

The occurrence and geographical distribution of longidorid and trichodorid nematodes associated with vineyards and orchards in China

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Accepted for publication 25 May 1996

Summary. To investigate the occurrence and geographical distribution of Longidoridae and Trichodoridae nematodes, several species of which are capable of transmitting plant viruses, a total of 1239 soil samples were collected from 165 orchards and vineyards in 22 provinces of China. Sixteen species belonging to four genera were identified: *Longidorus macromucronatus* Siddiqi, 1962; *L. martini* Merny, 1966; *L. moniloides* Heyns, 1966; *Paratrichodorus porosus* (Allen, 1957) Siddiqi, 1974; *Trichodorus kurumeensis* Yokoo, 1966; *T. nanjingensis* Liu & Cheng, 1990; *Xiphinema diffusum* Lamberti & Bleve-Zacheo, 1979; *X. elongatum* Stekhoven & Teunissen, 1938; *X. incognitum* Lamberti & Bleve-Zacheo, 1979; *X. insigne* Loos, 1949; *X. luci* Lamberti & Bleve-Zacheo, 1979; *X. radicolica* Goodey, 1936; *X. taylori* Lamberti *et al.*, 1991; *X. thornei* Lamberti & Bleve-Zacheo, 1986; and two putative *Xiphinema*: *X. sp. 1* and *X. sp. 2*. The most frequently occurring species were *X. thornei*, *X. diffusum* and *X. incognitum* each of which are members of the *X. americanum*-group.

Key words: *Longidorus*, orchards, *Paratrichodorus*, *Trichodorus*, vineyards, virus-vector, *Xiphinema*.

The initial report by Hewitt *et al.* (1958) that *Xiphinema index* was a natural vector of grapevine fanleaf nepovirus stimulated research examining members of the Longidoridae as potential virus-vectors. Nematode transmitted viruses cause important diseases to fruit trees. In China, fruit orchards are extensively cultivated throughout the country, providing important economic crops. There are several reports of *Longidorus*, *Xiphinema* and trichodorid nematodes recovered from the rhizosphere of fruit trees occurring in different areas of China (Liu & Cheng, 1990; Wang & Wu, 1992 a & b; Wang *et al.*, 1992; Wang *et al.*, 1994; Xu & Cheng, 1991, 1992; Xu *et al.*, 1995; Yin & Feng, 1981), but relatively little is known of the taxonomy, geographical distribution, host preferences of these nematodes, or their potential to transmit plant viruses. Also, damage being caused to grapevine and fruit tree crops in China as a result of direct feeding by longidorid nematodes, or by viruses they might transmit, has not been assessed.

A comprehensive survey was undertaken to determine the occurrence, geographical distribution and

host associations of potential virus-vector nematodes in vineyards and orchards throughout China and the results from it are reported here.

MATERIALS AND METHODS

A total of 1239 soil samples were collected from 165 vineyards and orchards distributed in 22 provinces in China where various fruit crops are extensively planted (Table 1, Fig. 1). Soil samples were collected from the rhizosphere of plants from a depth, depending on the plant species, of 20-60 cm, sealed in polythene bags, transported by rail to Beijing Agricultural University and stored at 4° C for a maximum of 30 days before being examined. Nematodes were extracted from the samples by a sieving and sugar centrifugation method, heat-killed and fixed in hot 2% formalin solution. Nematodes belonging to the genera *Longidorus*, *Paratrichodorus*, *Trichodorus*, and *Xiphinema* were identified under low magnification using a binocular stereo-microscope, specimens were hand-picked from each sample in which they occurred, processed to anhy-

drous glycerin and mounted on glass slides. Species identifications were made with the aid of a high resolution light microscope.

RESULTS

Virus-vector nematodes occurred in 252 of the 1239 soil samples (20.3%) from 80 orchards, vineyards and plantations. *Longidorus*, *Paratrichodorus*, *Trichodorus* and *Xiphinema* were found to occur in 13 of the 22 provinces, and a total of sixteen species were identified. The most frequently encountered nematodes were *Xiphinema*, of which 10 species were identified, with *X. thornei* being the most common and most widespread.

Longidorid and trichodorid nematodes were found associated with 20 of the 30 fruit tree genera sampled during the survey. The geographical distribution of the longidorid and trichodorid species and their association with different hosts are presented in Tables 1 & 2 and Fig. 1.

Species morphometrics and comments

Morphometrics obtained from specimens collected from a representative population for each species identified during the survey are presented, together with supplementary information on the species occurrence in China.

Longidorus species

L. macromucronatus Siddiqi, 1962. Morphometrics (18 females): L = 4.6 (4.2-5.1) mm, V = 50 (47-52)%; a = 109 (102-124); b = 11 (9.2-12); c = 166 (141-209); c' = 0.9 (0.8-1.1); odontostyle length = 115 (107-122) μ m; odontophore length = 73 (65-80) μ m; total stylet length = 188 (179-200) μ m; anterior to intestinal/oesophageal junction (IOJ) = 436 (401-476) μ m; lip height = 6.8 (6.3-8.4) μ m; lip width = 14 (14-15) μ m; anterior to guiding ring (DGR) = 62 (59-69) μ m; greatest body width (BW) = 43 (40-46) μ m; tail length = 28 (22-32) μ m; body width at anus (ABW) = 30 (26-32) μ m; tail hyaline = 4.3 (4.2-5.3) μ m. Morphometrics obtained from specimens from an apple orchard in Nankou, Beijing.

L. moniloides Heyns, 1966. Morphometrics (9 females): L = 3.7 (3.3-4.0) mm; V = 49 (42-50)%; a = 120 (114-125); b = 12 (10-15); c = 114 (97-134); c' = 1.58 (1.3-1.7); odontostyle length = 67 (63-69) μ m; odontophore length = 45 (38-50) μ m; total stylet length = 112 (107-116) μ m; IOJ = 318 (272-340) μ m; lip height = 4.8 (4.6-5.3) μ m; lip width = 10 (8.8-11) μ m; DGR = 30 (29-33) μ m; BW = 31

(29-34) μ m; tail length = 32 (29-35) μ m; ABW = 21 (19-23) μ m; tail hyaline = 7.4 (5.9-8.4) μ m. Morphometrics obtained from specimens recovered from the rhizosphere of jujube growing in Jingxin, Hebei Province.

L. martini Merny, 1966. Morphometrics (3 females): L = 4.2 (3.9-4.4) mm; V = 50 (48-54)%; a = 128 (122-134); b = 13 (13-14); c = 115 (100-122); c' = 1.55 (1.4-1.75); odontostyle length = 81 (77-87) μ m; odontophore length = 44 (36-50) μ m; total stylet length = 125 (116-137) μ m; IOJ = 312 (293-332) μ m; lip height = 5.6 (5.3-6.3) μ m; lip width = 11 μ m; DGR = 35 (34-36) μ m; BW = 33 (29-36) μ m; tail length = 37 (32-34) μ m; ABW = 24 (21-25) μ m; tail hyaline = 6.9 (5.3-9.5) μ m. The morphometrics were obtained from specimens from a vineyard in Longyang, Cixian, Hebei Province.

Paratrichodorus species

P. porosus (Allen, 1957) Siddiqi, 1974. Morphometrics (11 females): L = 0.74 (0.65-0.92) mm; V = 55 (53-58)%; a = 22 (19-27); b = 5.7 (4.5-7.1); b' = 5.4 (4.9-6.1); onchiostyle length = 53 (50-55) μ m; anterior genital branch (AGB) = 163 (141-189) μ m; posterior genital branch (PGB) = 144 (105-170) μ m; IOJ = 131 (101-153) μ m; anterior to base of posterior oesophageal lobe = 142 (118-164) μ m; vulva to first anterior pore = 14 (11-15) μ m; vulva to second anterior pore = 24 (21-26) μ m; vulva to first posterior pore = 6.4 (6.3-7.4) μ m; vulva to second posterior pore = 18 (16-20) μ m; BW = 34 (32-35) μ m. This species is widespread in China, especially in the southern Provinces where it is associated with a wide range of hosts. The morphometrics of all populations were very similar and those given here are from a population from the rhizosphere of yangtao growing in Changsha, Hunan Province.

Trichodorus species

T. nanjingensis Liu & Cheng, 1990. Morphometrics (14 males): L = 0.9 (0.8-1.1) mm; a = 22 (19-25); b = 6.4 (5.1-8.3); c = 64 (47-77); onchiostyle length = 46 (42-50) μ m; supplements (S), S1-S2 = 41 (29-55) μ m; S2-S3 = 26 (11-36) μ m; S3-anus = 21 (15-34) μ m; cervical pores (CP), CP1-CP2 = 12 (8.4-15) μ m; CP2-excretory (excr.) pore = 13 (11-15) μ m; IOJ = 144 (128-162) μ m; anterior to excr. pore = 99 (90-105) μ m; BW = 43 (40-45) μ m; tail length = 15 (13-19) μ m; spicule = 50 (45-52) μ m; gubernaculum = 14 (8.7-23) μ m.

Morphometrics (8 females): L = 0.9 (0.8-1.0) mm; V = 54 (52-57)%; a = 20 (17-24); b = 6.6 (5.2-



Fig. 1. The provinces from which soil-samples were collected during a survey to determine the occurrence and distribution of Longidoridae and Trichodoridae nematodes in fruit orchards and vineyards in China. ■ - location of samples containing longidorid and trichodorid nematodes (samples from different hosts were frequently obtained from the same location).

8.1); onchiostyle length = 48 (46-50) μm ; IOJ = 141 (111-162) μm ; anterior to cervical lateral pore = 117 (116-118) μm ; BW = 47 (42-53) μm . Several populations were found in orchard soils from Beijing and the species occurs at very high population densities. In an orchard in Nankou about 7 acres of older apple trees were non-productive due to stubby root disease caused by *T. nanjingensis*. This nematode species has also been found associated with pear and peach trees. Morphometrics were obtained from a population from a diseased apple orchard in Nankou, Beijing.

T. kurumeensis Yokoo, 1966. Morphometrics (1 male): L = 0.78 mm; a = 24; b = 5.4; c = 60; onchiostyle = 55 μm ; testes = 60%; S1-S2 = 48 μm ; S2-S3 = 32 μm ; S3-anus = 24 μm ; CP1-CP2 = 9.45 μm ; CP2-CP3 = 7.35 μm ; CP3-excr. pore = 7.35 μm ; IOJ = 145 μm ; anterior to excr. pore = 111 μm ; BW = 33 μm ; tail length = 13 μm ; spicule = 43 μm ; gubernaculum = 14 μm .

Morphometrics (2 females): L = 0.68, 0.76 mm;

V = 57%; a = 20, 21; b = 5.2, 5.8; c = 181, 180; onchiostyle = 46, 53 μm ; IOJ = 118, 147 μm ; anterior to excr. pore = 95 μm ; BW = 34, 36 μm ; AGB = 132, 168; PGB = 153, 160; tail length = 6.3, 4.2 μm . The morphometrics were obtained from specimens from a vineyard in Rusan, Shandong Province.

Xiphinema species

For each *Xiphinema* species (excluding those belonging to the *X. americanum*-group) the taxonomic group number and identification code are provided as listed by Loof & Luc (1990), and where appropriate in supplements by Loof & Luc (1993) and Loof *et al.*, (1996), in their polytomous identification key for *Xiphinema* species. Also, information is given of two undescribed *Xiphinema* species and a full taxonomic description of these species will be presented in a subsequent paper.

X. diffusum Lamberti & Blevé-Zacheo, 1979.

Table 1. The occurrence of Longidoridae and Trichodoridae nematodes and their associated hosts in China *.

Provinces/Localities	Hosts**	Nematodes
Anhui		
Funan	apple, pear	<i>X. thornei</i>
Beijing		
Nankou, Changping	apple	<i>L. macromucronatus</i> , <i>T. nanjingensis</i> , <i>X. thornei</i>
Sijiqing, Haidian	apple, pear	<i>T. nanjingensis</i>
Xishan, Haidian	apple	<i>T. nanjingensis</i>
Fujian		
Zhangzhou	litchi	<i>L. litchii</i> (Xu & Cheng, 1992), <i>X. radiculicola</i> (Xu & Cheng, 1995)
unknown	citrus	<i>P. porosus</i> , <i>X. elongatum</i> , <i>X. thornei</i> (Zhang & On, pers. comm.)
Gansu		
Fenghuangshan, Tianshui	apple	<i>L. macromucronatus</i> , <i>X. taylori</i>
Huaniuzhai, Tianshui	apple	<i>X. luci</i>
Guangdong		
Shenzhen	litchi	<i>P. porosus</i>
Suburb, Shenzhen	citrus	<i>X. elongatum</i>
Hebei		
Nuanquan, Huailai	grapevine	<i>L. martini</i> , <i>X. thornei</i>
Shaying, Huailai	grapevine	<i>X. thornei</i>
Shoulian, Zhuolu	grapevine	<i>P. porosus</i>
Dongsun, Huanghua	grapevine	<i>X. thornei</i>
Dajienan, Huanghua	grapevine	<i>X. thornei</i>
Huangjiatun, Xingtai	grapevine	<i>X. thornei</i>
Zhaodian, Wuan	grapevine	<i>X. thornei</i>
Tangshan	grapevine	<i>X. thornei</i>
Mengzhuang, Cixian	grapevine	<i>X. taylori</i> , <i>X. thornei</i>
Longyang, Cixian	grapevine	<i>L. martini</i>
Huocun, Xingtang	grapevine	<i>P. porosus</i> , <i>X. thornei</i>
Suburb, Changli	apple, pear	<i>X. thornei</i>
Balizhuang, Changli	peach	<i>X. thornei</i>
Xishancun, Changli	pear	<i>X. incognitum</i>
Caoliangtun, Changli	plum	<i>X. incognitum</i>
Jingxin	peach	<i>L. macromucronatus</i>
	apple	<i>L. martini</i>
	apricot, jujube, peach, pear	<i>L. moniloides</i>
	apple, apricot, hawthorn, jujube	<i>X. thornei</i>
	peach, pear	
	pear	<i>X. thornei</i>
Funing		
Henan		
Linbao	grapevine	<i>L. henanus</i> (Xu & Cheng, 1992)
Shangge, Luoning	apple, Chinese catalpa	<i>X. diffusum</i>
Suburb, Zhenzhou	grapevine	<i>T. kurumeensis</i>
Hunan		
Changsha	yangtao	<i>P. porosus</i>
	grapevine, yangtao	<i>X. radiculicola</i>
	citrus, grapevine	<i>X. thornei</i>
Inner Mongolia		
Ningcheng, Chifeng	pear	<i>X. thornei</i>
Yisakedalalaqi	pear	<i>X. thornei</i>
Donghe, Baotou	pear	<i>X. thornei</i>

Table 1 (continued). The occurrence of Longidoridae and Trichodoridae nematodes and their associated hosts in China*.

Provinces/Localities	Hosts**	Nematodes
Jiangsu		
Nanjing	peach	<i>T. nanjingensis</i> (Liu & Cheng, 1990)
Yizheng	apple	<i>L. fangi</i> (Xu & Cheng, 1992)
Shandong		
Yujia, Rushan	Chinese chestnut, walnut	<i>X. thornei</i>
Gushuitou, Rushan	hawthorn	<i>X. thornei</i>
Wuling, Rushan	grapevine	<i>X. thornei</i>
Yantai	grapevine	<i>X. thornei</i>
Shilibu, Pengalai	grapevine	<i>X. thornei</i>
Pingdu	grapevine	<i>X. thornei</i>
Xijicun, Rushan	grapevine	<i>T. kurumeensis</i>
Shanxi, Rushan	persimmon	<i>X. thornei</i>
Gaizaokuang, Rushan	peach	<i>X. thornei</i>
Qinjiashuang, Rushan	apple	<i>X. thornei</i>
Jiangcunwa, Rushan	apple, peach, pear	<i>X. thornei</i>
Nantangjia, Rushan	pear	<i>X. thornei</i>
Anjiacun, Rushan	pear	<i>X. thornei</i>
Gaomi	apple	<i>X. thornei</i>
Laiyang	grapevine	<i>X. diffusum</i>
Longkou	grapevine	<i>Xiphinema</i> sp. 2
Sichuan		
Daguan, Jinjiang, Chengdu	citrus	<i>X. insigne</i> , <i>X. thornei</i>
Jinjiang, Chengdu	citrus	<i>X. insigne</i>
Wucun, Jianyang	citrus	<i>X. insigne</i>
Jiangjin	citrus	<i>X. insigne</i>
Mianhua, Jianyang	citrus	<i>X. diffusum</i> , <i>X. insigne</i>
Panxian, Nanbu	citrus	<i>X. thornei</i>
Tianjin		
Shuangtang, Jinghai	jujube, pear	<i>X. thornei</i>
Xinjiang		
Urumqi	apple, Chinese flowering crabapple, strawberry, grapevine	<i>X. incognitum</i>
Tulufan	grapevine	<i>X. diffusum</i>
Hongbin	apple, peach	<i>X. incognitum</i>
Suburb, Yili	apple, Chinese flowering crabapple, grapevine, pear, peach	<i>X. incognitum</i>
Yunnan		
Nanping, Hekou	banana	<i>Xiphinema</i> sp. 1
Youmucum, Hekou	banana	<i>Xiphinema</i> sp. 1
Wudaohu, Hekou	banana	<i>Xiphinema</i> sp. 1
Longtou, Kunming	cherry, pear	<i>P. porosus</i>
	apple, pear	<i>X. diffusum</i>
Ciba, Kunming	peach	<i>P. porosus</i>
	pear	<i>X. diffusum</i>
Suburb, Kunming	olive, plum	<i>P. porosus</i>
	pear, plum	<i>X. diffusum</i>
	plum	<i>L. moniloides</i>
Luliang	peach	<i>P. porosus</i>
	apple, Chinese chestnut, peach	<i>X. diffusum</i>

* The reference is provided where a nematode species was not identified during the present survey. *Xiphinema brevicolle* (probably *X. thornei*) and *X. insigne* were reported from several non-specified hosts and provinces by Xu *et al.* (1995) and therefore are not included in the Table.

** See footnote in Table 2 for botanic name of each host.

Morphometrics (20 females): L = 1.9 (1.6-2.1) mm; V = 49 (47-52)%; a = 45 (40-48); b = 6.9 (6.2-7.8); c = 74 (59-87); c' = 1.0 (0.9-1.1); odontostyle length = 83.7 (81-90) μm ; odontophore length = 55 (53-59) μm ; total stylet length = 139 (132-149) μm ; IOJ = 278 (255-323) μm ; DGR = 76 (71-82) μm ; BW = 43 (40-48) μm ; tail length = 26 (24-32) μm ; ABW = 26 (24-32) μm ; tail hyaline = 7.6 (6.9-9.5) μm . A member of the *X. americanum*-group and the morphometrics were obtained from a population from a vineyard in Tulufan, Xinjiang Province. Populations from different localities or hosts have slight variations in body and stylet lengths, and occasionally in body width. However, the value c' of all populations was in the range of 0.9-1.0.

X. elongatum Steckhoven & Teunissen, 1938. Morphometrics (2 females): L = 2.0, 2.1 mm; V = 39, 39; a = 56, 72; b = 5.5; c = 33, 37; c' = 2.8, 2.9; odontostyle length = 87, 88 μm ; odontophore length = 57, 62 μm ; total stylet length = 145, 149 μm ; IOJ = 366 μm ; DGR = 85 μm ; BW = 29, 36 μm ; tail length = 57, 61 μm ; ABW = 20, 22 μm . The species is placed in group 7 and the identification code is A4-B4-C2-D3-E3-F2-G1-H2-I3-J2-K2-L1. The morphometrics were obtained from two female specimens collected from the rhizosphere of citrus growing in the Suburb of Shenzhen, Guangdong Province, which is the only record of this species in China.

X. incognitum Lamberti & Bleve-Zacheo, 1979. Morphometrics (21 females): L = 1.9 (1.7-2.1) mm; V = 50 (48-53)%; a = 49 (46-55); b = 6.4 (5.0-7.5); c = 69 (53-78); c' = 1.2 (1.0-1.5); odontostyle length = 89 (82-95) μm ; odontophore length = 55 (50-58) μm ; total stylet length = 144 (138-153) μm ; IOJ = 302 (268-357) μm ; DGR = 78 (74-82) μm ; BW = 39 (36-43) μm ; tail length = 29 (25-34) μm ; ABW = 25 (22-27) μm ; tail hyaline = 9.5 (6.5-10.1) μm . A member of the *X. americanum*-group, and the morphometrics were obtained from a population from a pear orchard at Xishancun, Changli, in Hebei Province. Specimens from all populations agreed in all respects to the species definition for *X. incognitum* in the identification key by Lamberti & Carone (1991). Some populations from different localities or hosts had slight variations in body and stylet length, and less frequently in body width. The value c' of all populations was in the range 1.0-1.5.

X. insigne Loos, 1949. Morphometrics (16 females): L = 2.30 (1.79-2.59) mm; V = 33 (30-37)%; a = 60 (47-70); b = 6.3 (5.1-7.3); c = 18 (15-24); c' = 5.7 (4.7-6.3); odontostyle length = 96.1 (91.4-101.9); odontophore length = 62.1 (56.9-65.1) μm ; total stylet length = 157.4 (150.2-163.8) μm ; IOJ = 365.4 (340-399.5) μm ; DGR = 84.5 (60.9-109.2)

μm ; BW = 38.4 (33.6-42.0) μm ; tail length = 127.8 (99.1-145.8) μm ; ABW = 22.5 (20.0-23.1) μm . The species is placed in group 7 and the identification code is A3-B4-C2-D2-E2-F2-G2-H2-I3-J2/1-K2/1-L1. Morphometrics were obtained from a population collected from a citrus orchard at Yanqiao, Jiangjin, Sichuan Province.

Xiphinema luci Lamberti & Bleve-Zacheo, 1979. Morphometrics (11 females): L = 2.8 (2.6-3.0) mm; V = 54 (52-55)%; a = 81 (77-91); b = 9.2 (8.3-10.4); c = 89 (76-100); c' = 1.7 (1.5-1.9); odontostyle length = 80 (74-83) μm ; odontophore length = 52 (50-55) μm ; total stylet length = 131 (124-134) μm ; IOJ = 307 (264-349) μm ; DGR = 74 (70-76) μm ; BW = 35 (32-38) μm ; tail length = 32 (27-34) μm ; ABW = 19 (17-20) μm . A member of the *X. americanum*-group and the morphometrics were obtained from a population from an apple orchard in Tianshui, Gansu Province, which is the only record of its occurrence in China.

X. radicolica Goodey, 1936. Morphometrics (10 females): L = 2.30 (2.1-2.5) mm; V = 26 (24-27)%; a = 54 (51-57); b = 6.8 (5.9-7.6); c = 57 (53-63); c' = 1.5 (1.2-1.7); odontostyle length = 112 (110-114) μm ; odontophore length = 71 (70-75) μm ; total stylet length = 183 (180-187) μm ; IOJ = 366 (274-407) μm ; DGR = 101 (95-104) μm ; BW = 42 (37-44) μm ; tail length = 40 (37-45) μm ; ABW = 28 (27-31) μm ; tail peg = 21 (20-22) μm . A member of group 1 and the identification code is A1-B4-C5-D4/5-E1-F2-G2-H2-I2/3-J5-K2-L1. The morphometrics were obtained from a population from a vineyard in the Suburb of Changsha City, Hunan Province. Wang & Wu (1992a) described *X. hunanensis* from specimens collected from the rhizosphere of grapevine but subsequently Loof *et al.* (1996) regarded this species a junior synonym of *X. radicolica*.

X. taylori Lamberti, Ciancio, Agostinelli & Coiro, 1991. Morphometrics (7 females): L = 2.1 (1.9-2.2) mm; V = 49 (46-50)%; a = 44 (41-47); b = 7.7 (6.8-8.6); c = 74 (66-78); c' = 0.96 (0.91-1.0); odontostyle length = 83 (78-88) μm ; odontophore length = 55 (50-59) μm ; total stylet length = 138 (130-147) μm ; IOJ = 270 (255-302) μm ; DGR = 73 (66-78) μm ; BW = 48 (43-53) μm ; tail length = 28 (26-32) μm ; ABW = 30 (26-32) μm . A member of the *X. americanum*-group and the morphometrics were obtained from a population from the rhizosphere of apple in Fenghuangshan, Tianshui, Gansu Province. Nematodes from this population had longer body lengths and smaller c' values than specimens from populations of the morphologically similar *X. thornei*.

X. thornei Lamberti & Bleve-Zacheo, 1986. Morphometrics (10 females): L = 1.8 (1.7-2.0) mm; V =

48 (45-50)%; a = 47 (40-50); b = 6.9 (5.6-8.3); c = 63 (56-69); c' = 1.1 (1.0-1.2); odontostyle length = 80 (78-82) μm ; odontophore length = 55 (51-59) μm ; total stylet length = 135 (130-141) μm ; IOJ = 270 (230-306) μm ; DGR = 75 (72-78) μm ; BW = 40 (38-42) μm ; tail length = 29 (27-32) μm ; ABW = 27 (25-29) μm ; tail hyaline = 7.8 (6.3-8.4) μm . A member of the *X. americanum*-group and is widespread throughout China. The morphometrics were obtained from specimens collected from the rhizosphere of pear in Tianyi, Ningcheng, Chifeng, in Inner Mongolia. Specimens from populations from different localities or hosts have slight variations in body and stylet lengths, and less frequently in body width. The value c' of all populations was in the range 1.0-1.2. Populations of *X. brevicolle* reported by Xu *et al.*, (1995) are probably *X. thornei*.

Xiphinema sp. 1 (an undescribed species). Morphometrics (11 females): L = 2.04 (1.8-2.4) mm; V = 27 (24-30)%; a = 45 (34-52); b = 5.5(4.5-6.2); c = 32 (21-42); c' = 2.3(1.9-2.7); odontostyle length = 128 (124-133) μm ; odontophore length = 72 (69-76) μm ; total stylet length = 200.5 (195-207) μm ; IOJ = 370 (319-425) μm ; DGR = 120 (109-125) μm ; BW = 46 (40-53) μm ; tail length = 65 (58-85) μm ; ABW = 28 (25-32) μm ; length of tail peg = 41 (34-46) μm . A member of group 1 and the identification code is A1-B4-C5-D4-E1-F2-G2/3-H2- I2/1-J2-K2-L1. The morphometrics were obtained from a population from the rhizosphere of banana growing in Wudaohu, Hekou, Yunnan Province.

Xiphinema sp. 2 (an undescribed species). Morphometrics (10 females): L = 1.9 (1.8-2.0) mm; V = 50 (48-52)%; a = 44 (38-48); b = 5.9 (5.5-6.8); c = 67 (59-76); c' = 0.97 (0.86-1.07); odontostyle length = 89 (84-92) μm ; odontophore length = 57 (53-61) μm ; total stylet length = 146 (139-151) μm ; IOJ = 327 (281-344) μm ; DGR = 77 (84-92) μm ; BW = 43 (40-50) μm ; tail length = 28.5 (25-32) μm ; ABW = 28.2 (25-30) μm ; tail hyaline = 9.7 (6.9-15) μm . A member of the *X. americanum*-group and the morphometrics were obtained from a population recovered from a vineyard in Longkou, Shandong Province.

DISCUSSION

Sixteen longidorid and trichodorid nematode species were recovered from soil samples collected as part of the first systematic and comprehensive nematological survey of orchards and vineyards in China. Several species which had previously been reported from China were not identified during the present survey *viz.* *X. brevicolle* (probably *X. thornei*) which previously had been found associated with several

genera of fruit trees (Xu *et al.*, 1995); *L. fangi* which was described from specimens collected from the rhizosphere of apple trees (*Malus pumila* Mill.) (Xu & Cheng, 1991); *L. litchii* and *L. henanus* which were described from litchi trees (*Litchi chinense* Sonn) and grapevine (*Vitis vinifera* L.), respectively (Xu & Cheng, 1992) and *P. minor* (= *P. christiei*) recovered from citrus orchard samples (Zhang & On, unpublished results). Virus-vector species such as *X. index*, *X. americanum sensu stricto*, *X. diversicaudatum*, *L. macrosoma*, and *L. elongatus* which, in association with their viruses, are widespread in Europe and America, were not recorded during the present survey. The apparent absence of these virus-vector species suggests that they may not occur, or at least may not be economically important, in China. Also, members the genus *Paralongidorus*, which is considered indigenous to Africa and Asia, have not been found in China.

Xiphinema species were most frequently recorded in samples from orchards, whereas *Longidorus*, *Paratrachodoros* and *Trichodoros* species were recorded much less frequently. However, *T. nanjingensis*, when found, was present in very large population densities. The survey results also indicate that some specificity in nematode-host association occurs with, for example, *X. insigne*, *X. elongatum*, and *X. sp.1*, each of which were found associated with a very limited range of fruit crops, whereas the other species had extensive host ranges. Of the ten *Xiphinema* species recorded during the survey, *X. insigne*, *X. elongatum*, *X. sp.1*, and *X. radicolica* were only found in clay soils from orchards in southern China, with the other species being recovered from loam soils from many parts of China. The most frequently occurring and widespread species were *X. thornei*, *X. diffusum* and *X. incognitum* all of which belongs to the *X. americanum*-group.

The earlier reports of longidorids and trichodorids found in China and the results of the present survey suggest that at least 21 species of the virus-vector genera *Longidorus*, *Paratrachodoros*, *Trichodoros* and *Xiphinema* are present in vineyards and orchards in China (Table 1).

Little research has yet been done to investigate if any of the species present in China are associated with nepo- or tobnaviruses. However, Zheng *et al.*, (1990) reported that tobacco rattle tobnavirus infecting *Narcissus tazetta* cv. *chinensis* growing in fields in Pingtan County, Fujian, was transmitted by an unidentified *Trichodoros* species. Therefore, further research of naturally occurring field associations between virus diseases and longidorid and trichodorid nematodes is required to identify the prevalence of nematode transmission of viruses in China.

ACKNOWLEDGEMENTS

We thank Dr. P.A.A. Loof for help with identifying *Xiphinema* species, and similarly Dr. M. R. Siddiqi for his help with *Trichodorus* populations. We are especially grateful to Ms. Tian Honglin for her technical assistance and to Mr. Zhang Chengguo who collected many of the soil samples for this study. This research was supported by grant No. 39070577 from the National Natural Science Foundation of China.

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Wang S., Chiu W. F., Yu C., Li C., Robbins R. T. Встречаемость и географическое распространение лонгидорид и триходорид, ассоциированных с виноградниками и садами в Китае.

Резюме. Для изучения встречаемости и географического распространения нематод семейств Longidoridae и Trichodoridae, некоторые из которых способны переносить вирусы растений, было собрано 1239 почвенных проб из 165 садов и виноградников в 22 провинциях Китая. Были обнаружены 16 видов нематод, относящиеся к 4 родам: *Longidorus macromicronatus* Siddiqi, 1962; *L. martini* Merny, 1966; *L. moniloides* Heyns, 1966; *Paratrichodorus porosus* (Allen, 1957) Siddiqi, 1974; *Trichodorus kurumeensis* Yokoo, 1966; *T. nanjingensis* Liu & Cheng, 1990; *Xiphinema diffusum* Lamberti & Bleve-Zacheo, 1979; *X. elongatum* Stekhoven & Teunissen, 1938; *X. incognitum* Lamberti & Bleve-Zacheo, 1979; *X. insigne* Loos, 1949; *X. luci* Lamberti & Bleve-Zacheo, 1979; *X. radicolica* Goodey, 1936; *X. taylori* Lamberti et al., 1991; *X. thornei* Lamberti & Bleve-Zacheo, 1986, а также две неопределенных вида ксифинем: *Xiphinema* sp.1 и *Xiphinema* sp.2. Наиболее часто встречающимися видами оказались *X. thornei*, *X. diffusum* и *X. incognitum*, относящиеся к группе *X. americanum*.