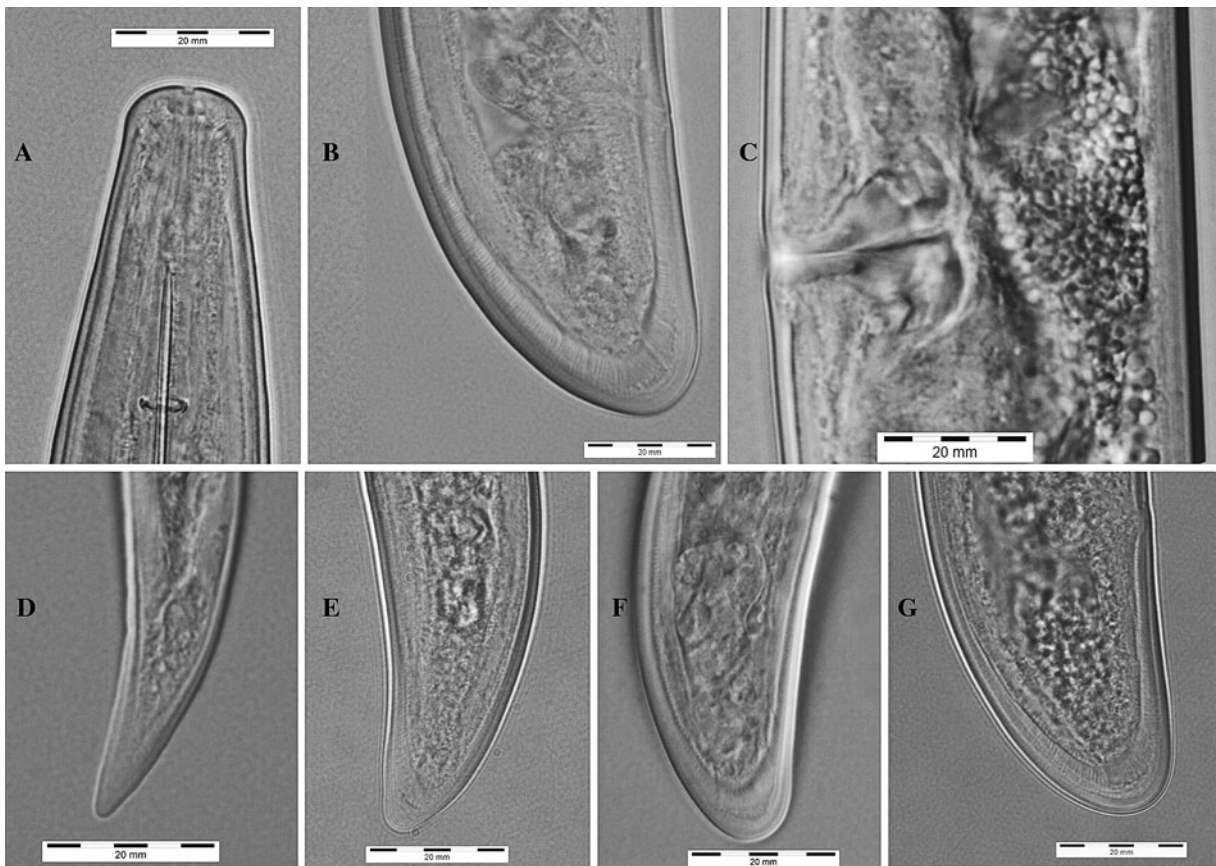


Fig. 3 Morphology of *Longidorus piceicola*. A. Female, anterior end; B. female, tail; C. female, vulval region; D–G. tails of J1–J4 juveniles, respectively. Scale-bars: 20 μ m

Table 3 Morphometrics of females and juveniles of *Longidorus piceicola* from Poland

Character	Females n = 9	J1 n = 6	J2 n = 5	J3 n = 4	J4 n = 4
Length	6,477 ± 468.6 (5,457–7,093)	1,446 ± 68.1 (1,368–1,529)	2,117 ± 160.4 (1,913–2,334)	2,883 (2,714–3,073)	4,249 (3,956–4,503)
a	111.8 ± 8.2 (102.5–126.0)	60.4 ± 4.2 (54.9–66.5)	70.7 ± 4.4 (65.0–75.3)	78.6 (71.7–84.2)	94.0 (82.7–100.1)
b	11.8 ± 0.7 (10.4–12.8)	4.6 ± 0.1 (4.5–4.8)	5.7 ± 0.4 (5.3–6.3)	6.6 (5.6–7.3)	8.1 (7.6–9.3)
c	137.3 ± 12.2 (118.6–153.6)	29.7 ± 1.7 (27.6–32.6)	40.7 ± 1.97 (39.1–44.0)	61.2 (54.8–66.8)	84.8 (75.7–97.8)
c'	1.09 ± 0.09 (0.96–1.24)	3.03 ± 0.27 (2.56–3.36)	2.25 ± 0.15 (2.04–2.45)	1.63 (1.54–1.70)	1.36 (1.19–1.51)
d	2.6 ± 0.2 (2.4–2.9)	2.6 ± 0.2 (2.4–2.9)	2.9 ± 0.2 (2.6–3.2)	2.9 (2.7–3.2)	2.8 (2.6–3.0)
d'	1.6 ± 0.1 (1.56–1.67)	1.6 ± 0.1 (1.56–1.67)	1.8 ± 0.01 (1.77–1.80)	1.8 (1.7–2.0)	1.7 (1.7–1.8)
V	49.3 ± 0.01 (46.8–51.6)	–	–	–	–
Odontostyle	153.9 ± 4.3 (144–158)	90.8 ± 3.6 (86–96)	102.4 ± 1.1 (101–104)	120.5 (118–122)	132.0 (127–140)
Replacement odontostyle	–	98.8 ± 4.2 (92–105)	116.4 ± 1.5 (114–118)	131.3 (127–140)	151.5 (148–160)
Odontophore	86.3 ± 8.4 (67–95)	48.2 ± 3.6 (45–54)	55.6 ± 3.2 (52–59)	67.0 (64–72)	78.3 (70–85)
Total stylet	n = 8 239.6 ± 9.4 (221–253)	n = 5 139.6 ± 6.5 (131–147)	n = 5 158 ± 3.9 (154–163)	n = 3 187.7 (182–194)	n = 3 211.0 (201–225)
Pharyngeal bulb length	n = 8 125.5 ± 4.4 (119–132)	n = 5 65.7 (60–71)	n = 5 83.8 ± 2.95 (80–88)	n = 3 99.8 (91–109)	n = 3 109.7 (102–115)
Pharyngeal bulb width	n = 8 24.9 ± 1.8 (22–27)	n = 4 15.5 (14–18)	n = 4 17.6 ± 1.1 (16–19)	n = 3 19.8 (18–22)	n = 3 21.3 (19–24)
Anterior end to guide ring	n = 8 41.7 ± 1.4 (40–44)	n = 4 23.8 ± 1.3 (22–26)	n = 4 27.8 ± 1.3 (26–29)	n = 3 32.6 (31–34)	n = 3 37.0 (34–42)
Genital primordium length	–	n = 5 27.4 ± 2.7 (23–30)	n = 4 33.4 (28–41)	n = 3 52.3 (45–62)	n = 3 108 (62–182)
Tail	47.3 ± 3.4 (43–52)	48.8 ± 4.5 (42–54)	52.0 ± 2.0 (49–54)	47.3 (44–51)	50.5 (44–56)
Hyaline tip	12.1 ± 1.2 (10–14)	9.6 ± 0.5 (9–10)	8.8 ± 0.8 (8–10)	9.0 8–10	9.8 (8–11)
Body width at Lip region	15.4 ± 0.5 (15–16)	9.0 ± 0.0 (9–9)	9.6 ± 0.6 (9–10)	11.3 (10–12)	13.5 (12–15)

Table 3 continued

Character	Females n = 9	J1 n = 6	J2 n = 5	J3 n = 4	J4 n = 4
Guide ring	27.0 ± 1.2 (26–29)	14.7 ± 0.5 (14–15)	17.2 ± 1.1 (16–18)	20.3 (20–21)	23.5 (22–25)
Base of pharynx	49.1 ± 2.3 (45–53)	24.0 ± 0.6 (23–25)	29.8 ± 1.6 (27–31)	35.3 (34–37)	41.5 (40–44)
Vulva or mid-body	58.1 ± 4.5 (51–64)	24.0 ± 1.6 (22–26)	30.0 ± 2.4 (26–32)	36.8 (35–39)	45.5 (40–52)
Anus	43.3 ± 1.9 (41–47)	16.2 ± 1.3 (14–18)	23.2 ± 2.3 (20–26)	29.0 (27–31)	37.6 (35–40)

Measurements (μm) and ratios are in the form: mean \pm standard deviation (range). The value of 'n' below the measurements indicates the number of specimens measured if different from that indicated in the heading. The standard deviation is not given when there are <5 measurements

Description (Fig. 3; Table 3)

Females (Fig. 3A–C)

Habitus from J-shaped to spiral, more strongly coiled in posterior part of body. Cuticle *c.*3 thick at guide ring region and in mid-body, and 5–7 on tail posterior to anus. Fine transverse cuticle striations present along entire body, *c.*2 striations per 1 μm . Lip region 5 high, broadly rounded anteriorly, rounded laterally, almost continuous with rest of body. Amphids in most specimens with indistinct fovea, pocket-shaped

when visible, symmetrically bilobed at base (according to terminology proposed by Decraemer & Coomans, 2007). Pharyngeal bulb occupies 23 (20–24)% of total pharynx length. Three gland nuclei present: dorsal nucleus located at 33 (32–33)% ($n = 3$) of bulb length; 2 ventro-sublateral nuclei at 53 (52–55)% ($n = 5$) and 54 (53–56)% ($n = 5$). Vagina occupies 45–52% of corresponding body width; *pars distalis vaginae* and *pars proximalis vaginae* 14.3 (13–16) and 14.1 (13–15) long, respectively. Tail dorsally convex, flat or shallowly concave ventrally.

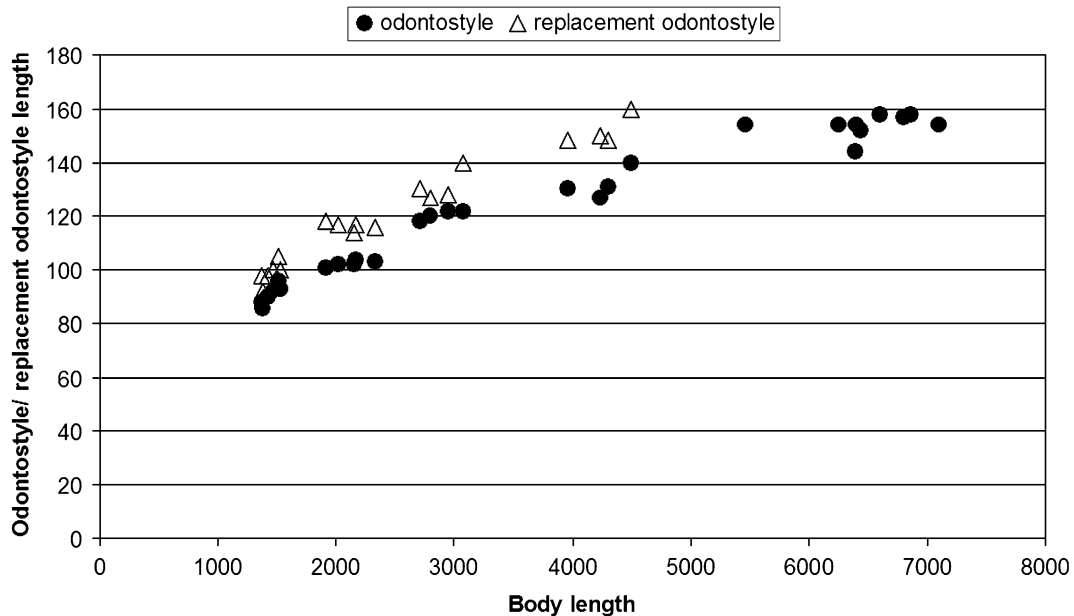


Fig. 4 Scatter plot of the functional and replacement odontostyle in relation to juvenile and female body length in a *Longidorus piceicola* population

Male. Not found.

Juveniles (Figs. 3D–G, 4)

General morphology similar to adult females. Body habitus similar in all stages, open C- (arcuate) to J-shaped. Tail of all juvenile stages conical, but becoming more rounded in subsequent stages (Fig. 2D–G).

Remarks

Specimens of *L. piceicola* from Poland are similar to the type-population from Slovakia (Lišková et al., 1997), except for the longer (mean 6,477 vs 5,190 µm) and more slender (mean a value 111.8 vs 94) body and longer tail (mean 47 vs 42 µm).

Barsi & Lamberti (2001) described several *L. piceicola* populations from Bosnia and Herzegovina, Serbia and Montenegro. In comparison with those populations, the nematodes from Poland have a narrower lip region (mean 15.4 vs means within the range of 16–17 µm) and a shorter odontostyle (mean 153.9 vs means within the range of 167–178 µm).

This species was reported in association with *Picea abies* L., *Abies alba* L. and *Fagus sylvatica* L. (Lišková et al., 1997; Barsi & Lamberti, 2001), and the finding of this species in Poland in association with *Carpinus betulus* extends the geographical and plant association ranges.

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