

Three trichodorid species (Nematoda: Trichodoridae) occurring in China

J. ZHENG, L. JIANG, D. LIANG, D. J. F. BROWN¹

Department of Plant Protection, College of Agriculture and Biotechnology, Zhejiang University, Hangzhou 310029, China. E-mail: jwzheng@zju.edu.cn; ¹Central Laboratory of General Ecology, Gagarin Street 2, 1113 Sofia, Bulgaria

Summary

Three species of the Family Trichodoridae were identified and described from China. Three populations of *Trichodorus nanjingensis* Liu & Cheng, 1990, were collected from the rhizosphere of bamboo (*Bambusa glaucescens* var. *riviereorum*) and Chinese mulberry (*Morus cathayana*) growing at Hangzhou, and from apple at Beijing, respectively, of which bamboo and Chinese mulberry are new hosts for this species. Two populations of *T. pakistanensis* Siddiqi, 1962, were recovered from the rhizosphere of *Metasequoia glyptostroboides* and bamboo growing at Hangzhou, and these represent new hosts for the species. Seven populations of *Paratrichodorus porosus* (Allen, 1957) Siddiqi, 1974, were collected from Fuyang, Zhejiang, with five associated with *Camellia japonica*, and the other two from *Ligustrum lucidum*, and from oriental cherry (*Prunus serrula*) that are new hosts for the species. These three trichodorid species are new records for Zhejiang province, China. Virus bait-testing of the species did not reveal any association with *Tobravirus*.

Key words: China; geographical distribution; new host; *Paratrichodorus*; *Trichodorus*; virus-vector

Introduction

Trichodorids are important pests of a wide range of vegetable and ornamental crops as a result of their direct feeding on plant roots, and several members in the genera *Trichodorus* and *Paratrichodorus* are natural vectors of the viruses comprising the genus *Tobravirus* (Taylor and Brown, 1997). The occurrence trichodorids in China have been published by several authors, but there is no unequivocal evidence of these nematodes being associated with a *Tobravirus* (Liu and Cheng, 1990; Zheng *et al.*, 1990; Wang *et al.*, 1996; Xie *et al.*, 1996, 2000; and Xu and De-craemer, 1995).

The occurrence of trichodorid associated with field crops, forests, and ornamental plants was examined in an extensive survey in Zhejiang, and several other provinces (cities) of China. The trichodorids discovered during this survey, and the results from virus bait-testing of the populations, are reported here.

Materials and Methods

Soil samples were collected from 10 to 40 cm depth from the rhizosphere of field crops, forest trees and ornamental plants. Trichodorids were extracted from the samples by a decanting and sieving method (Brown and Boag, 1988). Representative specimen from each population of trichodorids was heat killed, fixed in formalin, and processed and mounted in anhydrous glycerol on microscope slides for morphological identification. The remaining live specimens were used in virus bait-tests.

The bait-tests were done following the procedure described by Brown *et al.* (1989). Hand-picked individuals, or groups of 5, adult females were added to 0.5 cm³ plastic capsules that contained air-dried sieved sand with a particle size < 1500 µm and > 500 µm and water. A single *Nicotiana glauca* seedling was planted in each capsule and the capsules then were placed in a temperature-controlled cabinet, operating at 20°C, for 4 week. Thereafter, the nematodes were recovered from the capsules, counted, and the bait seedling placed in a sterile compost-block and grown for a further 4 week. The root of each bait plant was thoroughly washed to remove and adhering nematodes and then comminuted using a mortar and pestle. The suspension was rubbed by finger onto the surface of leaves, dusted with carborundum abrasive powder, of *Chenopodium amaranticolor* and *C. quinoa* virus assay-plants. After 10 days the leaves of the assay plants were examined for the presence of virus induced symptoms.

Results

Trichodorid species, hosts and distribution *Trichodorus nanjingensis* Liu & Cheng, 1990

(Fig.1.)

Measurements:

Females: see Table1.

Males: See Table 2.

Description:

Female: General appearance typical of the genus, body cylindrical almost straight or slightly ventrally curved upon fixation. The pharyngeal bulb offset. Excretory pore at level of the anterior end of the pharyngeal bulb, reproductive system didelphic, with pore-like vulva, vaginal sclerotization small to medium-sized triangular or rounded, vagina pear-shaped, spermathecae absent, and sperm distributed throughout the uteri. One pair of post vulvar lateral body pores present.

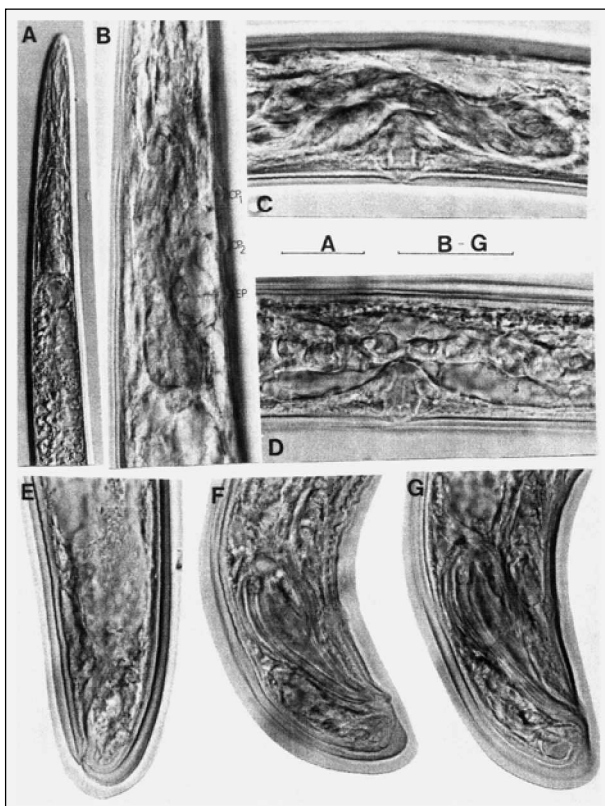


Fig. 1. Photomicrographs of *Trichodorus nanjingensis* from Chinese mulberry

A – female anterior; B – male anterior, showing the position of S-E pore (EP) and ventromedian cervical papillae (CP); C-D – female vaginal region; E – female tail; F-G – male tail.
(Scale bar: 30 μ m)

Male: Body cylindrical, slightly curved ventrally, tapering gradually anteriorly from oesophageal region. Body cuticle of three layers, little swollen upon fixation, about 4 μ m thick at mid-body. Lip region rounded with distinct labial papillae. Onchiostyle ventrally curved, posterior pharynx

Table 1. Morphometrics of female of *Trichodorus nanjingensis* from three Chinese populations (all measurement in μ m)

Population Host n	Hangzhou Bamboo 8	Hangzhou Mulberry 8	Beijing Apple 7
Body length	880 \pm 39 (832 – 933)	1023 \pm 82 (880 – 1133)	925 \pm 17 (740 – 1060)
Body width	39 \pm 4.3 (36 – 48)	44 \pm 4.1 (38 – 50)	41 \pm 3.5 (36 – 45)
Pharynx	157 \pm 13.8 (130 – 169)	162 \pm 10.7 (144 – 176)	155 \pm 7.3 (146 – 165)
Onchiostyle	46 \pm 2.5 (43 – 48)	49 \pm 2.0 (48 – 52)	46 \pm 4.2 (41 – 52)
Ant. end to S-E pore	126 \pm 6.5 (120 – 133)	126 \pm 9.9 (110 – 144)	131 \pm 15.3 (104 – 144)
Ant. Genital branch	150 \pm 16.1 (130 – 175)	200 \pm 19.3 (180 – 240)	185 \pm 35.5 (128 – 225)
Post genital branch	152 \pm 10 (140 – 166)	190 \pm 13.2 (173 – 213)	181.3 \pm 23.2 (150 – 203)
a	22 \pm 1.7 (19 – 24)	24 \pm 2.8 (21 – 29)	23 \pm 2.7 (19 – 26)
b	5.6 \pm 0.5 (4.9 – 6.5)	6.3 \pm 0.3 (5.7 – 6.7)	5.9 \pm 0.9 (4.5 – 7.3)
V %	54 \pm 2.3 (51 – 57)	57 \pm 2.3 (54 – 61)	58 \pm 1.3 (58 – 59)
Length of vagina	20 \pm 1.6 (17 – 23)	20 \pm 4.4 (17 – 30)	19 \pm 2.2 (17 – 23)
Size of vaginal pieces	2.1 \pm 0.4 (1.6 – 2.6)	2.1 \pm 0.3 (1.9 – 2.6)	2.0 \pm 0.6 (1.6 – 3.2)

gradually widening into a large bulb. Two conspicuous ventromedium cervical papillae (CP1 and CP2) anterior to the S-E pore and nerve ring. S-E pore at 10.2 (3.2 – 14) μ m from CP2, in 21 (12 – 28) μ m from CP1. Shape of spicules mainly straight, except for a slight bend proximally and at distal tip; manubrium short, slightly marked; shaft striated, and the spicule length 45 ρ 3.1 (41 – 50) μ m. Three preloocal supplement present, of which the posterior supplement clearly within the region of the retracted spicules.

Hosts and distribution:

Three populations of *T. nanjingensis* Liu & Cheng, 1990 were collected from the rhizosphere of bamboo (*Bambusa glaucescens* var. *riviereorum*) and Chinese mulberry (*Morus cathayana*) growing at Hangzhou, and apple at Beijing, of which bamboo and Chinese mulberry are new hosts for the species (Decraemer, 1995). Also, this represents the first record of the species occurring in Zhejiang Province.

Trichodorus pakistanensis Siddiqi, 1962 (Fig. 2.)

Measurements:

See Table 3.

Description:

Female: Body straight or slightly curved ventrally upon fixation. No dorsal intestinal overlap, or subventral to ven-

Table 2. Morphometrics of male of *Trichodorus nanjingensis* from three Chinese populations (all measurements in μm)

Population	Hangzhou	Hangzhou	Beijing
Host	Bamboo	Mulberry	Apple
n	7	10	8
Body length	865 \pm 56.2 (800 – 933)	1043 \pm 63 (993 – 1073)	849.0 \pm 57 (753 – 920)
Body width	34 \pm 2.9 (29 – 37)	40 \pm 5.0 (37 – 48)	42 \pm 3.4 (37 – 48)
Pharynx	173 \pm 10.1 (157 – 184)	160 \pm 11.7 (139 – 176)	145 \pm 18.7 (110 – 158)
Onchiostyle	49 \pm 3.9 (45–56)	48 \pm 3.8 (41 – 53)	46 \pm 2.8 (42 – 50)
Ant. end to S-E pore	119 \pm 6.6 (115 – 128)	123 \pm 7.8 (112 – 133)	116 \pm 6.8 (106 – 126)
CP1 to CP2	11 \pm 1.7 (9 – 14)	10 \pm 2.9 (7.1 – 13)	12 \pm 2.0 (9.7 – 14)
CP2 to S-E pore	10 \pm 4.6 (3.2 – 14)	10 \pm 2.6 (7.7 – 13)	19 \pm 7.0 (11 – 30)
a	26 \pm 4.0 (22 – 32)	27 \pm 2.5 (22 – 31)	21 \pm 2.2 (19 – 24)
b	4.9 \pm 0.4 (4.6 – 5.6)	6.6 \pm 0.5 (5.6 – 7.2)	5.9 \pm 0.6 (5.3 – 6.8)
T	59 \pm 2.8 (56 – 64)	64 \pm 4.1 (56 – 70)	65 \pm 3.4 (59 – 68)
Spicules	45 \pm 3.1 (41 – 50)	47 \pm 2.0 (45 – 50)	46 \pm 1 (44 – 47)
Gubernaculum	25 \pm 1.3 (24 – 26)	20.1 \pm 1.7 (17 – 21)	22 \pm 1.2 (21 – 24)
Cloaca to SP1	27 \pm 3.0 (24 – 32)	28.9 \pm 2.5 (26 – 33)	28 \pm 2.2 (26 – 32)
SP1 to SP2	32 \pm 7.8 (21 – 43)	32 \pm 6.3 (25 – 43)	35 \pm 2.6 (37 – 39)
SP2 to SP3	40 \pm 12.2 (23 – 50)	44.8 \pm 10 (33 – 65)	48 \pm 4.4 (43 – 55)

tral overlap, of the pharynx. Excretory pore at the level of the isthmus. Reproductive system didelphic-amphidelphic, each with an oval shaped spermatheca, often filled with sperm. Vaginal sclerotized pieces small, rounded to oval, vulva a transverse slit, with a short barrel-shaped vagina.

Male: General appearance typical of the genus. Body long, posterior end curved ventrally. Lip region with distinct labial papillae. Cuticle slightly to clearly swollen after fixation, with the body length 0.7 to 1.06 mm, and onchiostyle 43 to 57 μm . Pharyngeal bulb offset, three ventromedian cervical papillae, two anterior and one posterior to the S-E pore; a pair of lateral cervical pores near the level of the middle ventromedian cervical papilla. With the three ventromedian precloacal supplements, only the posterior supplement clearly within the region of the retracted spicules. The spicules cephalated, shaft with proximal part dorsally convex, distal half almost straight, with obvious striae except for a short, smooth mid-part. Tail obtusely rounded, terminal cuticle not thickened.

Hosts and distribution:

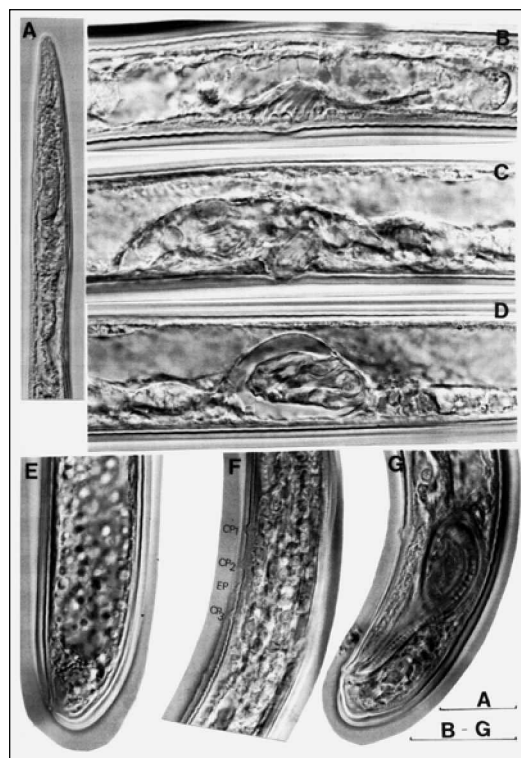


Fig. 2. Photomicrographs of *Trichodorus pakistanensis* from bamboo

A – female anterior; B–D – female vaginal region; E – female tail; F – part of male anterior showing the position of S–E pore (EP) and ventromedian cervical papillae (CP); G – mail tail.
(Scale bars: A – 50 μm ; B–G – 30 μm)

Two populations of *T. pakistanensis* were recovered from the rhizosphere of *Metasequoia glyptostroboides* and bamboo growing at Hangzhou, Zhejiang. These two hosts are new for *T. pakistanensis* (Decraemer, 1995).

Paratrichodorus porosus (Allen, 1957) Siddiqi, 1974 (Fig. 3.)

Measurements:

Females: See Table 4.

Male: Not found

Description:

Female: Body straight upon fixation. Pharyngeal bulb usually with a well developed anterior-dorsal intestinal overlap, bulb rarely offset. S-E pore between nerve ring and anterior end of pharyngeal bulb. Ventromedian body pores located prevulvar and postvulvar (usually two anterior and two posterior to vulva), lateral body pores absent. No differentiated spermathecae, rarely sperm in uteri, vagina short, wide, rounded, rectangular. Vaginal sclerotizations small, clearly observable as slightly separated oval pieces.

Host and distribution:

P. porosus is a widespread species, having been reported to occur more than ten countries, and associated with almost

Table 3. Morphometrics of two *Trichodorus pakistanensis* populations from Hangzhou, China (all measurements in μm)

Population/host n	Bamboo 10 (females)	<i>M. glyptostroboides</i> 8 (females)	Bamboo 14 (males)	<i>M. glyptostroboides</i> 7 (males)
Body length	884 \pm 114 (704 – 1064)	880 \pm 86 (800 – 1024)	859 \pm 94 (746 – 1100)	845 \pm 16 (825 – 864)
Body width	41 \pm 5.6 (32 – 53)	39 \pm 3.1 (37 – 43)	35 \pm 2.4 (31 – 39)	36 \pm 1.9 (34 – 38)
Pharynx	152 \pm 13.4 (131 – 176)	153 \pm 20.6 (133 – 181)	158 \pm 15.6 (131 – 184)	165 \pm 16.3 (143v181)
Onchiostyle	47 \pm 3.6 (43 – 52)	52 \pm 3.3 (49 – 57)	49 \pm 3.7 (43 – 57)	46 \pm 1.7 (43 – 48)
Ant. end to S-E Pore	125 \pm 16.1 (110 – 142)	100 \pm 3.3 (98 – 102)	112 \pm 12.5 (88 – 125)	94 \pm 6.4 (86 – 101)
CP1 to CP2	–	–	13 \pm 2.6 (7.7 – 14)	10 \pm 1.4 (8 – 12)
CP2 to CP3	–	–	12 \pm 3.2 (7.1 – 15)	13 \pm 2.7 (9.7 – 16)
CP3 to SE pore	–	–	10 \pm 4.1 (3.9 – 14)	8.5 \pm 3.7 (4.5 – 13)
a	23 \pm 1.7 (21 – 26)	23 \pm 0.5 (23 – 24)	24 \pm 2.8 (20 – 30)	24 \pm 1.2 (22 – 25)
b	5.8 \pm 1.1 (4.6 – 7.5)	5.7 \pm 0.4 (5.3 – 6.3)	5.6 \pm 0.8 (4.6 – 7.3)	5.1 \pm 0.6 (4.5 – 5.8)
T (V %)	54 \pm 2.4 (49 – 57)	54 \pm 1.8 (51 – 56)	60 \pm 5.9 (46 – 67)	58 \pm 4.2 (53 – 64)
Spicules	–	–	50 \pm 2.6 (47 – 55)	51 \pm 1.5 (49 – 53)
Gubernaculum	–	–	20 \pm 2.5 (16 – 24)	24 \pm 0.9 (24 – 25)
cloaca to SP1	–	–	40 \pm 5.3 (32 – 52)	42 \pm 9.1 (34 – 57)
SP1 to SP2	–	–	40 \pm 6.1 (34 – 53)	52 \pm 10.9 (48 – 91)
SP2 to SP3	–	–	48 \pm 12.2 (30 – 55)	45 \pm 11.9 (27 – 53)

Table 4. Morphometrics of female of two *Paratrachodorus porosus* populations from Zhejiang, China (all measurements in μm)

Population n	<i>Camellia japonica</i> 10		Oriental cherry 8	
Body length	709 \pm 40.8	(640 – 768)	677 \pm 51.5	(592 – 752)
Body width	36 \pm 4.4	(30 – 41)	35 \pm 3.8	(30 – 41)
Pharynx	149 \pm 16	(123 – 170)	124 \pm 7.2	(109 – 133)
Ochiostyle	52 \pm 6.8	(44 – 63)	50 \pm 1.7	(48 – 52)
Ant. end to S-E pore	99 \pm 13.7	(91 – 123)	87 \pm 9.5	(80 – 97)
Ant. Genital branch	152 \pm 13.7	(101 – 176)	166 \pm 25.4	(133 – 202)
Post genital branch	126 \pm 17.4	(106 – 146)	166 \pm 18	(138 – 192)
a	20 \pm 3.0	(16 – 25)	19 \pm 2.2	(17 – 23)
b	4.8 \pm 0.3	(4.3 – 5.3)	5.5 \pm 0.4	(4.7 – 5.8)
V%	53 \pm 1.4	(51 – 55)	54 \pm 1.5	(52 – 56)
Length of vagina	7.8 \pm 1.6	(6.5 – 10)	7.4 \pm 1.5	(6.1 – 9.9)
Size of vaginal pieces	1.3 \pm 0.1	(1.2 – 1.6)	1.2 \pm 0.1	(1.1 – 1.4)

100 host plant species (Decraemer, 1995). Seven populations of *P. porosus* from Fuyang, Zhejiang, including five from the rhizosphere of *Camelliae japonica*, one from *Li-*

gustrum lucidum, and one from oriental cherry (*Prunus serrula*), were collected during the survey. *L. lucidum* and oriental cherry are new host records for *P. porosus*.

Natural association of trichodorid nematodes from China with virus

Specimens of the three trichodorid nematode species, *T. nanjingensis*, *T. pakistanensis*, and *P. porosus*, from the different host plants were used in bait-tests, but *Tobravirus* was not found (Table 5).

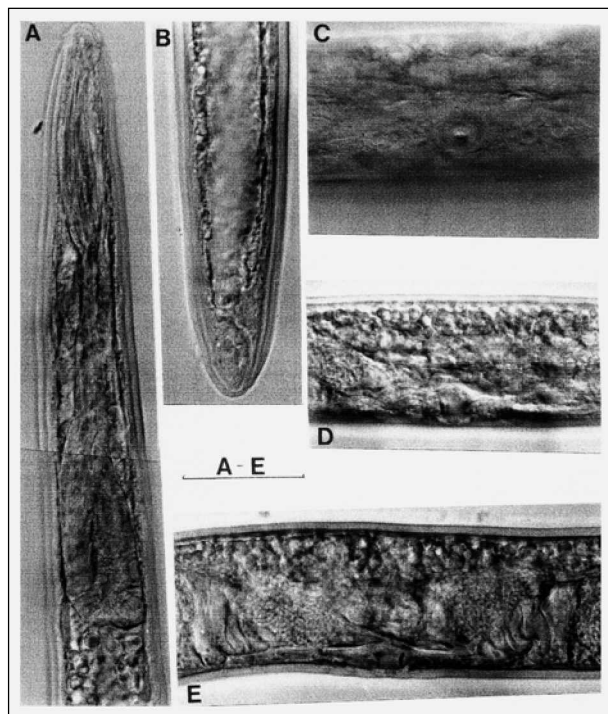


Fig. 3. Photomicrographs of *Paratrichodorus porosus* from *Camellia japonica*

A – female anterior; B – female tail; C – female vulva, ventral view; D-E – female vaginal region. (Scale bar: 30 μ m)

Discussion

The three trichodorid species identified during the survey each represent first records from Zhejiang, a southeast coastal province of China. Bamboo (*Bambusa glaucescens* var. *riviereorum*) and Chinese mulberry (*Morus cathayana*) are new hosts for *T. nanjingensis*; *Metasequoia glyptostroboides* and bamboo are new hosts for *T. pakistanensis*; and *Ligustrum lucidum* and oriental cherry (*Prunus serotina*) are new hosts for *P. porosus*.

The only record of a *Tobravirus* being transmitted by a trichodorid species in China is by Zheng *et al.* (1990), who reported that tobacco rattle virus infecting *Narcissus tazetta* cv. *chinensis* in fields in Fujian was transmitted by an unidentified *Trichodorus* species. Of the three trichodorid species reported here only *P. porosus* has been reported as a vector of a *Tobravirus* in North America (Weischer & Brown, 2000). Virus bait-testing of populations of the three species identified during the present study did not reveal any association of the nematodes with a *Tobravirus*, however, to determine if populations of these species occurring in China can transmit *Tobravirus* requires further study.

Acknowledgements

This study was part of an Anglo-Chinese collaborative research project sponsored by the Royal Society, London. Financial assistance provided by the Royal Society and the National Natural Science Foundation of China (30270165) is gratefully acknowledged.

References

BROWN, D. J. F., BOAG, B. (1988): An examination of methods used to extract virus-vector nematodes (Nematoda: Longidoridae and Trichodoridae) from soil samples. *Nematol. medit.*, 16: 93 – 99

Table 5. Total numbers of trichodorid nematodes virus bait-tested, number of nematodes recovered from bait-plants, and virus recovered from bait plants

Nematode species	Original host	Nematodes added per plant	Number of bait-plants	Nematodes recovered per plant (mean)	Virus detected
<i>T. nanjingensis</i>	Mulberry	1	50	0.7	0
		5	30	4.3	0
	Bamboo	1	35	0.8	0
		5	16	3.9	0
<i>T. pakistanensis</i>	Bamboo	1	45	0.6	0
	<i>M. glyptostroboides</i>	5	17	4.1	0
<i>P. porosus</i>	<i>C. sasanqua</i>	1	4	0.8	0
		1	76	0.7	0
	Oriental cherry	5	24	4.4	0
		5	9	3.9	0

- BROWN, D. J. F., PLOEG A. T., ROBINSON D. J. (1989): A review of reported associations between *Trichodorus* and *Paratrichodorus* species (Nematoda: Trichodoridae) and tobnaviruses with a description of laboratory methods for examining virus transmission by trichodorids. *Rev. Nematol.*, 12: 51 – 56
- DECRAEMER, W. (1995): *The family Trichodoridae: stubby root and virus vector nematodes*. Kluwer Academic Publishers, Dordrecht, Boston, London
- LIU, R., CHENG, H. (1990): Occurrence of trichodorid species (Nematoda: Trichodoridae) in China. *J. Nanjing Agric. Univ.*, 13: 50 – 54
- TAYLOR, C. E., BROWN, D. J. F. (1997): *Nematode vectors of Plant viruses*. CAB INT., Wallingford, UK
- WANG, S., CHIU, W. F., YU, C., LI, C., ROBBINS, R. T. (1996): The occurrence and geographical distribution of longidorid and trichodorid nematodes associated with vineyards and orchards in China. *Russ. J. Nematol.*, 4: 145-153
- WEISCHER, B., BROWN, D. J. F. (2000): *An Introduction to Nematodes: General Nematology a student's textbook*. Pensoft Publishers, Sofia
- XU, J., DECRAEMER, W. (1995): *Trichodorus* species from China, with a description of *T. paracedarus* n. sp. (Nematoda: Trichodoridae). *Fund. appl. Nematol.*, 18: 455 – 464
- ZHENG, X., LI, Q., XIE, L. (1990): The identification of tobacco rattle virus isolated from Narcissus in Fujian. *J. Fujian Agric. Coll.*, 19: 58 – 63
- XIE, H., FENG, Z. (1996): Identification of the species of genus *Paratrichodorus* Siddiqi, 1974 (Nematota: Trichodoridae) from Hong Kong. *J. S. China Agric Univ.*, 17: 70–73
- XIE, H., FENG, Z., ZHAO, L. (2000): Description of *Trichodorus guangzhouensis* n. sp. (Nematoda: Trichodoridae). *Acta Phytopath. Sin.*, 30: 349 – 352

RECEIVED MAY 27, 2002

ACCEPTED MAY 9, 2003

