

The occurrence and distribution of Longidoridae and Trichodoridae in the Slovak Republic

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Summary. The occurrence and geographical distribution in Slovakia of members of the Longidoridae was comprehensively examined during 1992 and 1993 and the occurrence of Trichodoridae in potato crops was also recorded. Nine *Longidorus*, one *Paralongidorus* and seven *Xiphinema* species were identified from soil samples collected in vineyards, orchards, hedgerows and forests. Additionally, from samples collected in potato fields, one *Paratrichodorus* and two *Trichodorus* species were identified. *Longidorus leptcephalus* and *P. maximus* occurred throughout the country whereas the other *Longidorus* species were restricted to discrete areas. *Xiphinema taylori* was widely distributed throughout Slovakia, *X. vuittenezi* was widespread in the warmer southern areas, and the other *Xiphinema* species had more localised distributions usually associated with particular soil or climatic characteristics or plant hosts. Longidorid nematodes were frequently recovered as populations comprised of two or more species. *Trichodorus similis* was present in the west, and *T. primitivus* and *Paratrichodorus pachydermus* in the east of the country, but trichodorids were not found in samples from the principal potato growing area. Southern Slovakia, which has relatively warm soil temperatures, appears to be the northern limit of the distribution of several species considered to indigenous to the Mediterranean region, viz. *X. italiae*, *X. pachtaicum* and *X. similis*.

Key words: *Longidorus*, *Xiphinema*, *Paralongidorus*, distribution, Slovakia.

Most of the records of the occurrence and distribution of longidorid and trichodorid nematodes in former Czechoslovakia have been the result of a few, restricted surveys, mostly in orchards and vineyards (Erbenova, 1975; Liskova, 1980; Liskova & Sabova, 1973b), or from investigations of associations with plant virus diseases e.g. *Longidorus euonymus* and *Xiphinema vuittenezi* associated with euonymus mosaic virus in spindle trees (Mali & Vanek, 1971, 1972; Mali & Hooper, 1974; Mali et al., 1975). Surveys to determine the presence of longidorids in vineyards and fruit orchards revealed the presence of several *Longidorus*, *Paralongidorus* and *Xiphinema* species (Liskova et al., 1992). Little information is available on the occurrence of trichodorid nematodes, only *Paratrichodorus pachydermus* having been reported

from vineyards in East Slovakia (Liskova, 1980; Liskova & Valocka, 1977). With the separation of the Slovak and Czech Republics, a systematic survey of longidorid and trichodorid nematodes was undertaken in Slovakia during 1991 and 1992 which established several new records of the occurrence of Longidoridae (Liskova et al., 1993). Based on a comprehensive survey and records from the literature, in this paper we provide an appraisal of the occurrence and distribution of *Longidorus* and *Xiphinema* species from several different habitats in Slovakia, and also of trichodorids present in the main potato producing area and in two areas of light sandy soils in West and East Slovakia. Furthermore, analyses of associations between species and several edaphic factors are provided.

MATERIALS AND METHODS

A comprehensive survey was undertaken in the main cultivated areas in Slovakia during the spring and autumn of 1991 and 1992, when the ground was neither frozen nor parched, to obtain representative soil samples from a majority of the 10 km map squares denoted by the Slovak National Grid. Samples were collected from fruit orchards, vineyards, hedgerows and stands of coniferous or deciduous trees. Samples were also collected from fields in the main potato producing areas. Composite samples of c. 5 kg were collected at 20-40 cm depth in vineyards and potato fields and at 20-30 cm depth in fruit orchards, in the rhizosphere of the plants sampled.

A total of 221 vineyards were sampled in 109 localities throughout the vine growing areas of Slovakia. Vines are mainly grown in southern Slovakia at an altitude of 100-200 m asl on soils ranging from sands to loams. In Slovakia the vineyards are cultivated throughout the growing year to maintain them free of weeds. The principal wine cultivars are Burgund, Frankovka, Muller-Thurgau and Reisling grown on *Berlandieri-Riparia*, *Riparia-Rupestris* and *Portalis* root-stocks and the table cultivars are *Cabianska*

Perla, *Kosut* and *Malinger* which are grown on *Berlandieri-Riparia* and *Riparia-Rupestris* root-stocks.

A total of 132 samples were collected from 96 fruit orchards mainly in southwest, east and central Slovakia. The orchards are at an altitude of 100-650 m asl on sand to loamy soils and receive 500-800 mm rainfall each year which compares with 400-600 mm rainfall in the viticulture areas. In Slovakia the fruit orchards mainly remain uncultivated throughout the year thus providing an extensive ground-cover consisting of a variety of weeds and grasses. Soil samples were also collected from 22 hedgerows (27 samples) and 13 stands of trees (17 samples). A total of 41 samples were collected from 32 fields in the main potato production areas.

Soil samples were transported by road or rail to the Parasitological Institute and immediately placed in a refrigerator at 4° C. Subsequently, and not later than 4 wk, nematodes were extracted from 500 g sub-samples by a decanting and sieving method with final separation overnight by Baermann funnel (Brown & Boag, 1988). Both longidorids and trichodorids were hand-picked from the resultant suspensions of nematodes, heat-killed at 60° C, fixed in hot FAA and

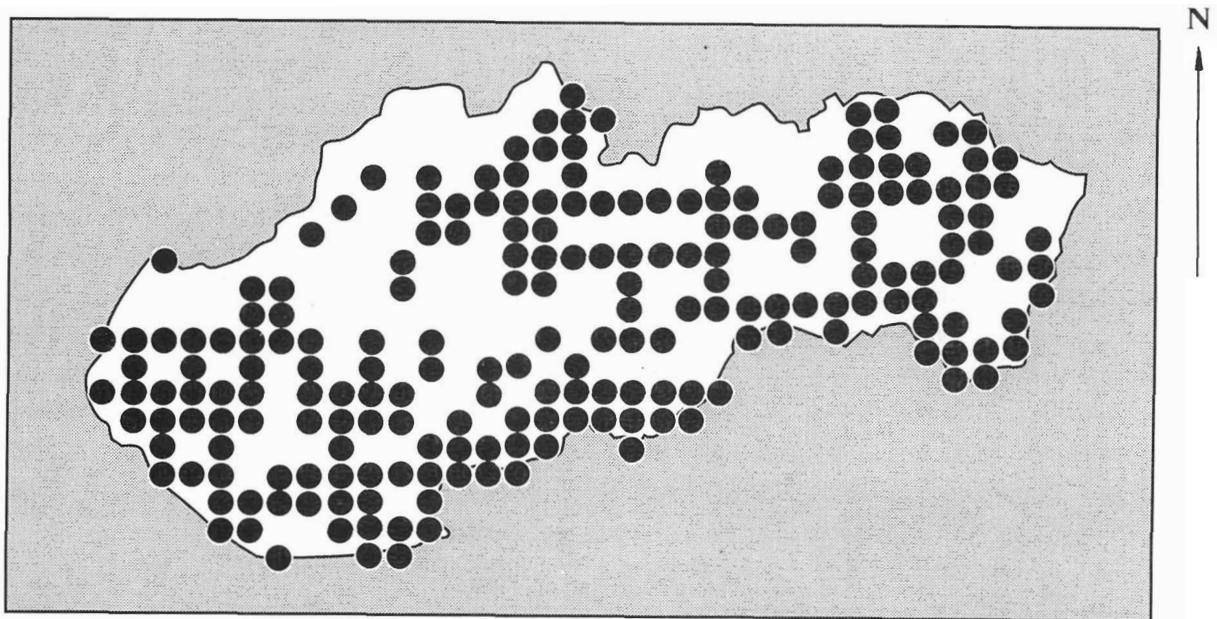


Fig. 1. Number of 10 km. map squares, denoted by the Slovak Republic National Grid, from which soil samples were collected.

then processed to anhydrous glycerol and mounted on microscope slides for identification.

RESULTS

Occurrence and distribution of species

Soil samples were obtained from 141 of the 10 km map grid squares which represents about 40% of the total land mass of Slovakia and 75% of the cultivated land (Fig. 1). The total number of longidorid species identified were seven *Xiphinema*, nine *Longidorus* and one *Paralongidorus* plus populations of two unidentified *Longidorus* spp. Prior to the survey a few records existed of the occurrence of *X. vuittenezi* (Mali & Vanek, 1971) and *X. brevicolle* (Liskova & Sabova, 1973a). The most frequently encountered species was *X. vuittenezi* which was recovered from 99 of 221 soil samples collected in vineyards, with population densities of up to 195 individuals per 500 g soil. This species is particularly prevalent in the southwest region and was also recovered from 19 samples collected in orchards, two from hedgerows, and one from potato.

Trichodorid nematodes were recovered from 5 out of 41 samples collected from potato fields and the samples containing trichodorids were from fields outside the main potato production area.

Longidorus

L. attenuatus Hooper, 1961 (Fig. 2) was recovered from two samples collected from an orchard at Stitnik in central Slovakia and in a forest at Moca, on the bank of the river Danube, respectively.

L. caespiticola Hooper, 1961 (Fig. 2) occurred in only one sample collected in an orchard at Tulcik in northeast Slovakia.

L. closelongatus Stoyanov, 1964 (Fig. 2) was found only in two of five samples from the rhizosphere of pine trees growing in west Slovakia.

L. elongatus (de Man, 1876) Thorne & Swanger, 1936 (Fig. 2) occurred very infrequently in orchards and vineyards and was not found in any of the hedgerows sampled nor in association with any trees.

L. elongatus has been redescribed at least nine times (Jacobs & Heyns, 1987) and is regarded by some as a species complex; specimens from the few populations from Slovakia were morphologically similar to those described from Britain by Hooper (1961).

L. euonymus Mali & Hooper, 1974 (Fig. 2) was described from specimens obtained from the rhizosphere of spindle trees (*Euonymus europaeus* L.) in west Slovakia (Mali & Hooper, 1974). During the present survey specimens of this species were recovered from a potato field in the region of the type locality and from a single sample collected in a vineyard at Hostice in south Slovakia.

L. juvenilis Dalmaso, 1969 (Fig. 2) was recovered from five samples collected in vineyards on the bank of the river Danube at Moca and Zlatna na Ostrove in southern Slovakia. Morphometrics of specimens from both locations were within the range of measurements of the original description (Dalmaso, 1969) which is based on specimens from southern France (Liskova et al., 1993). This species occurs relatively frequently in northern Italy and southern France and Liskova et al. (1993) speculated that as the samples from the banks of the Danube were adjacent to ancient Roman camps the nematodes could have been introduced with planting material during the Roman occupation.

L. leptcephalus Hooper, 1961 (Fig. 2) was the most frequently occurring and widely distributed of the 9 *Longidorus* species recovered in Slovakia. It occurred in 28 of 56 orchards sampled in the central and eastern regions, mostly in association with apple, cherry and plum trees, but was found in only two of 40 orchards in the southern region. It was also present in one of two samples from spindle spruce trees (*Picea* sp) and in two samples from potato fields but was not recovered from samples collected in vineyards. This species is regarded as indigenous to northern Europe (Brown & Taylor, 1987) and thus its frequent occurrence in Slovakia is remarkable; records of this species occurring in southern Poland and Germany are of doubtful identification. Comparison of the morphometrics of *L. leptcephalus* from Slovakia with those from populations from elsewhere in Europe confirmed that the populations occurring in Slovakia

were of the 'large' form of *L. leptocephalus* (Hooper, 1961, 1973).

L. picenus Roca, Lamberti & Agostinelli, 1984 (Fig. 2) was recovered from four samples, two from plum orchards at Piestany, one from spindle spruce at Budis in west Slovakia and from nut trees (*Juglans regia* L.) at Brekov in east Slovakia. This species is present in central and northern Italy and was recovered from a natural habitat in the valley of the river Po in northern Italy which led Liskova et al. (1993) to suggest that the species was probably introduced to Slovakia from Italy and not vice versa. Morphometrics of a female and male specimen are reported by Liskova et al. (1993).

L. raskii Lamberti & Agostinelli, 1993 (Fig. 2) was described from several specimens deposited in the Department of Nematology Collection, University of California at Davis, USA and which had been collected during 1961 from the rhizosphere of apple at Etoy, Switzerland by Professor D.J. Raski. A population of this species was found associated with nuts at Brekov in east Slovakia.

Paralongidorus

P. maximus Butschli, 1874 (Fig. 2) occurred in 10 soil samples collected in orchards, three samples from vineyards, one from the rhizosphere of oak and one

from a hedgerow. Specimens of this species were recovered from samples obtained from throughout Slovakia indicating the nematode's ecological flexibility and ability to colonise a wide diversity of biotopes. The species is widely distributed throughout Europe (Brown & Taylor, 1987) with little morphometric variability among populations.

Xiphinema

X. dentatum Sturhan, 1978 (Fig. 3) is a rare species having been recovered only from the rhizosphere of spruce trees (*Picea* sp.) at Gotovany in north Slovakia. This area is at an altitude of 700 m asl, has cold winters, an annual mean temperature of 60° C, a mean annual rainfall of 700-800 mm and has a clay loam non-calcareous soil, pH=4.2. The species was described from specimens recovered from forest soils in southern Germany and has also been reported from former Yugoslavia (Barsi & Horvatovic, 1986).

X. diversicaudatum (Micoletzky, 1927) Thorne, 1939 (Fig. 3) was recovered from eight samples collected in orchards, in association with plum at Cifare, Hodrusa, Hamre, Nizna Slana and Stitnik and from cherry at Nedožery. Also, it was recovered from a single sample collected in a vineyard at Myslenice. Morphometrics of males and females from two

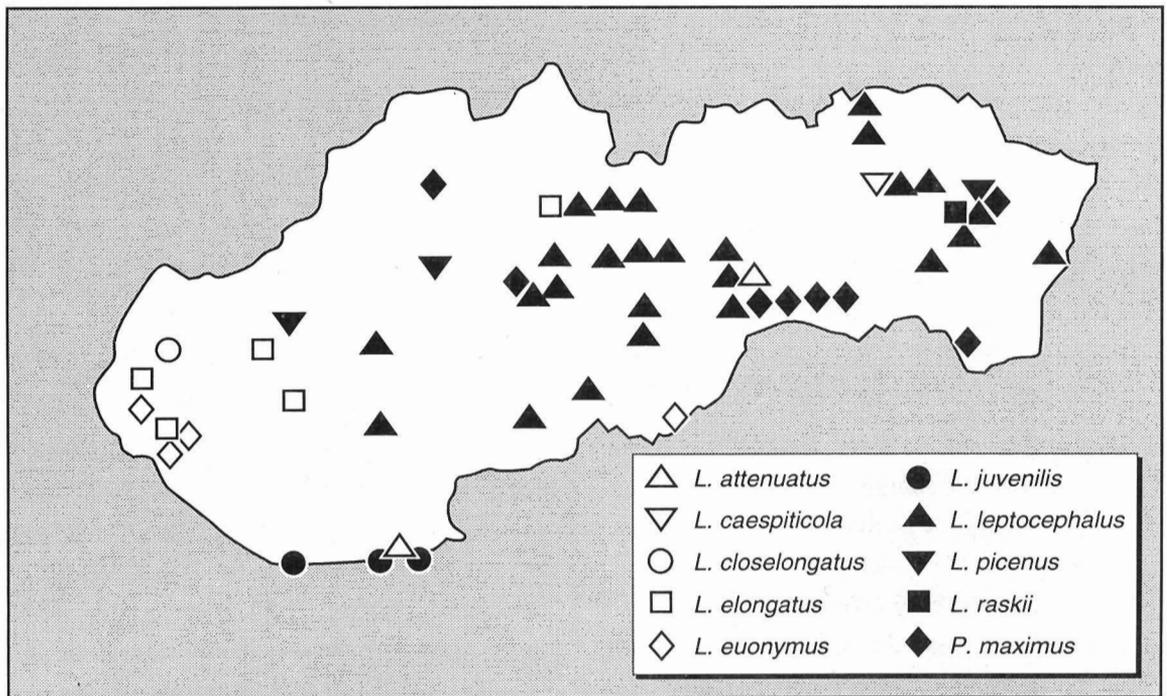


Fig. 2. Distribution of *Longidorus* species and *Paralongidorus maximus* in the Slovak Republic.

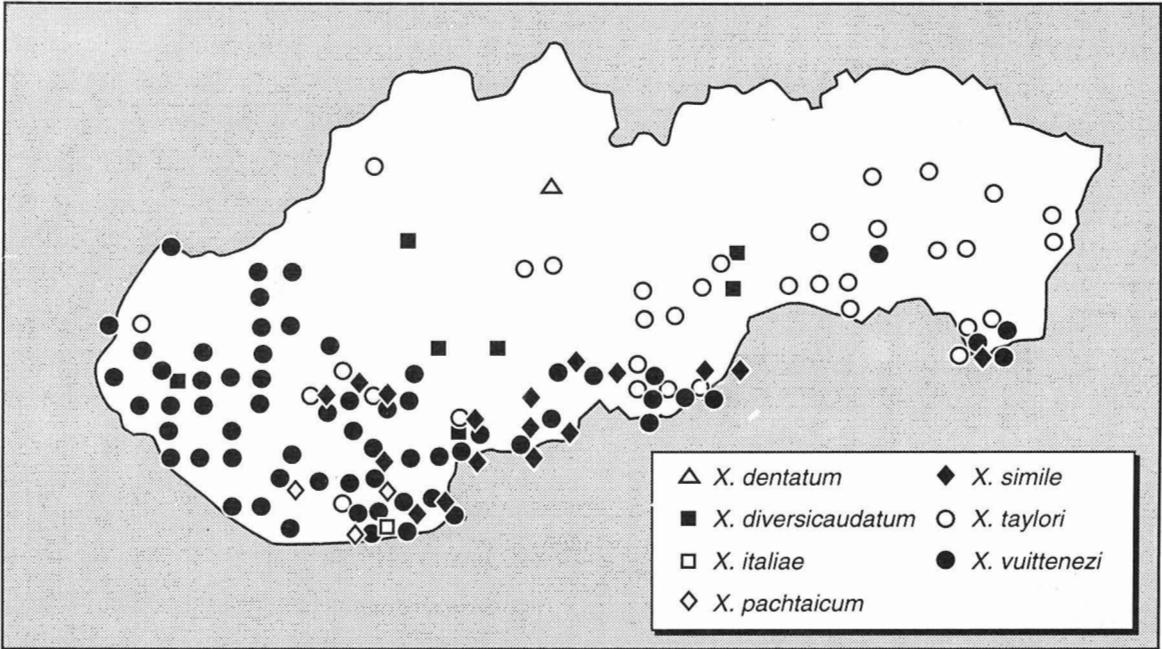


Fig. 3. Distribution of *Xiphinema* species in the Slovak Republic.

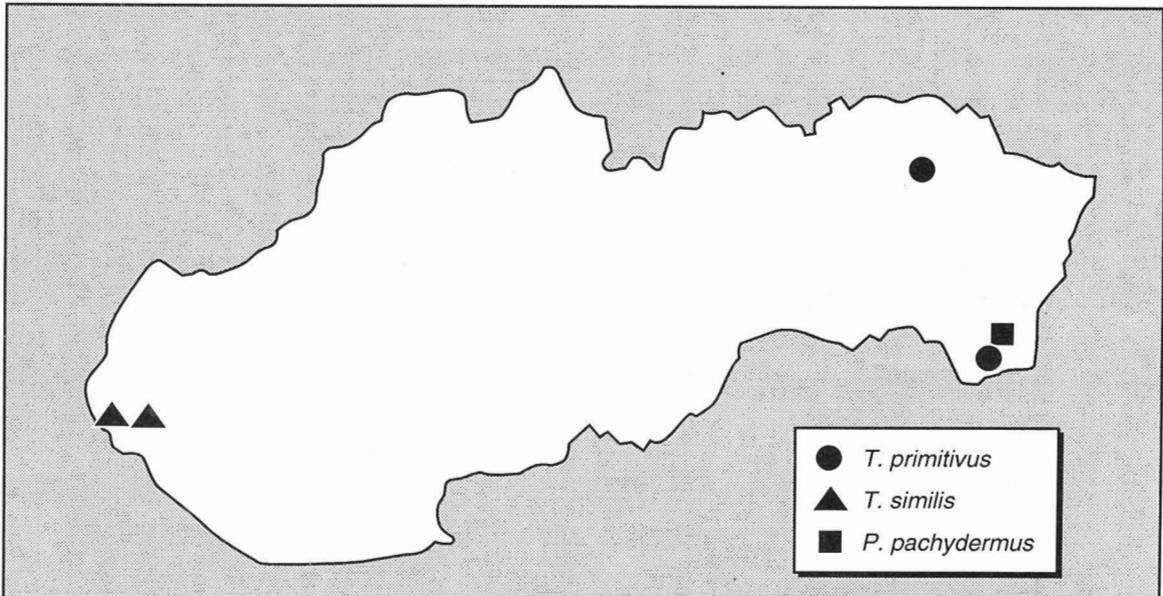


Fig. 4. Distribution of *Paratrichodorus* and *Trichodorus* species in the Slovak Republic.

Table 1. The occurrence of *Longidorus*, *Paralongidorus* and *Xiphinema* species in multiple species populations.

Composition of population*													
	L/P/X	L	2L	L+P	L+X	L+2X	2L+P+X	P	X	2X	X+P	X+2L	2X+2L
<i>L. attenuatus</i>	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>L. caespiticola</i>	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>L. closelongatus</i>	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>L. elongatus</i>	1	0	0	0	0	0	0	0	2	1	0	0	0
<i>L. euonymus</i>	0	0	0	0	0	0	0	0	1	1	0	0	0
<i>L. juvenilis</i>	0	0	0	0	0	0	0	0	3	2	0	0	0
<i>L. leptocephalus</i>	17	2	0	0	0	0	0	0	13	0	0	1	0
<i>L. picenus</i>	2	0	0	0	0	0	1	0	1	0	0	0	0
<i>L. raskii</i>	0	0	0	0	0	0	1	0	0	0	0	0	0
<i>P. maximus</i>	5	0	0	0	0	0	0	0	8	1	0	1	0
<i>X. dentatum</i>	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>X. diversicaudatum</i>	3	3	0	0	1	2	0	0	0	0	0	0	0
<i>X. italiae</i>	0	0	0	0	1	2	0	0	0	0	0	0	0
<i>X. pachtaicum</i>	0	0	0	0	0	2	0	0	1	2	0	0	0
<i>X. simile</i>	11	3	0	0	0	0	0	0	11	5	1	0	0
<i>X. taylora</i>	19	9	1	4	0	1	0	5	4	5	1	0	1
<i>X. vuittenezi</i>	94	8	0	0	0	2	0	0	11	5	1	0	0

* L/P/X, number of populations in which the species listed were not associated with another longidorid species; L, population with two species, comprised of the species listed and one other *Longidorus* species; 2L, population with three species, comprised of the species listed and two other *Longidorus* species, etc.

Table 2. The occurrence of single populations of *Longidorus*, *Paralongidorus* and *Xiphinema* species and their association with each other (in populations of two species).

	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	L. at.	L. ca.	L. cl.	L. el.	L. eu.	L. ju.	L. le.	L. pi.	L. ra.	P. ma.	X. de.	X. di.	X. it.	X. pa.	X. si.	X. ta.	X. vu.
L. at.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
L. ca.		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L. cl.			2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
L. el.				1	0	0	0	0	0	0	0	1	0	0	0	0	3
L. eu.					0	0	0	0	0	0	0	0	0	0	1	2	0
L. ju.						17	0	0	0	0	0	2	2	0	0	0	5
L. le.							0	3	1	0	0	4	0	0	2	8	0
L. pi.								2	1	1	0	0	0	0	0	1	1
L. ra.									0	1	0	0	0	0	0	1	0
P. ma.										5	0	0	0	0	1	9	0
X. de.											1	0	0	0	0	0	0
X. di.												3	0	0	1	1	1
X. it.													0	2	0	0	2
X. pa.														0	1	0	5
X. si.															11	10	13
X. ta.																19	7
X. vu.																	94

* See numeric list of species in Table 1 for explanation of species abbreviations.

populations, the distribution and a photomicrograph of the pseudo-Z organ in the distal part of the uterus of a female specimen are reported by Liskova et al. (1993). Although this species had been reported from Bohemia, Czechoslovakia by Erbenova (1975) the first record of its occurrence in Slovakia is that of Liskova et al. (1993b). The distribution of *X. diversicaudatum* in Slovakia is associated with sandy-loam non-calcareous soils, pH=5.5-6.5 at an altitude of 200 - 400 m with mild winters having mean yearly temperatures of 8 - 10° C and approximately 700 mm annual rainfall (Liskova et al., 1993). In several European countries populations of *X. diversicaudatum* are natural vectors of arabis mosaic and strawberry latent ringspot nepoviruses (Brown, 1989) but the species has not been found in association with these viruses in Slovakia.

X. italiae Meyl, 1953 (Fig. 3; Table 4) occurred in only two samples, both from vineyards at Moca in southern Slovakia. This species has been identified from 13 European countries, particularly those in the Mediterranean region, and from South Africa, Nigeria and Libya. The proximity of vineyards on the banks of the Danube to the sites of Roman camps led Liskova et al. (1993) to speculate that *X. italiae*, together with *L. juvenilis*, may have been introduced with planting material during the Roman occupation. Cohn et al. (1970) reported *X. italiae* as a vector of grapevine fanleaf nepovirus in Israel but this species has not been reported as a vector of the virus from any other locality and has not been shown to be a vector of GFLV in vineyards in Slovakia.

X. pachtaicum (Tulaganov, 1938) Kirjanova, 1951 (Fig. 3) is widespread throughout Europe, especially in the Mediterranean region, but was recovered from only three samples from vineyards at Ruban, Moca and Zemne and from one sample each from plum at Bajtava and nut trees at Salka, all in southern Slovakia.

X. simile Lamberti, Choleva & Agostinelli, 1983 (Fig. 3; Table 4) was found infrequently in samples from vineyards and orchards, mainly in the south and a single population was recovered from a sample from a hedgerow. Morphometric data were similar to those given in the original description. This species is

present in Bulgaria at several locations, including the southern bank of the river Danube, and its occurrence in Slovakia at locations on the northern bank of the Danube led Liskova et al (1993) to speculate that the species has spread from there to south-east Europe.

X. taylori Lamberti, Ciancio, Agostinelli & Coiro, 1991 (Fig. 3; Table 4). is relatively widespread in Slovakia, mainly occurring in vineyards and orchards with population densities reaching 130 individuals per 500 g soil; a few populations were found in association with birch and oak trees. The nematode's distribution could not be attributed to any specific climatic or soil condition.

In a review of nematode populations attributed to *X. brevicolle*, which is a putative member of the *X. americanum*-group of species, Lamberti et al. (1991) referred all records of its occurrence in Europe to *X. taylori*; *X. brevicolle* has been reported widely distributed in southern Europe (Alphey & Taylor, 1986) most frequently from Spain, Israel and Italy. There are several records of the occurrence of *X. brevicolle* from former Czechoslovakia (Liskova & Sabova, 1973a; Liskova, 1980) and these are now assumed to refer to *X. taylori*.

The morphometrics of four populations of *X. taylori* found during the present survey were similar (Table 4) and agree with those given in the original description of *X. brevicolle* and subsequently for *X. taylori*.

X. vuittenezi Luc, Lima, Weischer & Flegg, 1964 (Fig. 3; Table 4) was the most frequently encountered species of the genus, being particularly prevalent in the southwest region. It was recovered from 99 of 221 soil samples collected in vineyards with the populations densities ranging up to 195 individuals per 500 g soil. This species was also recovered from 19 samples collected in orchards, in two from hedgerows and in one from potato.

Paratrichodorus

P. pachydermus (Seinhorst, 1954) Siddiqi, 1974 (Fig. 4) was recovered from a light sandy-soil sample collected at Svetusa in eastern Slovakia.

Table 3. The occurrence of *Longidorus*, *Paralongidorus* and *Xiphinema* in association with crop plants and hedgerows.

	vineyards	potato	apple	apricot	berry	cherry	nuts	peach	pear	plum	hedgerows	forest	Total
<i>L. attenuatus</i>	0	0	1	0	0	0	0	0	0	0	0	1	2
<i>L. caespiticola</i>	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>L. closelongatus</i>	0	0	0	0	0	0	0	0	0	0	0	2	2
<i>L. elongatus</i>	2	0	0	0	2	0	0	0	0	0	0	0	4
<i>L. euonymus</i>	1	1	0	0	0	0	0	0	0	0	0	0	2
<i>L. juvenilis</i>	5	0	0	0	0	0	0	0	0	0	0	0	5
<i>L. leptcephalus</i>	0	2	8	0	1	6	4	0	2	9	0	1	33
<i>L. picenus</i>	0	0	0	0	0	0	1	0	0	2	0	1	4
<i>L. raskii</i>	0	0	0	0	0	0	1	0	0	0	0	0	1
<i>P. maximus</i>	3	0	1	0	0	1	6	0	0	2	1	1	15
<i>X. dentatum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>X. diversicaudatum</i>	1	0	0	0	0	1	0	0	0	7	0	0	9
<i>X. italiae</i>	2	0	0	0	0	0	0	0	0	0	0	0	2
<i>X. pachtaicum</i>	3	0	0	0	0	0	1	0	0	1	0	0	5
<i>X. simile</i>	17	0	1	0	1	1	3	1	0	6	1	0	31
<i>X. taylori</i>	18	0	6	0	0	8	7	1	1	7	0	2	50
<i>X. vuittenezi</i>	99	1	0	3	5	0	3	4	0	4	2	0	121
Total samples	221	41	23	3	6	19	22	8	5	46	27	17	

Trichodorus

T. primitivus (De Man, 1880) Micoletzky, 1922 was recovered from two light sandy-soil samples collected at Svetusa and Breznica in eastern Slovakia.

T. similis Seinhorst, 1963 was recovered from two sandy-soil samples collected at Lozorno and Lab in western Slovakia.

Multiple species populations

Approximately half the samples containing Longidoridae nematodes comprised two or more species. Three samples each contained three *Xiphinema* and two *Longidorus* species and only *L. caespiticola*, *L. closelongatus* and *X. dentatum* occurred in samples without any other longidorid (Table 1). *Xiphinema vuittenezi* was more frequently present in single species samples, 73%, than in association with other longidorids and approximately half of the samples containing *X. taylori* did not contain any other longidorid. The species *L. attenuatus*, *L. euonymus*, *L. juvenilis*, *L. raskii*, *X. italiae* and *X. pachtaicum* were present only in samples containing at least one other species of Longidoridae. *Xiphinema simile* occurred in samples as frequently by itself as it did with either with *X. taylori* or *X. vuittenezi* in populations containing only two longidorid species

(Table 2). Also, in samples with only two species present *P. maximus* occurred in nine samples with *X. taylori* whereas it was present in only five samples by itself and in one sample with one and two other *Xiphinema* and *Longidorus* species, respectfully.

Trichodorids also were found occurring together and with Longidoridae species: *T. primitivus* was present in one sample with *P. pachydermus*, in a second sample with *L. leptcephalus* and in a third sample from a potato field *T. similis* was found together with *L. euonymus* and *X. vuittenezi*.

Association with host plants

Relatively few samples collected from hedgerows and forest plantations contained longidorids. *Longidorus juvenilis* and *X. italiae* occurred only in samples collected in vineyards whereas *L. leptcephalus* was absent in such samples, occurring almost exclusively in samples from orchards and was most frequently associated with apple, cherry and plum trees (Table 3). Almost half of the samples containing *X. simile*, 60% of samples containing *X. taylori* and 90% containing *X. diversicaudatum* came from orchards, with the last named species almost exclusively associated with plum trees. *Xiphinema taylori* was recovered mainly from the rhizosphere of

Table 4. Morphometrics of selected populations of *Xiphinema italiae*, *X. simile*, *X. taylori* and *X. vuittenezi* occurring in the Slovak Republic.

Species	<i>X. italiae</i>		<i>X. simile</i>		<i>X. taylori</i>		<i>X. vuittenezi</i>	
Locality	Moca	Bajtava	Surice	Brekov	Moldava nad Bodvou	Velky Lapas	Piestany	
Host	<i>Vitis</i>	Plum	<i>Vitis</i>	Apple	<i>Vitis</i>	<i>Vitis</i>	Currant	
n	4	20	17	15	13	11	20	
L (mm)	2.8 (2.7-2.9)	2.3 (2.2-2.5)	2.0 (1.8-2.2)	2.2 (1.9-2.3)	2.2 (2.0-2.4)	3.1 (2.8-3.4)	3.6 (3.1-3.8)	
a	83 (79-84)	77 (72-81)	73 (67-78)	50 (44-54)	47 (44-52)	67 (61-73)	63 (56-72)	
b	7.7 (7.2-8.2)	7.8 (7.5-9.0)	6.5 (6.1-7.5)	6.9 (6.2-7.7)	6.8 (6.0-7.7)	7.0 (6.4-7.6)	6.9 (6.2-8.1)	
c	33 (30-34)	72 (67-79)	73 (65-80)	79 (69-89)	79 (66-90)	88 (79-94)	89 (76-101)	
c'	4.0 (3.8-4.3)	1.7 (1.6-2.0)	1.5 (1.3-1.9)	0.8 (0.7-1.1)	0.8 (0.7-1.0)	1.0 (0.9-1.1)	0.9 (0.8-1.3)	
V %	45 (42-45)	55 (54-56)	56 (54-58)	51 (49-53)	51 (48-53)	50 (45-52)	50 (48-53)	
Odontostyle μm	85 (84-87)	68 (63-72)	68 (63-77)	93 (84-98)	97 (91-98)	125 (120-130)	130 (120-137)	
Odontophore μm	58 (55-63)	43 (40-44)	42 (42-45)	56 (54-63)	58 (56-63)	75 (72-78)	83 (77-92)	
Anterior to guide ring μm	79 (77-82)	60 (56-64)	59 (56-63)	80 (72-84)	83 (80-87)	122 (118-130)	113 (107-132)	
Tail length μm	86 (84-91)	32 (28-35)	28 (26-31)	28 (24-30)	27 (22-31)	36 (33-40)	39 (37-45)	
'J' μm	10 (8-14)	7 (5-8)	7 (6-7)	10 (9-13)	12 (8-14)	11 (9-12)	13 (10-17)	
Body diam.: Lips μm	9 (8-10)	8 (7-8)	8 (7-10)	13 (12-15)	14 (13-14)	13 (12-15)	14 (12-14)	
Guide ring μm	26 (23-28)	20 (17-21)	21 (21-28)	30 (28-30)	32 (30-35)	39 (36-40)	39 (35-45)	
Oesophagus base μm	30 (28-31)	25 (22-26)	24 (21-28)	38 (35-43)	41 (36-42)	44 (40-48)	48 (45-52)	
Mid-body μm	35 (34-35)	30 (27-32)	28 (27-33)	44 (38-48)	47 (42-49)	50 (47-55)	57 (52-60)	
Anus μm	21 (21-22)	19 (16-20)	18 (14-21)	31 (27-35)	32 (28-35)	37 (32-40)	41 (37-45)	
Beginning of 'J' μm	7 (7-8)	7 (6-8)	7 (5-10)	19 (15-22)	20 (14-24)	24 (20-27)	28 (25-32)	

cherry, nut and plum trees. Only 19 samples from orchards contained *X. vuittenezi* and this species was most frequently recovered, 83%, from vineyard samples. The three species, *L. euonymus*, *L. leptcephalus* and *X. vuittenezi*, were recovered infrequently from samples collected in fields where potatoes were grown.

Virus associations

Two viruses with nematode vectors have been recorded in vineyards in Slovakia, namely arabis mosaic (AMV) and grapevine fanleaf (GFLV) nepoviruses (Liskova et al., 1994). Grapevine fanleaf nepovirus is relatively widespread but the principal vector species *X. index* has not been recovered from vineyard samples. *Xiphinema italiae*, a vector of GFLV in Israel, has been recorded only on two occasions. However, *X. vuittenezi*, which has been suggested as a possible vector of GFLV, is widespread in Slovakia. Arabis mosaic nepovirus occurs sporadically in vineyards throughout Slovakia but its vector, *X. diversicaudatum*, has only been recorded once from a vineyard sample. In Slovakia four species of

longidorids have been found in association with these viruses, *X. italiae* and *L. juvenilis* each were recovered from vineyards in which AMV was present and *X. pachtaicum* and *X. vuittenezi* in samples from vineyards in which AMV and/or GFLV were present. Little information is available concerning the possible occurrence of nematode transmitted nepoviruses in orchards or of tobacco rattle tobnavirus, transmitted by trichodorids and which can cause 'spraying' disease in potato tubers, in the potato production areas.

DISCUSSION

The present study identifies the occurrence and distribution of longidorid and trichodorid nematodes present in Slovakia and their association with crops and some natural vegetation. The results from our survey provide data which are of particular value in relation to the establishment of certified planting stock schemes and establishment and practice of phytosanitary regulations. From a limited sampling three trichodorid species were identified in association with potato but none was found in soils from the main

potato production area. Their association in Slovakia with tobacco rattle tobnavirus (TRV) is not known but each species has been identified as a vector of TRV (Brown et al., 1989). Several other virus-vector species have been identified e.g. *L. elongatus*, *P. maximus* and *X. diversicaudatum*, but they have not been found associated with any naturally transmitted nepoviruses. Nevertheless, these species represent a potential problem as virus-vectors if their associated viruses are introduced in planting material to the locations where the nematodes occur, or if the nematode vector species are introduced to areas where the viruses may be present in the absence of the vector. The relationship between the occurrence of AMV and GFLV in vineyards in Slovakia and the presence of virus-vector longidorid species is unknown. However, it is probable that the viruses have been distributed in vegetatively propagated grapevine cuttings which may account for their apparent association with longidorids not known as vectors. Nevertheless, the status of *X. vuittenezi* as a vector of GFLV in grapevine in Slovakia needs to be investigated as the occurrence of GFLV cannot be accounted for entirely by distribution of infected planting stocks. Also, in numerous instances GFLV has been observed to be spreading from plant to plant in infected vineyards where *X. vuittenezi* is present. This species has previously been implicated as a potential vector of GFLV (Rudel, 1980)

A diverse range of longidorid species is present in Slovakia. Northern species such as *L. elongatus*, *L. leptcephalus*, *L. raskii* and *X. diversicaudatum* occur in the cooler areas in Slovakia whereas the Mediterranean species such as *L. juvenilis*, *X. italiae*, and *X. pachtaicum* were recovered from samples collected in the warmer and dryer southern region. Several other species such as *L. euonymus*, *L. picenus*, *X. simile*, *X. taylori* and *X. vuittenezi* may be regarded as Central European species (Brown & Taylor, 1987) whereas *P. maximus* occurs sporadically and infrequently throughout Europe, except in southern Germany where it is relatively widespread, especially

in the Palatinate region in association with an atypical strain of raspberry ringspot nepovirus which it transmits (Jones et al., 1994).

Our survey provides the first comprehensive data on the occurrence and distribution of Longidoridae and Trichodoridae in Central Europe. The results provide information important for examination of the phylogeny and biogeography of the Longidoridae in Europe (Navas et al., 1990, 1993) and is of particular interest as Slovakia appears to be a regional boundary for the dispersal of northern European and Mediterranean species.

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Liskova M., Brown D.J.F., Taylor C.E. Обнаружение и распространение нематод семейства Longidoridae и Trichodoridae в Словакии.

Резюме. Приводятся результаты изучения в 1992-1993 гг. фауны и географического распространения нематод-лонгидорид в Словакии, а также сведения по распространению триходорид на картофельных полях в этой стране. Девять видов *Longidorus*, а также один вид *Paralongidorus* и семь видов *Xiphinema* были выявлены в пробах, собранных на виноградниках, во фруктовых садах и лесах. В пробах, собранных на картофельных полях, были обнаружены также один вид *Paratrichodorus* и два вида *Trichodorus*. Только *Longidorus leptocephalus* и *Paralongidorus maximus* встречались по всей территории Словакии, тогда как все остальные виды лонгидорусов были приурочены к своим специфическим биотопам и местностям. *Xiphinema taylori* обнаружена на всей территории Словакии, тогда как *X. vuittenezi* отмечена в основном в более теплых южных районах, а все остальные виды ксифинем были приурочены к местностям со специфическими почвенными или климатическими условиями или связаны с характерными растениями-хозяевами. Фауна лонгидорид была часто представлена сосуществующими популяциями двух и более видов. *Trichodorus similis* обнаружили на западе страны, а *T. primitivus* и *Paratrichodorus pachydermus* были выявлены в основном на востоке. Триходориды не были обнаружены в пробах из основных картофелеводческих районов страны. Южная Словакия с ее сравнительно высокой средней температурой почвы рассматривается как северная граница распространения ряда видов лонгидорид, характерных для Средиземноморского региона (*X. italiae*, *X. pachtaicum* и *X. similis*).
