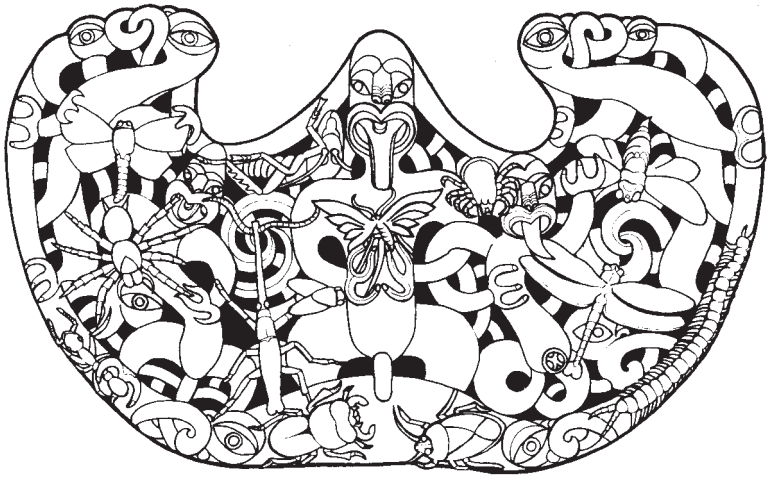


Fauna of New Zealand

Ko te Aitanga Pepeke o Aotearoa

Fauna of New Zealand
Ko te Aitanga Pepeke o Aotearoa

Number / Nama 79

Longidoridae and Trichodoridae

(Nematoda: Dorylaimida and Triplonchida)

by

Yu-Mei Xu
Agronomy College, Shanxi Agricultural University, Taigu 030801, China
Email: ymxu0310@163.com

Zeng-Qi Zhao
Manaaki Whenua - Landcare Research, 231 Morrin Road, Auckland, New Zealand
Email: ZhaoZ@landcareresearch.co.nz

Auckland, New Zealand
2019

Cataloguing in publication

Xu, Yu-Mei

Longidoridae and Trichodoridae (Nematoda: Dorylaimida and Triplonchida) / by Yu-Mei Xu, Zeng-Qi Zhao. -- Lincoln, N.Z. : Landcare Research NZ, 2019.

1 online resource

(Fauna of New Zealand, ISSN 1179-7193 (online) ; no. 79 = Ko te Aitanga Pepeke o Aotearoa ; nama 79)

ISBN 978-0-947525-66-8 (online)

ISBN 978-0-947525-65-1 (print)

1. Nematodes -- New Zealand. I. Title. II. Landcare Research New Zealand Ltd. III. Zhao, Zeng-Qi.

UDC 595.132.1 (931)

This work should be cited as:

Xu, Y.-M. & Zhao, Z.-Q. 2019. Longidoridae and Trichodoridae (Nematoda: Dorylaimida and Triplonchida). Lincoln, N.Z.: Landcare Research.

https://doi.org/10.7931/J2/FNZ.79

Prepared for publication by Zhi-Qiang Zhang and the authors using computer-based text processing, layout, and printing at Manaaki Whenua - Landcare Research, Private Bag 92170, Auckland, New Zealand.

To access on-line extracts from this series visit:

http://fnz.landcareresearch.co.nz/

Published by Manaaki Whenua - Landcare Research, P.O. Box 40, Lincoln, Canterbury, N.Z.

Website: http://www.landcareresearch.co.nz/

Printed by 3A

Cover design: Birgit Rhode

Date of publication: 4 October 2019

Publication of the Fauna of New Zealand series is supported by Core funding for Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group, for the Defining New Zealand's Land Biota research programme.

POPULAR SUMMARY

Phylum **Nematoda**
Class **Enoplea**
Order **Dorylaimida**
Superfamily **Dorylaimoidea**
Family **Longidoridae**

Phylum **Nematoda**
Class **Enoplea**
Order **Triplonchida**
Superfamily **Diphtherophoroidea**
Family **Trichodoridae**

Longidoridae and Trichodoridae are the only two families of nematodes proven to be polyphagous root-ectoparasites which can transmit plant viruses. Members of the family Longidoridae commonly include needle and dagger nematodes based on their odontostyle shape—like a needle in the subfamily Longidorinae and a dagger in the subfamily Xiphinematinae. The family Trichodoridae is commonly referred to as "stubby-root" nematodes because feeding by these nematodes can cause a stunted or “stubby” root system. The viruses associated with Longidoridae and Trichodoridae belong to different virus taxa: longidorids vector nepoviruses and trichodorids vector tobraviruses. To date, over 480 species have been described worldwide belonging to six genera, and two subfamilies, in the family Longidoridae and 109 species in six genera in the family Trichodoridae. Of these, 17 species have been reported in New Zealand. Unfortunately, only 12 of the 17 New Zealand species were available for the present study. Therefore, this monograph provides full descriptions and distributions of the 12 species, including seven species from two genera in Longidoridae and five species from three genera in Trichodoridae.

TE WHAKARĀPOPOTOTANGA

Ko ngāi Longidoridae me ngāi Trichodoridae anake ngā whānau nematode e mōhio māriretia ana he piriwaho-pakiaka, he kai i ngā momo mea maha, he kaituku huaketo tipu anō. Ko ētahi tino huānga o te whānau Longidoridae, ko ngā nematode ‘ngira me te oka’, nā runga i te niho o te hanga—me te ngira te hanga i te whānau whāiti Longidorinae, ā, me te oka te hanga i te whānau whāiti Xiphinematinae. Karangatia ai te whānau Trichodoridae he nematode “pakiaka poto”, i te mea ina kainga ngā pakiaka e ēnei nematode, ka tauwhena, ka popoto ngā pakiaka. Ko ngā huaketo e haere kōtui ana me ngāi Longidoridae rāua ko ngāi Trichodoridae, he rōpū kē, he rōpū kē: he kawe nepovirus ngā longidorid, he kawe tobravirus ngā trichodorid. Taka mai ki tēnei wā, i te whānau Longidoridae, neke atu i te 480 ngā momo kua āta whakaahutia ā-kupu, i ngā puninga e ono, i ngā whanau whāiti e rua. I te whānau Trichodoridae, e 109 ngā momo, nō ngā puninga e ono. O roto mai i ēnei, 17 ngā momo kua pūrongotia i Aotearoa. Heoi anō, tekau mā rua noa iho o ēnei momo 17 kei Aotearoa nei i wātea mai mō tēnei rangahautanga. Nō reira, ko tā tēnei tuhinga, he whakatakoto i ngā whakaahua ā-kupu paruhi me ngā kōrero mō te tītaringa o ngā momo 12, arā, mō ngā momo e 7 o ngā puninga e rua o ngāi Longidoridae, me ngā momo e rima o ngā puninga o toru o ngāi Trichodoridae.

THE CONTRIBUTORS

Contributor **Yu-Mei Xu** was born in Shanxi Province in North China. She graduated from Shanxi Agricultural University in 2002 with a Bachelor of Agricultural Science in Plant Protection and in 2005 with a Master of Agricultural Science in Plant Pathology. Since 2005, she has served as an assistant lecturer, lecturer and associated professor in Shanxi Agricultural University. She has taught courses including Plant Pathology, Turfgrass Pest Management, Horticulture Plant Pathology, and Molecular Plant Pathology. She conducted her PhD studies from 2011–2015 and received the PhD degree in Plant Pathology from Shanxi Agricultural University in 2015. Her project focused on classification and taxonomic research on longidorid and tripylid nematodes in Shanxi Province, China. From 2016 to 2017, she worked with Dr. Zeng-Qi Zhao as a visiting scientist in Landcare Research, New Zealand. So far, she has published 27 scientific papers on the classification and taxonomy of nematodes. Her main

research interests are the systematics of nematodes, especially the family Tripylidae and Longidoridae, and biological control of root-knot nematodes.

NGĀ KAITUHI

I whānau mai te kaituhi nei, a **Yu-Mei Xu** i te Takiwā o Shanxi, i te Raki o Haina. Ka whiwhi i tana Tohu Paetahi Pūtaiao Ahuwhenua mō te Tiaki Tipu i te 2002, i te Whare Wānanga Ahuwhenua o Shanxi. Ā, i te tau 2005, ko tana Tohu Kauati Pūtaiao Ahuwhenua mō ngā Tahumaero Tipu. Mai i te 2005, kua tū ia hei pūkenga whakahirihiri, hei pūkenga, hei pūkenga haere kōtui hoki i te Whare Wānanga Ahuwhenua o Shanxi. Kua whakaako i ētahi akoranga, tae atu ki: Te Mātai Tahumaero Tipu, Te Here Riha Pātītī, Te Mātai Tahumaero Tipu Ahumāra, me te Mātai Tahumaero Tipu ā-Rāpoingota. He mea kawe ake e ia ngā mahi mō tana Tohu Kairangi i te 2011–2015, ā, ka whakawhiwhia ki tana Tohu Kairangi mō te Mātai Tahumaero Tipu i te Whare Wānanga Ahuwhenua o Shanxi i te tau 2015. Ko te arotahinga, ko te rangahau i ngā whakapapa me ngā whakarōpūtanga o ngā nematode longidorid, tripylid hoki i te Takiwā o Shanxi, i Haina. Mai i te 2016 ki te 2017 he kaipūtaiao toro ia i Manaaki Whenua, Aotearoa, e mahi tahi ana ki a Tākuta Zeng-Qi Zhao. E 27 āna tuhinga pūtaiao mō ngā whakapapa me te whakarōpūtanga o ngā nematode. Ko āna whāinga rangahau matua, ko ngā tātai whakapapa nematode, mātua rā te whānau Tripylidae me te whānau Longidoridae, me te pēhi ā-koiora i ngā nematode pona-pakiaka.

Contributor **Zeng-Qi Zhao** was born in Shanxi Province in North China. He gained a Bachelor of Agricultural Science from Shanxi Agricultural University, China in 1985. After graduation, he was employed as a teacher in Shanxi Agricultural University. From 1985–1999, he was involved in teaching, research and administration in the University. He was promoted to Head Administrator of the Department of Agronomy in 1996. After arriving in Australia in 1999, he worked and studied in the School of Agriculture, Food and Wine, University of Adelaide, Australia for 7 years (in the former Department of Applied and Molecular Ecology). His PhD project focused on the taxonomy, biology, ecology and pathogenicity of above-ground nematodes in pine plantations in Australia. After receiving his PhD degree in 2006, he joined Manaaki Whenua - Landcare Research as a scientist in 2007. Since then, Zeng-Qi's primary interest has been in free living nematodes, especially the family Tripylidae, but he

retains a broad interest in Nematoda, particularly plant parasitic nematodes. As a nematologist, he has also been contracted by the Ministry for Primary Industries (MPI) for nematode identification and responses work since 2007. Zeng-Qi has published over 50 scientific papers.

NGĀ KAITUHI

I whānau mai anō hoki tērā atu kaituhi, a **Zeng-Qi Zhao** i te Takiwā o Shanxi, i te Raki o Haina. Ka whiwhi i tana Tohu Paetahi Pūtaiao Ahuwhenua i te Whare Wānanga Ahuwhenua o Shanxi i te 1985. Nō muri mai ka mahi hei kaiako ki reira. Ā, mai i te1985–1999, e tū ana hei kaiako, hei kairangahau, hei kaiwhakahaere anō hoki i taua Whare Wānanga. Nō te 1996, ka piki ki te tūranga o te Kaihautū Taha Whakahaere o te Tari Mātai Tipu Ahuwhenua. Nō te 1999 ka hūnuku a Zeng-Qi ki Ahitereiria, ā, ka whai mahi, ka noho anō hei ākonga mō te 7 tau i te Kura Ahuwhenua, Kai, Waina (ko te Tari Mātai Hauropi Whakahāngai, Rāpoingota o mua) i te Whare Wānanga o Atareta, i Ahitereiria. Ko tana Tohu Kairangi, e aro ana ki te whakarōpūtanga, te koiora, me ngā āhuatanga hauropi, tukumate o ngā nematode kei runga ake o te whenua i ngā māra paina i Ahitereiria. Ka whiwhi ia i tana tohu kairangi i te 2006, ā, i te tau i muri mai ka tūhono ki Manaaki Whenua. Mai i taua wā, ko te aronga matua a Zeng-Qi, ko ngā nematode neke noa, mātua rā te whānau Tripylidae, engari me te aro nui anō ki ngāi Nematoda nui tonu, mātua rā ngā nematode pirinoa ki te tipu. I tana tū hei kaimātai nematode, kua mahi ā-kirimana mā Te Manatū Ahu Matua (MPI) mai i te tau 2007, ko te tautohu nematode me ōna anō urupare te mahi. Kua hipa ake i te 50 ngā tuhinga pūtaiao a Zeng-Qi.

Māori translation by Hēni Jacob

ABSTRACT

Longidoridae (Nematoda: Dorylaimida) and Trichodoridae (Nematoda: Triplonchida) are commonly known as plant-parasitic nematodes, and some can transmit plant viruses. Within these two families, 17 species have been reported from New Zealand, of which, 12 species belonging to five genera are studied here. These include four *Longidorus* species and three *Xiphinema* species in the Longidoridae; one *Nanidorus* species, two *Paratrichodorus* species and two *Trichodorus* species in the Trichodoridae.

For each species, detailed descriptions, morphometrics and illustrations of the female, males and juveniles (if available) are given. Distribution, habitat and maps of the collection localities in New Zealand are presented. A differential diagnosis to distinguish each from other species is presented. Sequences of SSU and D2–D3 of LSU molecular characterisation and phylogenetic relationship trees are provided for four species. The plant viruses transmitted by five of the species are provided. Keys to all taxa including family, subfamily and genus for the 12 species are provided.

Of the 12 species, *Longidorus elongatus, Xiphinema brevicolle, X. diversicaudatum* and *Nanidorus minor* are the most common and widespread species. *Longidorus orongorongensis* and *Trichodorus cottieri* appear to be endemic species; *L. taniwha*, *Paratrichodorus lobatus* and *X. waimungui* are also indigenous to New Zealand.

Keywords: Nematoda, nematodes, Longidoridae, Trichodoridae, New Zealand, classification, distribution, species, fauna

http://www.zoobank.org/urn:lsid:zoobank.org:pub:E3DA6DE9-85C4-4A3D-875D-BEF5D032922A

Accepted by Zhi-Qiang Zhang: 17 September 2019; published: 4 October 2019

CHECKLIST OF TAXA

CONTENTS

INTRODUCTION

Longidoridae (Thorne, 1935) Meyl, 1961 and Trichodoridae (Thorne, 1935) Siddiqi, 1961 are the only families of nematodes within the Class Enoplea Inglis, 1983 known to be plant-parasitic nematodes, and some of the species can transmit plant viruses. The Longidoridae are classified within the subclass Dorylaimia Inglis, 1983 (order Dorylaimida Pearse, 1942, superfamily Dorylaimoidea De Man, 1876), while the Trichodoridae belong to the subclass Enoplia (order Triplonchida Cobb, 1920, superfamily Diphtherophoroidea Micoletzky, 1922) (Decraemer & Robbins 2007).

The family Longidoridae includes about 480 species in seven genera and two subfamilies, and they can cause damage to an extensive range of crop plants by their direct feeding on plant root cells, resulting typically in stunted plant growth with concomitant yield reduction (Decraemer & Robbins 2007). Four species in Longidoridae are listed as A1 and A2 quarantine pests by the European and Mediterranean Plant Protection Organisation (EPPO, www.eppo.int/QUARANTINE/). Eleven *Longidorus*, one *Paralongidorus* and nine *Xiphinema* are of potentially greater economic importance because they can transmit 13 nepoviruses (nematode-transmitted virus with polyhedral particles) (Table 1), leading to diseases in a wide range of fruit and vegetable crops (Archidona-Yuste *et al.* 2016a; Brown *et al.* 1995; Brown *et al.* 2004; Decraemer & Chaves 2012; Decraemer & Robbins 2007; Gutiérrez-Gutiérrez *et al.* 2013a, b; Peneva *et al.* 2012; Taylor & Brown 1997). Among these nepoviruses, 11 plant viruses are in the list of Biosecurity Organisms Register for Imported Commodities (BORIC) and considered as regulated organisms by Ministry for Primary Industries (MPI) in New Zealand[1].

The family Trichodoridae includes 109 species and one subspecies in six genera (Asghari *et al.* 2018; Decraemer & Geraert 2013; Decraemer & Robbins 2007), and feeding by these can cause cessation of root elongation and an abbreviated or "stubby" root system termed stubby root disease (Cooke 1973). Four *Trichodorus* species and seven *Paratrichodorus* and two *Nanidorus* (Table 1) have been reported to transmit three tobraviruses (nematode-transmitted tubular particles), including *Tobacco rattle virus* (TRV), *Pea early browning virus* (PEBV) and *Pepper ringspot virus* (PepRSV) (Brown *et al.* 1989, 1995; Decraemer & Robbins 2007; Ploeg & Brown 1995). TRV and PepRSV are in the BORIC list and considered as regulated organisms by MPI in New Zealand.

1. https://www.biosecurity.govt.nz/news-and-resources/resources/registers-and-lists/biosecurity-organisms-register-for-imported-commodities (updated 28 May 2019).

Table 1. Plant viruses transmitted by Longidoridae and Trichodoridae.

PLANT VIRUS	NEMATODE	REFERENCE
Nepoviruses		
Arabis mosaic virus (AMV)	**L. caespiticola*	Valdez 1972
	**X. bakeri*	Iwaki & Komuro 1974
	**X. coxi*	Fritzsche & Thiele 1979
	X. diversicaudatum	Brown 1986; Brown & Trudgill 1983; Jha &Posnette 1959, 1961; Harrison & Cadman 1959; Harrison & Winslow 1961; Taylor & Thomas 1968; Valdez *et al.* 1974
	**X. index*	Fritzsche & Thiele 1979
#*Artichoke Italian latent virus* (AILV)	*L. apulus*?	Rana & Roca 1973
	L. fasciatus	Roca & Lamberti 1981
#*Cherry rasp leaf virus* (CRLV)	*X. californicum*	Brown & Halbrendt 1992; Brown *et al.* 1994a
	X. rivesi	Brown & Halbrendt 1992
Cherry rosette virus (CRV)	*L. arthensis*	Brown *et al.* 1994b
	X. californicum	Brown *et al.* 2004
	X. rivesi	Brown *et al.* 2004
#*Grapevine chrome mosaic virus* (GCMV)	**X. index*	Mali *et al.* 1975
Grapevine fanleaf virus (GFLV)	*X. index*	Hewitt *et al.* 1958; Harrison, 1961, 1964; Cadman, 1963; Taylor & Brown, 1997; MacFarlane 2003
	X. italiae	Cohn *et al.* 1970; Širca *et al.* 2010
	**X. vuittenezi*	Rüdel 1985
#*Mulberry ringspot virus* (MRSV)	*L. martini*	Yagita & Komuro 1972
#*Peach rosette mosaic virus* (PRMV)	*L. breviannulatus*	Allen 1986
	L. diadecturus	Eveleigh & Allen 1982
	L. elongatus	Allen & Ebsary 1988
#*Raspberry ringspot virus* (RRSV)	**L. caespiticola*	Valdez 1972
	L. elongatus	Harrison 1964; van der Meer 1965; Taylor 1962; Taylor & Murant 1969
	**L. leptocephalus*	Valdez 1972
	L. macrosoma	Harrison 1964
	**L. profundorum*	Fritzsche & Kegler 1968
	P. maximus	McElroy *et al.* 1977; Jones *et al.* 1994; Brown *et al.* 2004
	**X. diversicaudatum*	Fritzsche & Kegler 1968; Valdez 1972
Strawberry latent ringspot virus (SLRSV)	**X. coxi*	Putz & Stocky 1970
	X. diversicaudatum	Lister 1964; Brown 1985; Brown *et al.* 2004; Brown & Trudgill 1983; Taylor & Thomas 1968
	**P. maximus*	McElroy *et al.* 1977
^*Tobacco ringspot virus* (TRSV)	*X. bricolensis*	Brown & Halbrendt 1992
	X. californicum	Brown & Halbrendt 1992
	**X. coxi*	van Hoof 1971
	X. intermedium	Brown *et al.* 2004
	X. rivesi	Brown & Halbrendt 1992; Forer *et al.* 1984; Širca *et al.*, 2007
	X. tarjanense	Brown *et al.* 2004
Tomato black ring virus (TBRV)	*L. attenuatus*	Harrison 1964
	L. elongatus	Harrison *et al.* 1961; Taylor & Murant 1969; van der Meer 1965
	X. bricolensis	Brown *et al.* 2004
	X. californicum	Brown *et al.* 2004; Hoy *et al.* 1984
	X. intermedium	Brown *et al.* 2004

..... *continued on the next page*

Table 1 (continued).

PLANT VIRUS	NEMATODE	REFERENCE
	X. tarjanense	Brown *et al.* 2004
	X. rivesi	Brown *et al.* 2004
#*Tomato ringspot virus* (ToRSV)	**X. brevicolle*	Fritzsche & Kegler 1968
	**X. bricolensis*	Graham *et al.* 1988; Brown & Halbrendt 1992
	X. californicum	Hoy *et al.* 1984; Brown *et al.* 1993
	X. rivesi	Forer & Stouffer 1981; Širca *et al.* 2007
Other Viruses		
#*Brome mosaic virus* (BMV)	**L. breviannulatus*	Huff *et al.* 1987
	**L. macrosoma*	Fritzche 1968
	**X. coxi*	Schmidt *et al.* 1963
	**X. diversicaudatum*	Schmidt *et al.* 1963
Carnation ringspot virus (CRSV)	**L. elongatus*	Fritzsche *et al.* 1979
	**L. macrosoma*	Fritzsche 1968
	**X. diversicaudatum*	Fritzsche & Schmelzer 1967
#*Cowpea mosaic virus* (CPMSV)	**X. basiri*[②]	Caveness *et al.* 1975
Euonymus mosaic virus (EuoMV)	**L. euonymus*	Mali & Hooper 1973
Pear stoney pit virus	**L. macrosoma*	Kegler *et al.* 1976
^*Prunus necrotic ringspot virus* (PNRSV)	**L. macrosoma*	Fritzsche 1968
Spoon leaf virus (SLV)	*L. elongatus*	van der Meer 1965
Tobravirus		
^*Tobacco rattle virus* (TRV)	*N. minor*	Ayala & Allen 1968; Brown & Trudgill 1998; Komuro *et al.* 1970; Walkinshaw *et al.* 1961
	N. nanus	Cooper & Thomas 1970
	P. allius	Jensen & Allen 1964
	P. anemones	Brown & Trudgill 1998
	P. hispanus	Brown & Trudgill 1998
	P. divergens	Decraemer & Robbins 2007; de Almeida *et al.* 2005
	P. pachydermus	Sol & Seinhorst 1961; Brown & Trudgill 1998
	P. porosus	Ayala & Allen 1968; Barriga 1965; Chevres-Roman *et al.* 1971
	P. teres	Van Hoof 1964; Brown & Trudgill 1998
	P. tunisiensis	Roca & Rana 1981; Brown & Trudgill 1998
	T. cylindricus	Brown *et al.* 1989; Ploeg *et al.* 1992a
	T. primitivus	Harrison 1961; Mowat & Taylor 1962; Ploeg *et al.* 1992b
	T. similis	Brown *et al.* 1996; Brown & Trudgill 1998
	T. viruliferus	Roca *et al.* 1977; Brown & Trudgill 1998
#*Pepper ringspot virus* (PepRSV)	*N. minor*	Salomao 1973
Pea early browning virus (PEBV)	*P. anemones*	Brown & Trudgill 1998
	P. pachydermus	Van Hoof 1962
	P. teres	Brown & Trudgill 1998; Van Hoof 1962
	T. cylindricus	Brown & Trudgill 1998
	T. primitivus	Harrison 1966; Brown & Trudgill 1998
	T. viruliferus	Brown & Trudgill 1998

① Species originally identified as *L. attenuatus* and redescribed as *L. apulus* by Lamberti & Bleve-Zacheo (1977)

② Nematodes species originally identified as *X. ifacolum* but subsequently identification corrected to *X. basiri* (M. Luc, in litt.)

* indicates virus and vector association which do not fulfil the criteria published by Trudgill *et al.* (1983) for assessing the transmission of nepoviruses.

# indicates virus is regulated biosecurity organisms register for imported commodities in New Zealand.

^ some strains of virus are regulated biosecurity organisms register for imported commodities in New Zealand.

Traditional identification of the species of Longidoridae and Trichodoridae is problematic because of their high intra-specific morphological variability, which can lead to considerable overlap of many characteristics and ambiguous interpretation (Archidona-Yuste *et al.* 2016a; He *et al.* 2005). Molecular markers and DNA sequences have been applied as useful diagnostic tools in resolving the problems. Currently, the sequences of the D2–D3 of LSU rDNA, ITS and COX1 (protein-coding mitochondrial gene cytochrome c oxidase subunit 1) genes are considered widely as good markers for species identification (Palomares-Rius *et al.* 2017). Several studies conducted with SSU rRNA gene sequences were also attempted, but this gene did not provide taxonomic clarity among Longidoridae since it apparently evolves too slowly to be useful as a marker for phylogenetic studies at the species level (Gutiérrez-Gutiérrez *et al.* 2010; Oliveira *et al.* 2004; Zasada *et al.* 2014).

As virus-transmitting nematodes, Longidoridae and Trichodoridae are both biosecurity and market access issues for New Zealand. The first record of a nematode from these two families from New Zealand was *Trichodorus cottieri* Clark, 1963 (based on the accepted publication date, although *Longidorus taniwha* Clark, 1963 and *T. cottieri* were both reported in 1963 by Clark (1963a, b)). Since then, 15 additional species of longidorids and trichodorids have been described or recorded (Clark 1963b, c; Dale 1971, 1972; Grandison 1991; Hay & Close 1992; Shah *et al.* 2009; Thomas & Procter 1972; Yeates 1967, 1973, 2010; Yeates *et al*. 1992; Yeates & Prestidge 1986). These include: *Longidorus elongatus* (de Man, 1876) Thorne & Swanger, 1936, *L. orongorongensis* Yeates, van Etteger & Hooper, 1992, *L. waikouaitii* Yeates, Boag & Brown, 1997, *Nanidorus minor* (Colbran, 1956) Siddiqi, 1974, *Paratrichodorus allius* (Jensen, 1963) Siddiqi, 1974, *P. lobatus* (Colbran, 1965) Siddiqi, 1974, *P. pachydermus* (Seinhorst, 1954) Siddiqi, 1974, *P. porosus* (Allen, 1957) Siddiqi, 1974, *Trichodorus christiei* Allen, 1957, *T. primitivus* (de Man, 1880) Micoletzky, 1922, *Xiphinema americanum* Cobb, 1913, *X. brevicolle* Lordello & da Costa, 1961, *X. diversicaudatum* (Micoletzky, 1927) Thorne, 1939, *X. krugi* Lordello, 1955, *X. radicicola* Goodey, 1936 and *X. waimungui* Yeates, Boag & Brown, 1997. Of these 17, *X. brevicolle* was the only species studied for which molecular sequences from New Zealand were available (Shah *et al*. 2009).

There has been limited research on Longidoridae and Trichodoridae in New Zealand (Dale 1971; Shah *et al*. 2009; Sturhan *et al.* 1997). Only five species had full descriptions and the other 12 were missing information on their taxonomic status, i.e., identifications, distribution and host associations. Unfortunately, only 12 species with material and samples were available for this study. This monograph combines 12 species together with species descriptions, host associations, and diagnostic keys. Four of the twelve species were analysed with SSU, D2–D3 of LSU and ITS1 (if available) rRNA sequences are compared their closely related species; the other eight species descriptions are based only on morphological characters, and include five based on the type population deposited in the National Nematode Collection of New Zealand (NNCNZ). For each species, detailed descriptions including morphometrics and illustrations of the female, males and juveniles (if available) are given. Distribution, habitat, and maps of the collection localities in New Zealand are presented. A differential diagnosis to distinguish each from the other species is presented. Keys to all taxa including family, subfamily, and genera covered for the 12 species are provided.

MATERIALS AND METHODS

Nematode sampling, extraction and processing. More than 325 nematodes, including 147 females (five holotype females), 18 males, and 160 juveniles, mounted on 150 slides deposited in from the National Nematode Collection of New Zealand (NNCNZ), the Nematology Collection of MPI, and the Nematology Collection of AsureQuality, New Zealand, were examined using an interference contrast microscope with an attached camera (Nikon Eclipse 90*i*, Japan). For newly collected material, nematodes were extracted from soil samples using the tray method of Whitehead & Hemming (1965), hand-picked and fixed with hot 3% formalin for 48 h. They were gradually transferred to glycerol and mounted onto permanent slides for morphological study (Davies & Giblin-Davis 2004; Hooper 1986; Seinhorst 1959). Measurements were made using NIS Elements BR 3.1 (Nikon, Japan). Drawings were made using a drawing tube Y-IDT (Nikon, Japan).

Body length was measured along the mid-line. Maximum body diameter was measured at the vulval region for females and at mid-body length for males, respectively. Spicules were measured along the median line. De Man's (1880) Indices were determined as follows: a=total body length divided by greatest body diameter; b=total body length divided by distance from anterior end to posterior of pharynx (including pharyngeal-intestinal glands); c =total body length divided by tail length; c'=tail length divided by body diameter at anus or cloaca; V=anterior end to vulva as a percentage of total body length; T=cloaca to testis end as a percentage of body length. The morphometrics are shown in the tables as mean and standard deviation (range).

Geographical codes. The two letter geographical codes of Crosby *et al.* (1998) are used to define collection areas in New Zealand, which refer to specific regions: AK—Auckland, BP—Bay of Plenty, BR—Buller, CL—Coromandel, CO—Central Otago, DN—Dunedin, FD—Fiordland, GB—Gisborne, HB—Hawkes Bay, KA—Kaikoura, MB—Marlborough, MC—Mid Canterbury, MK—Mackenzie, NC—North Canterbury, ND—Northland, NN—Nelson, OL—Otago Lakes, RI—Rangitikei, SC—South Canterbury, SD—Marlborough Sounds, SI—Stewart Island, SL—Southland, TK—Taranaki, TO—Taupo, WA—Wairarapa, WD—Westland, WI—Wanganui, WN—Wellington, WO—Waikato.

DNA extraction. A single nematode was hand-picked from a living nematode suspension for DNA extraction, and several other nematodes of apparently the same species were also individually put into tubes containing DNA extraction suspension (10µl ddH_2O, 8µl worm lysis buffer and 2µl proteinase K) and stored at –20°C for future DNA extraction. Total genomic DNA from a single nematode was extracted using worm lysis buffer containing proteinase K (Williams *et al*. 1992; Zheng *et al.* 2002). DNA extracts were stored at –4°C until used as PCR template. More details are given in Zhao & Buckley (2009).

Polymerase chain reaction (PCR), PCR product purification and DNA sequencing. Two pairs of primers for SSU amplification were used: first forward primer 1096F (5′-GGT AAT TCT GGA GCT AAT AC-3′) and reverse primer 1912R (5′-TTT ACG GTC AGA ACT AGG G -3′); and second forward primer 1813F (5′-CTG CGT GAG AGG TGA AAT-3′) and reverse primer 2646R (5′-GCT ACC TTG TTA CGA CTT TT-3′) (Holterman *et al*. 2006). Primers for D2-D3 of LSU amplification were: forward primer D2A (5′-ACA AGT ACC GTG AGG GAA AGT TG-3′) and reverse primer D3B (5′-TGC GAA GGA ACC AGC TAC TA-3′) (Nunn 1992). Primers for ITS1 amplification were forward primer ITS5 (5'-GGA AGT AAA AGT CGT AAC AAG G-3') (White *et al*. 1990) and reverse primer ITS26 (5'-ATA TGC TTA AGT TCA GCG GGT-3') (Howlett *et al*. 1992). PCR was performed in a 20 µl PCR mixture containing 10 µl Go Tag® Green Master Mix (Promega), 1 µl (2 µM) each of forward and reverse primers, 2 µl of DNA template and 6 µl ddH_2O. The thermal cycling program was as follows: denaturation at 95°C for 3 min, followed by 30 cycles of denaturation at 94°C for 30 sec, annealing at 55°C for 30 sec and extension at 72°C for 45 sec. A final extension was performed at 72°C for 10 min. PCR products were purified by Wizard® SV gel and PCR Clean-up System (Promega Corporation, Madison, WI, USA).

Purified DNA PCR products were cycle sequenced in both directions with the appropriate primers using Bigdye Terminator Ready Reaction Mix v3.1 (Applied Biosystems, USA). Sequences were obtained using a 3130xl genetic analyzer (Applied Biosystems, USA) and assembled and edited with Sequencher 4.8 (Gene Codes Corp.). Each sequence was confirmed by sequencing at both directions.

Sequence alignment and phylogenetic inference. Published sequences were obtained from GenBank and included in the phylogenetic analyses. Nematode species and GenBank accession numbers are listed for each taxon in the phylogenetic trees. DNA sequences were aligned in Clustal X (Thompson *et al*. 1997) using the multiple alignment method with default parameter values. The jModelTest 2.1.4 (Darriba *et al*. 2012; Guindon & Gascuel 2003) software was used to select the best fit model of DNA evolution with the Akaike Information Criterion (AIC). A Bayesian tree was obtained using MrBayes V3.1.2 (Ronquist & Huelsenbeck 2003). Four heated chains were run for 5,000,000 generations under the best-fit model. Prior distributions were as follows: revmatpr (dirichlet=1,2,1,1,2,1), statefreqpr (dirichlet=1,1,1,1), brlenspr (exponential=10), shapepr (exponential=5), pinvarpr (uniform=1–10) and topologypr (uniform). The thinning interval and burn in were 1,000 and 500,000 respectively. This analysis was repeated twice and results compared between runs to ensure that convergence was reached. The posterior probabilities for nodes were taken from summarizing the output set of trees (Larget & Simon 1999).

SYSTEMATICS

Key to Longidoridae and Trichodoridae

1 Body 1.5 to 12 mm long; stylet including elongated odontostyle and odontophore, sometimes with three strong, basal flanges; three pharyngeal glands..... Longidoridae
- Body 0.5 to 1.5 mm long; stylet including onchiostyle and onchiophore, onchiostyle distally solid, dorsally convex; five pharyngeal glands ..... Trichodoridae

Family LONGIDORIDAE (Thorne, 1935) Meyl, 1961

Diagnosis: (Adapted from Hunt 1993). Dorylaimoidea. Long to very long, slender nematodes ranging from 1.5 to 12 mm in length. Cuticle smooth. Cephalic region rounded, continuous with body contour or offset. Lips amalgamated with the usual 6 + 10 circlets of papillae. Amphidial apertures ranging from small pores to broad transverse slits. Amphids large, pouch-like or stirrup-shaped. Lateral chords broad with 1–3 rows of lateral body pores. Dorsal and ventral series of body pores usually present. Odontostyle greatly elongate, attenuate, 50–220 µm long. Odontophore elongate, sometimes with three strong, basal flanges. Junction of cheilostome and stomodaeum marked by a strongly sclerotized guide ring varying in position from near the lip region to near the odontostyle base. Pharynx in two parts: an anterior, narrow, tubular section and posterior, short cylindrical, bulb containing longitudinal valve plates. Three pharyngeal glands, one dorsal and two ventrosublateral. Female vulva located anteriorly to post-median in position, usually median. Female with various arrangements of possible reproductive systems: amphidelphic (two genital branches, one running anteriorly and the other posteriorly), monodelphic (one posterior genital branch) or pseudomonodelphic (one posterior functional genital branch with anterior branch is reduced, atrophied and non-functional) (Cohn & Sher 1972; Coomans *et al.* 2001). Uterus of some species of *Xiphinema* and *Xiphidorus* with various sclerotized structures in the lumen and/or attached to the walls. Male genital tracts diorchic, opposed. Spicules large, ventrally arcuate with lateral accessory guiding pieces. Copulatory supplements in the form of an adanal pair and a ventromedian series of one to 20 papillae. Tail shape variable, but generally similar in each sex.

The family Longidoridae belongs to the Order Dorylaimida and is subdivided into two subfamilies: Longidorinae Thorne, 1935 and Xiphinematinae Dalmasso, 1969 (Coomans 1985, 1996; He *et al*. 2005). The key to these two subfamilies is as below:

Key to subfamilies Longidorinae and Xiphinematinae

(Adapted from Hunt 1993 and Decraemer *et al.* 2019a)

1 Odontostyle nonforked; odontophore flanges usually not developed or some moderately developed; guide ring single, usually in anterior third of odontostyle; guide sheath never extending well anterior to guide ring when the odontostyle is fully retracted; dorsal gland nucleus elongate, smaller than those of the ventrosublateral glands and located at some distance posterior to its orifice ..... Longidorinae
- Odontostyle forked; odontophore with heavily sclerotized, well developed basal flanges; guide ring double, located near odontostyle/odontophore junction; guide sheath extending anterior to guide ring when odontostyle is retracted; dorsal gland nucleus round, larger than those of the ventrosublateral glands and located adjacent to its orifice .... Xiphinematinae

Subfamily LONGIDORINAE Thorne, 1935

Diagnosis: (adapted from Hunt 1993). Longidoridae. Body from 2 to 12 mm. Amphidial apertures either pore-like or transverse slits. Amphidial fovea pouch-like or stirrup shape. Odontophore flanges usually not developed, but moderately developed in some *Paralongidorus*. Guide ring single, usually in anterior third of odontostyle, rarely located at up to 60% of its length. Guiding sheath never extending well anterior to guide ring when odontostylet is

fully retracted. Dilatores buccae absent. Dorsal pharyngeal gland nucleus smaller than the nuclei of the ventrosublateral glands and located some distance posterior to the orifice. Female genital tracts always amphididelphic, reflexed; never reduced. No uterine differentiation in the form of spines, etc. Male ventromedian series of copulatory supplements up to 20 in number and beginning without a break from the adanal pair.

Six genera of Longidorinae are currently recognised: *Australodorus* Coomans, Olmos, Casella & Chaves, 2004, *Longidoroides* Khan, Chawla & Saha, 1978, *Longidorus* Micoletzky, 1922, *Paralongidorus* Siddiqi, Hooper & Khan, 1963, *Paraxiphidorus* Coomans & Chaves, 1995 and *Xiphidorus* Monteiro, 1976 (Coomans 1985, 1996; Coomans *et al.* 2004; Doucet *et al.* 1998; He *et al.* 2005). Their systematics have been debated intensely and reviewed during the last 30 years (Coomans 1985, 1996; Hunt 1993).

Genus *Longidorus* Micoletzky, 1922

Diagnosis: (adapted from Hunt 1993). Longidoridae. Body long to very long (3 to more than 10 mm) and slender. Heat relaxed form varying from more or less straight to C-shaped. Lateral chords broad and with one or two rows of lateral body pores. Cephalic region rounded; continuous or offset. Lips fused and with the usual 6+10 arrangement of papillae. Amphidial apertures in the form of small, inconspicuous pores which lead back to well developed pouch-like amphid fovea. Odontostyle elongate, needle-like; not heavily sclerotized. Guiding apparatus a simple ring usually situated within a couple of head-widths of the anterior end, but exceptionally further posterior, at up to 40% of the odontostyle length. Junction of odontostyle and odontophore simple. Odontophore about two thirds of the odontostyle in length, moderately sclerotized, thickened slightly in the posterior region, but lacking basal flanges. Odontostyle protractor muscles attached to base of odontophore and running parallel to the cephalic region. Pharynx comprising a narrow, cylindrical anterior section, which is looped back on itself when the odontostyle is in the retracted position, and a posterior bulboid expansion which is muscular and glandular with valve plates running almost the full length of the expansion. Three glands: one dorsal and two ventrosublateral. The nucleus of the dorsal gland is situated some distance posteriorly to the orifice and is smaller than the ventrosublateral nuclei. Nerve ring located around the narrow anterior section of the pharynx; a second nerve ring, located more posteriorly, occurs in some species. Hemizonid prominent. Intestine simple, prerectum well developed and several anal body diameter long. Anus in the form of a transverse slit. Vulva a transverse slit, median in position. Vagina well developed, muscular, at right angles to the body axis and leading to a substantial ovijector. Genital tract amphididelphic, reflexed. Tail short, dorsally convex-conoid to a finely rounded terminus, or broadly rounded. Several pairs of caudal pores present. Male genital tract diorchic, opposed, the posterior testis being reflexed. Both testes join a common vas deferens well anterior to the cloaca. Spicules dorylaimoid, paired, massive, ventrally arcuate and with short accessory guiding pieces located distally. Oblique copulatory muscles prominent and extending for several body diameter anterior to the cloaca. Copulatory supplements consisting of an adanal pair (some species have two or three pairs) and then a ventromedian series of up to 20 extending anteriorly without a break between the adanal pair and the series. In some species the ventromedian series may in part form a double, staggered row. Tail similar in shape to that of the female.

The genus *Longidorus* was erected with *L. elongatus* as its type species. Peneva *et al.* (2013) listed 158 species for the genus when *L. cholevae* was described. Among the 158 species, *L. moesicus* Lamberti, Choleva & Agostinelli, 1983 is a junior synonym of *L. iranicus* Sturhan & Barooti, 1983 proposed by Maafi *et al.* (2015). Since 2013, 15 additional species have been described (Archidona-Yuste *et al*. 2016a; Barsalote *et al*. 2018; Esmaeili *et al*. 2017; Gharibzadeh *et al.* 2018; Lazarova *et al.* 2019; Peneva *et al.* 2013; Roshan-Bakhsh *et al.* 2016; Trisciuzzi *et al*. 2015; Xu *et al.* 2017, 2018). The distribution and host associations of the 171 *Longidorus* species recorded are listed in Table 2. Of these, four *Longidorus* species have been reported in New Zealand: *Longidorus elongatus*, *L. orongorongensis*, *L. taniwha* and *L. waikouaitii*.

Table 2. Species, world distribution and hosts of *Longidorus*.

SPECIES	WORLD DISTRIBUTION	HOSTS
L. aetnaeus Roca, Lamberti, Agostinelli & Vinciguerra, 1986	Bulgaria, Euromediterranea, Georgia, Iran, Italy, Russia, Serbia, Ukraine, USA, Yugoslavia (former)	*Acer tataricum*, *Alnus glutinosa*, grasses, *Juglans regia, Juniperus* sp., *Populus alba*, *P. deltoids*, *Salix alba*, *Salix fragilis*, *Quercus cerris, Q. ilex*, *Q. pubescens*
L. africanus Merny, 1966	Canada, Egypt, Euromediterranea, Greece, India, Iran, Israel, Jordan, Mexico, Pakistan, Portugal, Rhodesia, Somalia, South Africa, Sudan, Tardicauda, Tunisia, USA, Zimbabuwe	*Allium* sp., *Beta vulgaris*, *Cucummis* sp., *Citrus* × *paradisi*, *Citrus* sp., *Corchorus olitorius*, *Daucus carota, Gossypium barbadense, Gossypium hirsutum*, grasses, *Hordeum vulgare*, *Lactuca* sp., *Medicago sativa, Mentha spicata, Olea europaea, Phlomis fruticose, Phoenix dactylifera, Prunus caroliniana, Prunus persica, Saccarum officinarum, Sorghum* sp., *Vitis vinifera*
L. alaskaensis Robbins & Brown, 1996	USA	*Populus tremuloides, Rosa* sp., *Salix* sp.
L. alvegus Roca, Pereira & Lamberti, 1989	Portugal, Spain	*Capsicum annum*, *Olea europaea*, *Vitis vinifera*
L. americanum Handoo, Carta, Skantar, Ye, Robbins, Subbotin, Fraedrich, Stephen & Cram, 2005	USA	*Pinus taeda*
L. ampullatus Jacobs & Heyns, 1987	South Africa	*Ficus* sp.
L. andalusicus Gutiérrez- Gutiérrez, Cantalapiedra- Navarrete, Monte-Borrego, Palomares-Rius & Castillo, 2013	Germany, Spain	*Halimione portulacoides, Salicornia ramossisima*
L. apuloides Roca, 1996	Italy	*Populus nigra*
L. apulus Roca & Bleve-Zacheo, 1977	Euromediterranea, Greece, Italy, Yugoslavia (former)	*Cichorium intybus*, *Cynara scolymus*, *Foeniculum vulgare*, *Solanum tuberosum*, weeds
L. arenosus Kankina & Ivanova, 1986	Tadzhikistan	*Calligonum mucrocarpum*, *Haloxylon persicum*, *Populus pruinosa*
L. artemisiae Rubtsova, Chizhov & Subbotin, 1999	Poland, Russia	*Artemisia* sp., *Elytrigia* sp., *Poa* sp., *Trifolium* sp., *Urtica dioica*
L. arthensis Brown, Grunder, Hooper, Klinger & Kunz, 1994	Australia, Germany, Switzerland	*Fagus sylvatica, Prunus avium*, *Pyrus communis*, *Vitis vinifera*
L. asiaticus Trisciuzzi, Archidona-Yuste, Troccoli, Fanelli, De Luca, Vovlas, N & Castillo, 2015	Imported into Italy from China	*Lagerstroemia indica*
L. athesinus Lamberti, Coiro & Agostinelli, 1991	Italy	*Prunus avium*
L. attenuatus Hooper, 1961	Australia, Austria, Belgium, Bulgaria, Euromediterranea, France, Germany, Holland, Hungary, Italy, Portugal, Slovakia, Spain, Turkey, UK, Ukraine, USSR (former)	*Beta vulgaris, Cynara scolymus, Lactuca sativa, Vitis vinifera*
L. auratus Jacobs & Heyns, 1987	South Africa	*Vitis vinifera*
L. azarbaijanensis Gharibzadeh, Pourjam, Pedram, 2018	Iran	*Setaria italica*
L. baeticus Gutiérrez- Gutiérrez, Cantalapiedra- Navarrete, Monte-Borrego, Palomares-Rius & Castillo, 2013	Spain	*Citrus aurantium, Vitis vinifera*
L. balticus Brzeski, Peneva & Brown, 2000	Poland	*Elymus arenarius*, *Salix* sp.
L. belloi Fe Andrés & Arias, 1988	Euromediterranea, Spain	Grass and bushes, *Hordeum vulgare*, pasture, *Pyrus communis*, *Quercus pyrenaica*, *Triticum aestivum*, *Ulex* sp., *Ulmus* sp., *Vicia* sp.
L. belondiroides Heyns, 1966	South Africa	*Saccharum officinarum*

..... continued on the next page

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. bernardi Robbins & Brown, 1996	USA	*Populus tremuloides, Rosa* sp., *Salix* sp.
L. biformis Ye & Robbins, 2004	USA	*Acer* sp., *Celtis occidentalis*, *Ulmus americana*
L. boshi (Khan, Chawla & Saha, 1972) Decraemer & Coomans, 2007=*paralongidorus boshi* Khan, Chawla & Saha, 1972	India	*Prunus domestica*
L. breviannulatus Norton & Hoffmann, 1975	Canada, India, Sudan, Thailand, USA	*Acer negundo*, *Acer* sp., *Platanus occidentalis*, *Populus deltoides*, *Prunus persica, Prunus serotina*, *Salix* sp., *Zea mays*
L. brevis Swart, Cadet & N'Diaye, 1996	Senegal	*Blumea viscosa, Carex gmelinii*, *Cordyla pinnata*, *Guiera senegalensis, Pennisetum pedicellatum*
L. caespiticola Hooper, 1961	Belgium, Czech Republic, Germany, Italy, Netherlands, Russia, Slovakia, Spain, Switzerland, UK	*Fragaria* × *ananassa*, grassland, *Humulus lupulus*, *Malus domestica*, *Prunus avium*, *Ptelea trifoliata*, *Rubus caesius, Rubus vestitus,* turf, *Vitis vinifera*
L. camelliae Zheng, Peneva & Brown, 2000	China	*Camellia japonica*
L. carniolensis Širca, Urek, Lasarova, Elshishka & Peneva, 2011	Slovenia	*Vitis vinifera*
L. carpathicus Lišková, Robbins & Brown, 1997	Euromediterranea, Slovenia	*Fagus sylvatica, Vitis vinifera*
L. carpetanensis Arias, Andres & Navas, 1986	Spain	*Cytisus purgans*
L. cedari (Khan, Saha & Seshadri, 1978) Decraemer & Coomans, 2007=*Longidoroides cedari* Khan, Saha & Seshadri, 1978	India	*Cedrus libani*
L. cheni Barsalote, Pham, Lazarova, Peneva & Zheng, 2018	China	*Larix gmelinii var. principis-rupprechtii*, *Pyracantha fortuneana*
L. cholevae Peneva, Lazarova, De luca & Brown, 2013	Bulgaria	*Prunus avium*
L. closelongatus Stoyanov, 1964	Bulgaria, France, Greece, Italy, Slovakia	*Olea europaea, Vitis vinifera*
L. cohni Heyns, 1969	Euromediterranea, Germany, Israel	*Avena sativa, Chloris gayana*, *Medicago sativa*
L. concavus Singh & Khan, 1997	India	*Prunus domestica*
L. congoensis Aboul-Eid, 1970	Africa, Algeria, Congo, Euromediterranea, Spain	*Phoenix dactylifera, Yushania alpina*
L. conicaudatus Khan, 1986	India	*Thuja* sp.
L. conicaudoides Jacobs & Heyns, 1987=*L. conicaudatus* Jacobs & Heyns, 1987 *nec* Khan, 1987	South Africa	*Ananas comosus*
L. conicephalus Singh & Khan, 1996	India	*Musa paradisiaca*
L. crassus Thorne, 1974	Canada, USA	*Acer negundo, Acer* sp., *Arundinaria gigantea, Betula* sp., *Carya* sp., *Catalpa bignonioides, Celitis occidentalis, Eremochloa ophiuroides, Glycine max*, *Ilex crenata*, lawn grass, *Liquidambar styraciflua, Maclura pomifera, Parthenocissus quinquefolia, Prunus virginiana,Quercus alba*, *Quercus nigra*, *Quercus* sp., *Taxodium distichum, Ulmus americana, Wisteria floribunda, Zea mays*
L. crataegi Roca & Bravo, 1996	Portugal, Spain	*Crataegus rhipidophylla*, *Vitis vinifera*
L. cretensis Tzortzakakis, Peneva, Terzakis, Neilson & Brown, 2001	Greece	*Vitis vinifera*
L. curvatus Khan, 1986	India	*Pinus palustris*
L. cylindricapitatus Krnjaić, Roca, Krnjaić & Agostinelli, 2005	Serbia	*Amorpha fruticosa*, *Picea omorika, Populus* sp.

..... *continued on the next page*

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. cylindricaudatus Kozlowska & Seinhorst, 1979	Belgium, Euromediterranea, Germany, Netherlands, Slovakia	*Calluna vulgaris, Pinus sylvestris, Quercus robur*
L. dalmassoi Peneva, Loof & Brown, 1998	France	Meadow grasses
L. danuvii Barsi, Lamberti & De Luca, 2007	Poland, Serbia, Ukraine	*Amorpha fruticosa*, *Malus domestica, Populus* sp., *Pyrus* sp., *Rubus idaeus, Salix alba*
L. diadecturus Eveleigh & Allen, 1982	Canada, USA	*Acer* sp., *Celtis occidentalis*, *Liquidambar styraciflua*, *Maclura pomifera*, *Populus deltoides*, *Prunus persica*, *Ulmus americana*
L. dimorphicaudatus Baniyamuddin & Ahmad, 2006	India	Grasses
L. distinctus Lamberti, Choleva & Agostinelli, 1983	Bulgaria, Balkans Peninsula, Euromediterranea, Poland, Russia, Serbia, Slovakia, Ukraine, Yugoslavia (former)	*Alnus glutinosa*, *Carpinus betulus*, *Cydonia oblonga*, *Juglans regia*, *Prunus domestica, Salix* sp.
L. doonensis (Singh & Khan, 1996) Ye & Robbins, 2004	India	*Prunus armeniaca*
L. dunensis Brinkmam, Loof & Barbez, 1987	Netherlands	*Elaeagnus rhamnoides*
L. edmundsi Hunt & Siddiqi, 1977	Dominica, Italy, Saint Lucia, West Indies	*Coccoloba uvifera, Vitis vinifera*
L. elongatus (de Man 1876) Thorne & Swanger, 1936=*Dorylaimus elongatus* de Man, 1876=*Dorylaimus tenuis* von Linstow, 1879=*Longidorus menthasolanus* Konicek & Jensen, 1961=*Longidorus monohystera* Altherr, 1953=*Trichodorus elongatus* (de Man, 1876) Filipijev, 1921	Australia, Austria, Belgium, Bulgaria, Canada, Czech Republic, Denmark, Egypt, Estonia, Euromediterranea, Finland, France, Germany, Greece, Hungary, India, Ireland, Italy, Latvia, Moldavia, Netherlands, New Zealand, Norway, Pakistan, Poland, Romania, Russia, Slovakia, South Africa, Spain, Sweden, Switzerland, Tadzhikistan, Thailand, Turkey, Ukraine, UK, USA, USSR (former), Vietnam	*Acer negundo, Acer platanoides, Actinidia deliciosa, Allium cepa, Alnus incana*, *Anthoxanthum odoratum*, *Arbutus unedo, Avena sativa, Beta vulgaris, Cydonia oblonga, Daucus carota, Elaeagnus angustifolia, Fragaria × ananassa*, *Gossypium hirsutum,* grass*, Helianthus* sp., *Holcus lanatus*, *Hypochaeris radicata, Leptinella* sp., *Lolium perenne*, *Malus domestica, Malus sylvestris, Medicago sativa, Mentha piperita, Nicotiana* sp., *Persea americana, Phebalium squameum, Platanus acerifolia, Poa annua*, *Prunus persica*, *Prunus* sp., *Pyrus communis*, *Quercus* sp., *Rubus caesius*, *Rubus idaeus, Rubes nigrum, Ribes rubrum, Saccharum officinarum, Salix alba, Salix fragilis, Salix* sp., *Solanum tuberosum, Sorghum* sp., *Trifolium repens*, *Trifolium subterraneum*, *Tulipa gesneriana*, *Urtica dioica, Vitis vinifera*, *Zea mays*
L. eridanicus Roca, Lamberti & Agostinelli, 1984	Euromediterranea, Italy	Grass and woodlands, *Vitis vinifera*
L. euonymus Mali & Hooper, 1974	Austria, Bulgaria, Czech Republic, Czechoslovakia, Euromediterranea, Greece, Italy, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Syria, Tunisia, Yugoslavia (former)	*Amorpha fruticosa*, *Artemisia* sp., *Asparagus* sp., *Cicer* sp., *Cynara cardunculus* var. *scolymus, Cydonia oblonga*, *Daucus carota,* grasses, *Euonymus europaeus*, *Fragaria × ananassa*, *Hordeum vulgare*, *Juglans regia, Malus domestica*, *Nicotiana tabacum*, *Olea europaea, Pinus nigra, Pinus sylvestris, Populus* sp., *Prunus avium*, *P. cerasus*, *P. domestica*, *Prunus persica*, *Prunus* sp., *Ribes nigrum*, *Rosa damascena, Rosa* sp., *Rubus idaeus, Rubus vestitus*, *Salix* sp., *Sambucus nigra, Solanum tuberosum*, *Triticum aestivum*, *Urtica dioica*, *Vitis vinifera*, *Zea mays*
L. fagi Peneva, Choleva & Nedelchev, 1997	Bulgaria	*Fagus sylvatica*
L. fangi Xu & Cheng, 1991	China	*Euonymus japonicus, Malus pumila*, *Prunus mume, Quercus fabrei*

..... continued on the next page

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. fasciatus Roca & Lamberti, 1981	Euromediterranea, Greece, Italy, Spain	*Cynara cardunculus*, *Vitis vinifera*
L. ferrisi Robbins, Ye & Pedram, 2009	USA	*Citrus reticulata*
L. fragilis Thorne, 1974	USA	*Platanus occidentalis, Populus deltoides*
L. fursti Heyns, Coomans, Hutsebaut & Swart, 1987	China, South Africa	*Acacia cyclops*, *Chrysanthemoides monilifera*, *Cynodon dactylon*, *Mesembryanthemum aitonis*, *Styphnolobium japonicum*
L. globulicauda Dalmasso, 1969	Euromediterranea, France, India	Unknown host
L. glycines Ye & Robbins, 2004	Tunisia, USA	*Glycine max, Olea europaea*
L. goodeyi Hooper, 1961=*L. elongatus apud* Goodey, 1951	Belgium, Euromediterranea, Netherlands, France, Germany, Netherlands, Slovakia, Spain, UK	Turf grass
L. grandis Ye & Robbins, 2003	USA	*Maclura pomifera*, *Platanus occidentalis*, *Salix* sp., *Ulmus americana*
L. hangzhouensis Zheng, Peng, Robbins & Brown, 2001	China	*Osmanthus delavayi*
L. helveticus Lamberti, Kunz, Grunder, Molinari, De Luca, Agostinelli & Radicci, 2001	Czech Republic, Germany, Serbia, Slovakia, Slovenia, Switzerland	*Acer platanoides, Carpinus betulus*, *Prunus avium*
L. henanus Xu & Cheng, 1992	China	*Phyllostachys pubescens*, *Populus* sp., *Vitis vinifera*
L. heynsi Andrassy, 1970	South Africa	Unknown host
L. himalayensis (Khan, 1986) Xu & Hooper, 1990=*Neolongidorus himalayensis* Khan, 1987	India	*Prunus persica*
L. holovachovi Peneva, Susulovsky & Lazarova, 2009	Ukraine	*Fagus sylvatica*
L. igoris Krnjaić, Lamberti, Krnjaić, Agostinelli & Radicci, 2000	Montenegro	*Crithmum maritimum*, *Smilax aspera*
L. indalus Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
L. indicus Prabha, 1973	India	*Moringa pterygosperma*
L. intermedius Kozlowska & Seinhorst, 1979	Austria, Belgium, Bulgaria, China, Czech Republic, Euromediterranea, Germany, Italy, Macedonia, Netherlands, Poland, Russia, Slovakia, Spain, Turkey, Yugoslavia (former)	*Carpinus betulus, Cornus mas, Crataegus rhipidophylla*, *Euonymus europaeus, Fagus orientalis*, *Olea europaea* var. *sylvestris*, *Prunus serotina*, *Quercus robur*, *Quercus* sp., *Quercus suber*, *Robinia pseudoacacia*
L. iranicus Sturhan & Barooti, 1983= *L. moesicus* Lamberti, Choleva & Agostinelli, 1983 in Maafi *et al.*, 2015=*Paralongidorus serbicus* Krnjaic, Lamberti, Krnjaic, Agostinelli & Radicci, 2002	Bulgaria, Euromediterranea, Greece, Iran, Italy, Serbia	*Aesculus hippocastanum*, *Brassica oleracea, Ficus carica, Malus domestica*, *Morus nigra*, *Olea europaea*, *Oryza sativa*, *Populus nigra*, *Prunus* sp., *Ribes nigrum*, *Rosa* sp., *Solanum lycopersicum*, *Vitis vinifera*
L. ishigakiensis Hirata, 2002	Japan	*Pleioblastus linearis*
L. ishrati Javed, 1983	India	*Tamarindus indica*
L. israelensis Peneva, Orion, Shlevin, Bar-Eyal & Brown, 1998	Israel	*Daucus carota*
L. iuglandis Roca, Lamberti & Agostinelli, 1984	Euromediterranea, Italy, Slovakia, Spain	*Helianthus annuus, Juglans regia, Vitis vinifera*
L. jagerae Heyns & Swart, 1998	South Africa	*Galenia africana*
L. jiangsuensis Xu & Hooper, 1990	China	*Fragaria* × *ananassa*
L. jonesi Siddiqi, 1962=*Neolongidorus jonesi* (Siddiqi, 1962) Khan, 1987	China, India, Japan	*Cupressus funebris, Prunus armeniaca, Prunus mume*, *Prunus persica*
L. juglandicola Liskova, Robbins & Brown, 1997	Slovenia	*Juglans regia*

..... *continued on the next page*

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. juglans Xu, Guo, Ye, Wang, Zheng & Zhao, 2017	China	*Juglans regia*
L. juvenilis Dalmasso, 1969	Argentina, France, Italy, Slovenia, Slovakia, South Africa, Yugoslavia (former)	*Citrus* sp., *Pinus strobus*, *Prunus persica*, *Saccharum officinarum, Vitis vinifera*
L. juveniloides Jacobs & Heyns, 1987	South Africa	Grass
L. kakamus Jacobs & Heyns, 1987	South Africa	*Vitis vinifera*
L. kheirii Pedram, Niknam, Robbins Ye & Karegar, 2008	Iran	*Rosa* sp.
L. kuiperi Brinkmam, Loof & Barbez, 1987	France, Greece, Italy, Netherlands	*Ammophila arenaria*, *Tamarix smyrnensis*
L. laevicapitatus Williams, 1959	Argentina, Cameroon, Colombia, Congo, Costa Rica, Dominica, Egypt, Ethiopia, France, French West Indies, Germany, Israel, Jamaica, Kenya, Martinique, Mauritius, Montserrat, Panama, Portugal, Santa Lucia, Sao Tome and Principe, South Africa, Sudan, Swaziland, Switzerland, Trinidad	*Ananas comosus, Capsicum annuum*, *Citrus* sp., *Coffea* sp., *Dioscorea* sp., *Ipomoea batatas*, *Musa* sp., *Rosa* sp., *Saccharum officinarum*, *Solanum tuberosum, Theobroma cacao, Vitis vinifera*
L. laricis Hirata, 1995	Japan	*Larix kaempferi*
L. leptocephalus Hooper, 1961	Austria, Belgium, Czech Republic, Euromediterranea, Germany, Netherlands, Russia, Scandinavia, Slovenia, Slovakia, Switzerland, UK	*Humulus lupulus*, *Malus domestica*, grassland, *Poa annua, Prunus avium*, *Prunus cerasus*, *Prunus* sp., *Ptelea trifoliata*, *Pyrus communis*, *Solanum tuberosum, Urtica dioica*, *Vitis vinifera*
L. lignosus Chizhov, Subbotin, Romanenko & Kruchina, 1991	Russia, USA	*Acer campestre*, *Fagus orientalis, Quercus petraea* subsp. *iberica, Rhododendron* sp.
L. litchii Xu & Cheng, 1992	China	*Litchi chinensis*
L. longicaudatus Siddiqi, 1962	USA	*Ardisia crenata*
L. lusitanicus Macara, 1985	Portugal, Spain	*Olea europaea, Populus* × *canadensis*
L. macrodorus Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
L. macromucronatus Siddiqi, 1962	China, India, Italy, USA	*Malus sylvestris*
L. macrosoma Hooper, 1961	Belgium, Bulgaria, Czechoslovakia, Euromediterranea, France, Germany, Ireland, Italy, Netherlands, Slovakia, Spain, Switzerland, UK, Yugoslavia (former)	*Fagus sylvatica*, *Prunus avium*, *Pyrus communis, Quercus robur, Rubus idaeus*
L. macroteromucronatus Altherr, 1974	Germany, India	Ground water
L. magnus Lamberti, Bleve-Zacheo & Arias, 1982	Euromediterranea, Italy, Malta, Spain	*Olea europaea*, *Prunus domestica*, *Vitis* sp., *Vitis vinifera*
L. major Roca & D'Errico, 1987	Italy	*Vitis* sp.
L. makatinus Jacobs & Heyns, 1987	South Africa	*Saccharum officinarum, Vitis vinifera*
L. martini Merny, 1966	Africa, Japan, Rhodesie, Zimbabwe, Tadzhikistan	*Morus nigra, Vitis* sp., *Vitis vinifera*
L. milanis (Krnjaić, Lamberti, Krnjaić, Agostinelli & Radicci, 2000) Roca, 2006=*Paralongidorus milanis* Krnjaic, Lamberti, Krnjaic, Agostinelli & Radicci, 2000	Montenegro	*Quercus pubescens*
L. mindanaoensis Coomans, Tandingan De Ley, Angsinco Jimenez & De Ley, 2012	Philippines	Silty sediment in *Avicennia* mangrove swamp
L. mirus Khan, Chawla & Seshardi, 1971	India	*Citrus limon*, *Punica granatum, Zea mays*
L. mobae Jacobs & Heyns, 1987	South Africa	*Saccharum officinarum*

..... continued on the next page

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. monegrensis (Escuer & Arias, 1997) Decraemer & Coomans, 2007=*Paralongidorus monegrensis* Escuer & Arias, 1997	Spain	*Rhamno-Cocciferetum*
L. monile Heyns, 1966	South Africa	*Themeda triandra*
L. moniloides Heyns, 1966	China, South Africa	*Acacia* sp., *Themeda triandra*
L. naganensis Hirata, 1995	Japan	*Fagus crenata*
L. nanus Romanensko, 1993	Russia	*Malus domestica*
L. nevesi Macara, 1985	Euromediterranea, Portugal, Slovakia	*Cistus monspeliensis*, *Erica scoparia, Juniperus phoenicea*, *Pinus halepensis*, *Pulicaria odora*, *Quercus coccifera*
L. nirulai Siddiqi, 1965	India	*Solanum tuberosum*
L. oleae Gutiérrez-Gutiérrez, Cantalapiedra-Navarrete, Monte-Borrego, Palomares-Rius & Castillo, 2013	Spain	*Olea europaea*
L. olegi Kankina & Metliskaya, 1983	Russia, Tadzhikistan	*Rubus idaeus*
L. onubensis Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
L. orientalis Loof, 1982	Iraq, Saudi Arabia, USA	*Phoenix dactylifera*, *Vitis vinifera*
L. orongorongensis Yeates, Van Etteger & Hooper, 1992	New Zealand	*Agrostis capillaris, Carpodetus serratus, Dacrydium cupressinum, Holcus lanatus, Juncus* sp., *Leiospermum racemosum, Lotus pedunculatus*, *Metrosideros robusta, Prumnopitys ferrugineus, Prumnopitys taxifolius, Ranunculus acris*
L. paraelongatus Altherr, 1974	France, Germany	Interstitial waters
L. paralaskaensis Robbins & Brown, 1996	USA	*Alnus maritima*, *Rosa* sp.
L. paralongicaudatus Ye & Robbins, 2003	USA	*Acer* sp., *Quercus* sp., *Ulmus americana*
L. paramirus Darekar & Khan, 1982	India	*Piper betle*
L. paramonile Jacobs & Heyns, 1982	Brazil, South Africa, Swaziland	Grass, *Saccharum officinarum*
L. paravineacola Ye & Robbins, 2003	USA	*Acer negundo*, *Acer* sp., *Cercis canadensis*, *Maclura pomifera*, *Platanus occidentalis, Ulmus americana*, *Vitis* sp.
L. pauli Lamberti, Molinari, De Luca, Agostinelli & Di Vito, 1999	Syria	*Ficus carica*
L. pawneensis Luc & Coomans, 1988	China, USA	Grassland, *Myrica rubra*
L. persicus Esmaeili, Heydari, Archidona-Yuste, Castillo & Palomares-rius, 2017	Iran	*Rosa* sp.
L. perangustus Roshan-Bakhsh, Pourjam & Pedram, 2016	Iran	*Pinus* sp.
L. piceicola Liskova, Robbins & Brown, 1997	Poland, Romania, Slovakia	*Fraxinus* sp., *Larix decidua*, *Picea abies*, *Quercus* sp., *Tilia* sp.
L. picenus Roca, Lamberti & Agostinelli, 1984	Italy, Slovakia	*Malus communis*
L. pini Fe Andres & Arias, 1987	Bulgaria, Egypt, Spain	*Juncus* sp., pasture, *Pinus sylvestris*, *Quercus pyrenaica*
L. pinus Xu, Ye, Wang & Zhao, 2018	China	*Fraxinus chinensis*, *Pinus bungeana*, *Populus* sp., *Styphnolobium japonicum*, *Zea mays*
L. pisi Edward, Misra & Singh, 1964=*L. latocephalus* Lamberti, Choleva & Agostinelli, 1983=*Xiphinema brevocaudatum apud* Siddiqi, 1959=*L. siddiqii* Aboul-Eid, 1970	Africa, Boswana, Bulgaria, Cameroon, China, Cyprus, Egypt, Euromediterranea, India, Iran, Iraq, Israel, Ivory Coast, Jordan, Libya, Malawi, Mozambique, Nigeria, Pakistan, Senegal, South Africa, Sudan	*Colocasia esculenta, Corchorus olitorius, Glycine max, Gossypium hirsutum, Jasminum sambac, Malus domestica*, *Pelargonium odoratissimum, Pisum sativum*, *Saccharum officinarum, Vitis vinifera*
L. pius Barsi & Lamberti, 2001	Macedonia	*Carpinus orientalis*

..... *continued on the next page*

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. poessneckensis Altherr, 1974	Czech Republic, Germany, Poland, Slovakia	*Acer rubrum*, *Betula alleghaniensis*, *Betula* sp., *Carpinus betulus*, *Carpinus* sp., grasses, *Quercus robur*, *Quercus* sp., *Rubus* sp., Spring
L. polyae Lazarova, Elshishka, Radoslavov & Peneva, 2019	Bulgaria	*Pyrus communis*
L. profundorum Hooper, 1966	Belgium, Bulgaria, Euromediterranea, France, Germany, Ireland, Netherlands, Russia, Slovakia, Spain, Switzerland, UK	*Cydonia oblonga, Fraxinus* sp., grasses and bushes, *Malus domestica*, *Malus sylvestris, Pyrus communis*, *Quercetum* sp., *Rosa damascena*
L. protae Roca & Bleve-Zacheo, 1977=*L. attenuatus apud* Prota *et al.*, 1971	Euromediterranea, Italy	*Vitis* sp., *Vitis vinifera*
L. proximus Sturhan & Argo, 1983	Euromediterranea, Germany, Greece, Italy	*Cynara cardunculus, Juglans regia*
L. pseudoelongatus Altherr, 1976	France, Germany, Greece	Interstitial water, *Olea europaea*, *Vitis vinifera*
L. psidii Khan & Khan, 1972=*L. chikmagalurensis* Dhanam & Jairajpuri, 1997	India	*Camellia sinensis, Psidium guajava, Vitis* sp.
L. raskii Lamberti & Agostinelli, 1993	Slovakia, Switzerland	*Mallus sylvestris*
L. reisi Roca & Bravo, 1993	Portugal	*Prunus persica*
L. reneyii Raina, 1966	India	*Zea mays*
L. rotundicaudatus Jacobs & Heyns, 1987	South Africa	*Vitis vinifera*
L. rubi Tomilin & Romanenko in Romanenko, 1993	Poltava, Spain, Ukraine	*Malus domestica, Pinus pinea, Rubus idaeus*
L. saginus Khan, Seshardi, Weischer & Matten, 1971	India	*Cocos nucifera*
L. seinhorsti Peneva, Loof & Brown, 1998	Netherlands	Grass
L. silvae Roca, 1993	Italy, Serbia, Slovakia	Natural woodland, *Quercus petraea*
L. silvestris Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
L. socialis Singh & Khan, 1997	India	*Pyrus communis*
L. spiralis (Khan, Saha & Seshadri, 1972) Decraemer & Coomans, 2007=*Paralongidorus spiralis* Khan, Saha & Seshadri, 1972	India	*Pinus palustris*
L. sturhani Rubtsova, Subbotin, Brown & Moens, 2001	Belgium, Germany	Grass and weed, *Malus domestica*
L. sylphus Thorne, 1939=*L. striola* Merzheevskaya, 1951	Bulgaria, Canada, Korea, Moldavia, USA, Ukraine	*Fragaria* × *ananassa, Rosa damascena*
L. tabrizicus Niknam, Pedram, Ghahremani Nejad, Ye, Robbins & Tanha Maafi, 2010	Iran	*Rosa* sp.
L. taniwha Clark, 1963	Australia, Israel, New Zealand	*Agrostis capillaris, Carpodetus serratus, Holcus lanatus*, *Juncus* sp., *Leiospermum racemosum, Lotus pedunculatus*, *Locus uliginosus*, *Ranunculus acris, Sophora microphylla*
L. tardicauda Merzheevskaja, 1951	Russia, Tadzhikistan	*Linum* sp, *Solanum* sp., *Vitis vinifera*
L. tarjani Siddiqi, 1962	France, USA	*Quercus virginiana*
L. trapezoides Nazira & Maqbool, 1995	Pakistan, Palestine	*Solanum tuberosum, Symphytum tuberosum*
L. unedoi Arias, Fe Andres & Navas, 1986	Euromediterranea, Portugal, Romanya, Spain	*Quercus faginea*
L. uroshis Krnjaić, Lamberti, Krnjaić, Agostinelli & Radicci, 2000	Montenegro	*Hedera helix*, *Juniperus oxycedrus*, *Myrthus communis, Smilax aspera*
L. vallensis Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*

..... continued on the next page

Table 2 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
L. vineacola Sturhan & Weischer, 1954	Belgium, Bulgaria, Euromediterranea, France, Greece, Germany, Ireland, Israel, Moldavia, Moldova, Netherlands, Portugal, Spain, UK, USSR (former)	*Allium cepa*, Gramineae, *Humulus lupulus, Olea europaea*, *Pinus pinea*, *Ptelea trifoliata, Salvia officinalis, Vitis vinifera, Vitis vulpina*
L. vinearum Bravo & Roca, 1995	Portugal	*Vitis vinifera*
L. waikouaitii Yeates, Boag & Brown, 1997	New Zealand	*Melicytus ramiflorus, Sophora microphylla*
L. wicuolea Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*

Key to *Longidorus* species in New Zealand

1. Mean guide ring position more than 60 µm from anterior end..... 2
- Mean guide ring position less than 59 µm from anterior end..... 3
2. Body length 7.0–8.0 mm; odontostyle length 154–164 µm; male present ..... *L. orongorongensis*
- Body length 6.5–7.0 mm; odontostyle length 116–120 µm; male absent..... *L. waikouaitii*
3. Guide ring 27–41 µm from anterior end; odontostyle length 89–101 µm ..... *L. elongatus*
- Guide ring 51–58 µm from anterior end; odontostyle length 120–128 µm ..... *L. taniwha*

Longidorus elongatus (de Man, 1876) Thorne & Swanger, 1936

Figs 1–4. Map 1.

Syn: *Dorylaimus elongatus* de Man, 1876
Dorylaimus tenuis von Linstow, 1879
Longidorus menthasolanus Konicek & Jensen, 1961
Longidorus monohystera Altherr, 1953
Trichodorus elongatus (de Man, 1876) Filipijev, 1921

Measurements. Table 3.

Morphology. Females: Body ventrally curved to C shape when heat relaxed. Lip region continuous or very slightly setoff from neck contour, 10–16 µm wide. Cuticle 1.8–2.9 µm thick near lip region, 1.7–2.8 µm at guide ring, 2.3–4.0 µm at base of pharynx, 2.9–4.3 µm near vulva and 14–19 µm at the tail terminus. Body pores not observed. Amphidial fovea large, pouch-like. Odontostyle slender, 89–101 µm long, odontophore base slightly flanged. Guide ring situated 27–41 µm from anterior end. Nerve ring posterior to base of odontophore. 'Mucro' not observed. Pharyngeal bulb cylindrical, 76–128 µm long, 21–28 µm wide, position of pharyngeal gland nuclei typical of the genus. Cardia at junction of pharyngeal bulb and intestine, bluntly convex-conoid. Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 306–474 µm long, posterior reproductive system 258–392 µm long. Vulva a transverse slit situated at mid-body length. Vagina perpendicular to body axis with a thick cuticular layer, 24–36 µm long, occupying 38–54% of corresponding body diameter. Prerectum 106–304 µm long. Rectum 26–40 µm long. Tail short, 44–56 µm, conoid, two caudal pores present on each side.

Males: Rare (ratio 1: 10 females). Morphologically similar to female except for genital system, but with posterior region slightly curved ventrally. Spicules large, arcuate, 70 µm long. Lateral guiding pieces 17 µm long. An adanal pair plus a ventromedian series of eight supplementary papillae present. Tail short, 53 µm long, bluntly conoid, and dorsally convex, with two caudal pores present on each side.

Juveniles: Four juvenile stages found. A replacement odontostyle present in pharyngeal region in all juvenile stages. First-stage juvenile (J1) has tip of the replacement odontostyle situated near base of functional odontostyle; conoid tails (c'=2.7–3.3). Second-stage juvenile (J2) replacement odontostyle correlated well with odontostyle length of the subsequent third-stage juvenile (J3). J3 replacement odontostyle correlated well with odontostyle length of the following fourth-stage juvenile (J4). In addition, the length of the J4 replacement odontostyle correlated well with female odontostyle length. The relationship between the lengths of the functional and replacement odontostyles and body length confirmed the presence of four juvenile stages (Fig. 5).

Table 3. Morphometrics of *Longidorus elongatus* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	FEMALES	MALE	J1	J2	J3	J4
n	9	1	6	4	2	1
L	5107 ± 527 (4107–5797)	5036	1126 ± 56.7 (1074–1231)	1874 ± 67.6 (1806–1937)	2876, 2978	3855
a	72.8 ± 6.3 (62.4–80.7)	86.9	46.3 ± 3.5 (41.6–51.4)	46.7 ± 1.9 (45.1–49.4)	49.9, 54.6	66.5
b	14.4 ± 3.2 (10.9–18.8)	11.0	4.2 ± 0.2 (3.9–4.4)	6.2 ± 1.2 (5.1–7.9)	8.3, 12.3	15.1
c	104.8 ± 18.4 (76.4–132)	95.5	23.1 ± 0.7 (22.1–23.9)	36.6 ± 3.8 (32.9–40.3)	55.2, 50.0	71.1
c'	1.0 ± 0.1 (0.8–1.1)	1.0	3.0 ± 0.2 (2.7–3.3)	1.9 ± 0.2 (1.7–2.1)	1.2, 1.6	1.3
V/T	48.2 ± 2.5 (42.9–50.9)	–	–	–	–	–
Odontostyle	90.7 ± 4.0 (89.0–100.9)	93.7	56.0 ± 1.5 (53.5–57.9)	64.9 ± 1.3 (63.9–66.7)	75.7, 75.3	82.7
Odontophore	49.7 ± 9.1 (33.5–60.8)	66.2	41.8 ± 5.3 (36.7–49.7)	39.3 ± 6.5 (30.2–44.1)	37.9, 50.2	48.1
Replacement odontostyle	–	–	63.9 ± 1.9 (61.4–66.9)	73.0 ± 2.2 (70.0–74.9)	81.3, 83.6	91.8
Pharynx length	365 ± 63.3 (250–442)	460	268 ± 20.3 (248–305)	310 ± 46.1 (244–352)	345.2, 242.6	255.7
Tail width	49.4 ± 3.4 (44.5–54.3)	51.6	24.4 ± 1.8 (22.0–26.5)	27.6 ± 2.5 (25.1–30.0)	43.5, 38.4	43.2
Tail length	49.3 ± 4.1 (43.9–55.9)	52.7	47.8 ± 1.9 (46.3–51.0)	51.7 ± 6.2 (44.9–59.0)	52.1, 59.6	54.3
Guide ring-anterior	31.3 ± 4.1 (27.0–40.8)	32.5	16.1 ± 0.5 (15.4–16.6)	21.5 ± 0.8 (20.4–22.4)	25.4, 27.7	28.2
Amphid-anterior	6.7 ± 1.1 (5.3–8.3)	6.3	3.2 ± 0.4 (2.8–3.7)	2.7 ± 0.2 (2.6–2.9)	5.2, 6.0	4.5
Body width at:						
-guide ring	25.7 ± 2.0 (22.5–28.4)	21.9	14.8 ± 0.5 (14.2–15.6)	19.1 ± 1.4 (17.5–20.3)	22.6, 20.1	23.1
-lip region	14.0 ± 1.1 (12.3–15.5)	14.2	8.9 ± 0.1 (8.7–9.0)	10.3 ± 0.8 (9.2–11.1)	11.9, 11.4	8.6
-mid-body	69.6 ± 4.6 (64.6–76.8)	58.0	24.4 ± 1.8 (22.0–26.5)	40.2 ± 3.0 (36.5–43.0)	57.7, 54.5	57.9
-vulva	70.2 ± 5.1 (62.5–79.1)	–	–	–	–	–
-base of pharynx	57.4 ± 2.6 (52.5–61.2)	53.6	26.2 ± 1.2 (25.0–28.4)	37.6 ± 3.0 (34.1–41.5)	51.7, 45.0	48.3
Bulb length	102 ± 15.8 (76–128)	99.6	57.3 ± 4.8 (48.8–62.1)	67.5 ± 4.3 (63.5–73.2)	78.1, 74.0	82.4
Bulb diameter	25.5 ± 1.8 (22.0–27.9)	22.9	11.2 ± 1.5 (8.7–13.0)	14.3 ± 0.4 (14.0–14.8)	18.7, 21.7	21.3
Rectum	35.1 ± 4.2 (26.5–39.8)	–	–	–	–	–
Cuticle at:						
-lip region	2.2 ± 0.3 (1.8–2.9)	1.6	1.1 ± 0.1 (1.0–1.2)	1.4 ± 0.1 (1.3–1.5)	1.6, 1.1	2.1
-guide ring	2.2 ± 0.3 (1.8–2.8)	2.1	1.1 ± 0.1 (1.0–1.3)	1.7 ± 0.2 (1.5–2.0)	1.5, 1.6	1.4
-base of pharynx	3.3 ± 0.5 (2.3–4.0)	3.7	1.3 ± 0.1 (1.1–1.4)	1.8 ± 0.1 (1.7–1.9)	2.1, 2.4	2.5
-vulva	3.4 ± 0.4 (2.9–4.0)	–	–	–	–	–
Tail hyaline	16.2 ± 1.8 (13.6–19.1)	15.7	8.3 ± 0.8 (6.9–9.1)	9.6 ± 1.2 (7.9–10.4)	12.1, 11.6	9.8

Differential diagnosis. *Longidorus elongatus* is characterised by females having a median body size (4.1–5.8 mm long); lip region flattened, continuous or setoff with body contour (10–16 µm wide); medium length odontostyle (63–101 µm), guide ring 27–41 µm from the anterior end; and a conoid tail (44–56 µm, *c* =76–132, *c*'=0.8–1.1). Four developmental juvenile stages and the first juvenile stage has a conoid tail (c'=2.7–3.3). According to the polytomous key of Chen *et al.* (1997) and additional juvenile characters of Peneva *et al.* (2013), the codes for *L. elongatus* are: A34-B23-C3-D3-E2-F23-G12-H2-I12-J1-K6.

Molecular and phylogenetic relationships. The sequenced fragments of SSU and D2-D3 of LSU (both ten populations) are approximately 1600 bp and 800 bp respectively. The DNA sequences are available in the GenBank database under the accession numbers MN103811–MN103820 (SSU) and MN123747–MN123756 (D2-D3 of LSU).

A BLAST search revealed maximum scores in SSU with six sequences for *L. elongatus* (GU199044, AY687992, KJ636419, AF036594, EU503141 and KJ636420, 99–100% similarity). No intraspecific variation in SSU was detected between these ten populations except 2 bp differences in MN103813 (*L. elongatus* isolate LN 1491). In the molecular phylogenetic analysis of *L. elongatus* based on SSU under TIM2ef+I+G model, including 75 sequences and 1727 total characters (Fig. 6), all *L. elongatus* populations clustered together but with low 33% posterior probability (PP) support.

A BLAST search revealed maximum scores in D2-D3 of LSU with eight sequences for *L. elongatus* (AY601578, AF242299, AF480076, KF242294, KF242296, KF242297, KF242305, KF242306, 100% similarity). No intraspecific variation in LSU was detected between these ten populations of *L. elongatus* except for 3 bp differences in MN123749 (lettuce isolate) and MN123756 (No. 30 isolate). In the molecular phylogenetic analysis of *L. elongatus* based on D2-D3 of LSU under GTR + I + G model, including 85 sequences and 854 total characters (Fig. 7), all *L. elongatus* populations clustered together with 100% PP support.

Material examined. 20 females and 85 juveniles from NNCNZ; 15 females, one male and six juveniles from Nematology Collection of AsureQuality.

Distribution (Map 1). From material examined: New Zealand: **North Island:** Waiouru, TO; AgResearch Campus, Hamiton, WO; Paddock, Cambridge, WO; Otorohanga, WO; Awatea Reservation, Palmerston North, WI; Parakawau Rd, Levin, WN; Waikato river bank, Hamilton, WO; Horowhenua, WN; Egmont National park, Taranaki, TK; Taihape, Rangitikei, RI. **South Island:** Westport, BR; Murchison, NN; Havelock, SD; Endendale, SL.

From literature: New Zealand: **North Island:** Levin, WN; Havelock North, HB; Auckland, AK; Bay of Plenty, BP; Taranaki, TK; GB and WA; **South Island:** Nelson, NN; Westport, BR; Christchurch area, MC (Dale 1971; Knight 2001; Sturhan *et al.* 1997; Yeates 1973). For world distributions see Table 2.

Habitat and hosts. From material examined: New Zealand: Perennial ryegrass (*Lolium perenne*), London plane tree (*Platanus acerifolia*), oak tree (*Quercus* sp.).

From literature: New Zealand: apple trees (*Malus sylvestris*), avocado (*Persea americana*), catsear (*Hypochaeris radicata*), cotula (*Leptinella* sp.), kiwifruit (*Actinidia deliciosa*), lucerne (*Medicago sativa*), peach trees (*Prunus persica*), perennial ryegrass (*Lolium perenne*), *Phebalium squameum, Salix* sp., strawberries (*Fragaria* sp.), subterranean clover (*Trifolium subterraneum*), sweet vernal grass (*Anthoxanthum odoratum*); tobacco (*Nicotiana* sp.), tulip (*Tulipa gesneriana*), white clover (*Trifolium repens*) and Yorkshire fog (*Holcus lanatus*) (Dale 1971; Sturhan *et al.* 1997; Yeates 1973). For more hosts worldwide see Table 2.

Plant viruses association. It has been reported that *L. elongaus* can transmit *Carnation ringspot virus* (CRSV), *Raspberry ringspot virus* (RRSV), *Tomato black ring virus* (TBRV), *Spoon leaf virus* (SLV) and *Peach rosette mosaic virus* (PRMV) (Allen & Ebsary 1988; Fritzsche *et al.* 1979; Harrison 1964; Harrison *et al.* 1961; Taylor 1962; Taylor & Murant 1969; Taylor & Robertson 1969; van der Meer 1965). Virus particles were observed between the odontostyle and the guiding sheath of *L. elongatus* (Taylor & Robertson 1969). PRMV and RRSV are listed in BORIC by MPI in New Zealand.

Remarks. Dale (1971) first reported *L. elongatus* in New Zealand from roots of strawberries (*Fragaria* sp.) at Levin; in soil around peach trees (*Prunus persica* var. *nemaguard*) at Havelock North, and apple trees (*Malus sylvestris*) at Auckland. Subsequently, *L. elongatus* was reported from pasture, fruit trees and flowers, including lucerne (*Medicago sativa*) (Dale 1972); associated with severe stunting of lucerne in Taranaki (Yeates 1973); tulip (*Tulipa gesneriana*), cotula (*Leptinella* spp.), *Phebalium squameum* (Knight *et al.* 1997); pasture, bowling turf,

cultivated plants such as tobacco, strawberries, *Salix* sp. and various flowers, from the North Island and the South Island (Sturhan *et al.* 1997); avocado (*Persea americana*) in Taranaki and kiwifruit (*Actinidia deliciosa*) in Bay of Plenty and Nelson (Knight 2001); grazed pasture including the grasses sweet vernal (*Anthoxanthum odoratum*), perennial ryegrass (*Lolium perenne*) and Yorkshire fog (*Holcus lanatus*); legumes including white clover (*Trifolium repens*) and subterranean clover (*T. subterraneum*), and the herb catsear (*Hypochaeris radicata*) (Yeates *et al.* 2008). In the present study, two new host records were added: London plane tree (*Platanus acerifolia*) and oak tree (*Quercus* sp.). Sturhan *et al.* (1997) suggested that *L. elongatus* was almost exclusively present in cultivated soil, and may be a "European" species introduced to New Zealand by man.

SSU and D2–D3 of LSU rDNA sequences of the New Zealand *L. elongatus* populations were studied and submitted to GenBank. The phylogenetic trees showed that the New Zealand *L. elongatus* clustered with other *L. elongatus* populations in one clade, although with low support (Fig. 6).

In the present study, it is noted that one female specimens (body length 5140 µm, and odontosytle 63 µm), the same odontosytle length as J2 of *L. elongatus*. It is possibly be another species mixed with *L. elongatus*.

***Longidorus orongorongensis* Yeates, van Etteger & Hooper, 1992**

Figs 8–11. Map 2.

Measurements. Table 4.

Morphology. Females: Body ventrally curved to C shape when heat relaxed. Lip region rounded, continuous, 21–23 µm wide. Cuticle 3.2–4.4 µm thick near lip region, 3.8–5.2 µm at guide ring, 4.4–8.0 µm at base of pharynx, 5.3–7.5 µm near vulva and 6.0–17.3 µm at the tail terminus. Body pores prominent; six lateral pores present in pharyngeal region on each side of the body, first ventral and dorsal pore located anterior to the guide ring, two ventral and dorsal pores present in the odontostyle region. Amphidial fovea funnel-shaped without lobes. Odontostyle slender, 154–164 µm long, odontophore base not flanged. Guide ring situated 45–47 µm from anterior end. Nerve ring at level of odontophore base. 'Mucro' not observed. Pharyngeal bulb cylindrical, 100–135 µm long, 27–29 µm wide, position of pharyngeal gland nuclei typical of the genus. Cardia at junction of pharyngeal bulb and intestine, simple, generally with rounded projection into anterior intestine; Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 623–712 µm long, posterior reproductive system 549–835 µm long. Egg present in one specimen, 288 µm long and 55 µm wide. Vulva a transverse slit situated at mid-body length. Vagina perpendicular to body axis with a thick cuticular layer, 27–36 µm long, occupying 39–45% of corresponding body diameter. Prerectum 352–465 µm long, rectum 34–43 µm long. Tail short, bluntly conoid, 2 caudal pores present on each side.

Males: Anterior region similar to female in general morphology, but body more curved ventrally in region of supplements. Spicules large, arcuate, 81–88 µm long. Gubernaculum not observed. Tail short, bluntly conoid, and dorsally convex, with three caudal pores present on each side. Supplements comprise an adanal pair and a ventromedian series of nine beginning anterior to the proximal end of the spicules.

Juveniles: Four juvenile stages found. A replacement odontostyle present in pharyngeal region in all juvenile stages. Tip of the replacement odontostyle situated near the base of functional odontostyle in the J1. J2, J3, and J4 replacement odontostyles correlated well with the odontostyle length of the subsequent stage. The relationship between the lengths of the functional and replacement odontostyles and body length also indicated the presence of four juvenile stages (Fig. 12). In all juvenile stages the tail is broadly rounded, with three caudal pores present on each side (Figs 10–11).

Differential diagnosis. *Longidorus orongorongensis* is characterised by its large body size (7.0–8.0 mm long); lip region rounded and continuous with the body, 21–23 µm wide, amphidial fovea a large and sac-like in shape; long odontostyle (145–172 µm), guide ring far posterior and more than 63–67 µm from anterior end, at level of mid-odontostyle; female with a bluntly rounded tail less than an anal body diameter long (tail length=36–41 µm, *c*=174–223, *c'*=0.5–0.8). The male is 7.2–8.2 mm long, with ten single ventromedian supplements, a short and bluntly conoid tail bearing three caudal pores on each side, and spicules 81–88 µm long. The first stage juvenile has a bluntly rounded tail (c'=1.1–1.3). According to the polytomous key of Chen *et al.* (1997) and additional juvenile characters of Peneva *et al.* (2013), *L. orongorongensis* has the following codes: A67-B4-C5-D1-E4-F(3)4-G2-H1-I2-J1-K2.

Table 4. Morphometrics of *Longidorus orongorongensis* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	HOLOTYPE	FEMALES	MALES	J1	J2	J3	J4
n	1	4	3	12	13	6	11
L	7572	7381 ± 603 (6977–8074)	7716 ± 492 (7250–8230)	1952 ± 129 (1751–2111)	2674 ± 235 (2307–3059)	3639 ± 213 (3342–3855)	5308 ± 525 (4451–5938)
a	73.9	92.8 ± 7.8 (85.8–101.2)	97.7 ± 13.6 (85.0–112)	59.6 ± 5.5 (49.6–67.3)	65.7 ± 6.2 (53.1–72.1)	76.3 ± 7.8 (63.9–83.9)	80.8 ± 9.3 (64.1–92.2)
b	12.3	13.5 ± 1.3 (12.3–14.8)	13.7 ± 0.7 (13.0–14.3)	6.0 ± 0.6 (5.3–6.8)	6.9 ± 1.1 (5.9–10.3)	8.7 ± 0.7 (7.5–9.5)	11.2 ± 1.9 (8.4–15.4)
c	222.9	198 ± 25 (174–223)	183 ± 11 (170–192)	59.5 ± 4.4 (53.1–69.2)	74.5 ± 7.2 (64.6–87.5)	99.3 ± 5.6 (91.3–110)	132 ± 10.9 (114–147)
c'	0.5	0.7 ± 0.1 (0.6–0.8)	0.8 ± 0.0 (0.7–0.8)	1.2 ± 0.1 (1.1–1.3)	1.1 ± 0.1 (1.0–1.2)	0.9 ± 0.1 (0.8–1.0)	0.8 ± 0.1 (0.7–0.9)
V/T	52.9	52.0 ± 2.4 (49.3–53.8)	42.9 ± 6.3 (35.7–47.4)	–	–	–	–
Odontostyle	159.9	159 ± 4.9 (154–164)	156 ± 3.5 (153–160)	93.3 ± 5.1 (86.0–102)	104 ± 9.0 (90–128)	120 ± 9.3 (101–131)	139 ± 12.6 (118–166)
Odontophore	68.1	85.6 ± 5.9 (82.1–92.4)	84.8 ± 12 (71.7–95.0)	53.8 ± 8.6 (40.4–71.5)	65.3 ± 9.0 (50.9–86.1)	74.0 ± 5.8 (65.9–82.2)	77.3 ± 6.4 (65.8–88.7)
Replacement odontostyle	–	–	–	104 ± 3.9 (99.4–114)	118 ± 8.7 (107–140)	128 ± 7.9 (115–138)	151 ± 13.0 (124–167)
Pharynx length	613.7	546 ± 21.3 (525–567)	566 ± 50.2 (508–598)	327 ± 28.2 (279–378)	392 ± 48.5 (298–466)	419 ± 29.3 (371–451)	481 ± 70.5 (376–605)
Tail width	71.5	55.6 ± 4.5 (49.3–59.7)	53.3 ± 1.4 (51.6–54.3)	27.4 ± 2.7 (23.4–31.7)	34.6 ± 1.7 (32.7–38.7)	41.0 ± 1.5 (38.6–43.0)	51.8 ± 3.8 (46.8–59.8)
Tail length	34.0	38.4 ± 2.6 (36.1–41.1)	42.2 ± 2.1 (39.9–44.2)	32.9 ± 2.6 (28.4–37.7)	36.4 ± 1.9 (33.8–40.3)	36.7 ± 2.3 (33.0–39.2)	40.3 ± 4.0 (34.2–46.7)
Guide ring-anterior	66.8	65.5 ± 2.1 (63.1–67.1)	66.1 ± 1.1 (65.1–67.3)	39.8 ± 1.7 (37.8–43.2)	46.8 ± 3.7 (40.4–53.1)	53.3 ± 4.5 (47.1–60.9)	61.6 ± 5.3 (52.1–70.2)
Amphid-anterior	15.1	16.7 ± 2.0 (15.0–18.8)	16.1 ± 1.5 (14.9–17.8)	9.3 ± 1.0 (7.7–10.6)	9.6 ± 1.2 (7.6–10.8)	11.6 ± 1.3 (10.3–13.8)	13.9 ± 1.7 (10.7–16.7)
Body width at: -guide ring	55.7	46.2 ± 0.9 (45.4–47.2)	47.7 ± 0.0 (47.7)	21.6 ± 1.4 (19.9–25.4)	27.1 ± 2.5 (20.2–31.2)	32.3 ± 2.7 (26.8–36.0)	40.9 ± 3.3 (35.2–46.1)
-lip region	23.2	21.7 ± 0.5 (21.3–22.2)	21.6 ± 2.1 (19.9–24.0)	10.8 ± 0.8 (9.5–12.2)	13.6 ± 1.0 (11.4–14.8)	15.9 ± 0.7 (14.8–16.9)	19.9 ± 2.1 (16.0–22.0)
-mid-body	102.4	78.0 ± 6.5 (70.5–81.9)	79.5 ± 5.9 (73.5–85.3)	33.2 ± 5.0 (26.5–42.4)	40.8 ± 2.3 (36.9–45.4)	47.9 ± 2.9 (43.7–52.8)	66.1 ± 5.7 (55.3–74.0)
-vulva	95.8	76.6 ± 6.5 (67.7–82.7)	–	–	–	–	–
-base of pharynx	89.5	61.3 ± 7.0 (54.7–71.4)	70.8 ± 6.5 (65.7-78.1)	32.6 ± 4.7 (28.0–43.1)	38.5 ± 2.6 (35.2–45.5)	46.1 ± 3.4 (42.9–53.1)	59.3 ± 4.1 (53.1–64.4)
Bulb length	117.8	117.4 ± 14.8 (99.5–134.8)	120 ± 6.5 (114–126)	74.5 ± 5.9 (64.5–82.5)	85.9 ± 14.7 (50.1–103)	97.7 ± 10.8 (80.2–112)	101.1 ± 10.9 (81.5–115)
Bulb diameter	31.9	28.0 ± 0.9 (27.4–29.3)	30.0 ± 2.6 (27.0-31.7)	17.1 ± 2.1 (13.9–21.9)	19.7 ± 2.8 (13.1–23.6)	23.5 ± 2.0 (21.6–27.5)	28.2 ± 8.8 (22.8–54.1)
Rectum	45.7	39.2 ± 4.2 (33.6–43.3)	–	–	–	–	–
Cuticle at: -lip region	3.5	3.8 ± 0.6 (3.2–4.4)	4.4 ± 0.5 (3.9-4.7)	1.4 ± 0.3 (1.1–2.1)	2.0 ± 0.4 (1.5–2.8)	2.3 ± 0.4 (1.7–2.7)	2.7 ± 0.8 (1.3–3.9)
-guide ring	4.2	4.6 ± 0.7 (3.8–5.2)	5.0 ± 0.4 (4.6–5.4)	1.7 ± 0.3 (1.3–2.5)	2.1 ± 0.6 (1.3–2.8)	2.5 ± 0.4 (1.8–3.0)	3.4 ± 0.7 (1.7–4.1)
-base of pharynx	5.2	5.5 ± 1.7 (4.4–8.0)	4.7 ± 0.1 (4.7–4.8)	2.0 ± 0.4 (1.4–2.8)	2.4 ± 0.8 (1.8–4.7)	3.2 ± 0.8 (2.0–4.5)	3.5 ± 0.6 (2.7–5.0)
-vulva	5.2	6.1 ± 1.0 (5.3–7.5)	–	–	–	–	–
Tail hyaline	25.2	16.8 ± 1.6 (15.5–18.8)	15.1 ± 1.4 (4.5–7.2)	8.5 ± 1.2 (6.4–10.0)	9.4 ± 1.0 (7.9–11.4)	10.8 ± 0.9 (9.3–11.7)	13.3 ± 1.4 (10.5–15.0)
Spicules	.	.	84.7 ± 3.6 (81.2–88.4)	.	.	.	.

Material examined. Holotype and 49 paratype specimens. **Holotype** female. New Zealand: NNCNZ, slide No. 143. **Paratypes**: four females, three males and 42 juveniles, NNCNZ, slide nos 2123–2149.

Distribution (Map 2). From material examined: New Zealand: **North Island**: Orongorongo Valley, WN. World distribution: reported only from New Zealand.

Habitat and hosts. From material examined: New Zealand: broadleaved forest associated with *Dacrydium cupressinum*, *Metrosideros robusta*, *Prumnopitys ferrugineus* and *P. taxifolius*.

Plant viruses association. Unknown.

Remarks. *Longidorus orongorongensis* has only been reported from New Zealand. Attempts to re-collect the nematode at the type location in 2014 failed.

The distance of the guide ring from the anterior end is an important morphological character for species identification within *Longidorus*. Having the guide ring at mid-odontostyle level (*ca* 60 µm from anterior end) (Robbins & Brown 1991) may be considered as an ancestral trait (Chen *et al.* 1997; Heyns *et al.* 1987; Robbins & Brown 1991; Xu & Cheng 1991). The guide ring of *L. orongorongensis* is in the mid-odontostyle area (Barsalote *et al.* 2018; Xu *et al.* 2017).

***Longidorus taniwha* Clark, 1963**

Figs 13–16. Map 3.

Measurements. Table 5.

Morphology. Females: Body ventrally curved to C shape when heat relaxed. Cuticle 1.5–2.8 µm thick near lip region, 2.4–3.9 µm at guide ring, 3.2–5.8 µm at base of pharynx, 3.6–4.8 µm near vulva and 10–16 µm at the tail terminus. Lip region continuous with body contour, 15–17 µm wide. Body pores not observed under light microscope. Amphidial fovea large, pocket-shaped, symmetrical bilobed. Odontostyle slender, 120–128 µm long. Odontophore base slightly swollen. Guide ring situated 51–58 µm from anterior end. Excretory pore not observed. Nerve ring posterior to base of odontophore. 'Mucro' not observed. Pharyngeal bulb cylindrical, 112–118 µm long, 31–34 µm wide, position of pharyngeal gland nuclei typical of the genus. Junction between pharyngeal bulb and intestine has a medium, but variable pharyngo-intestinal valve. Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 483–610 µm long, posterior reproductive system 487–720 µm long. Vulva a transverse slit situated at mid-body length. Vagina perpendicular to body axis with a thick cuticular layer, 30–32 µm long, occupying 29–37% of corresponding body diameter. Spermatozoa present. Prerectum 71 µm long (in one specimen). Rectum 28–34 µm long. Tail short, 22–37 µm, conoid, two caudal pores present on each side.

Males: (after Clark 1963a). Anterior region similar to female in general morphology, but body more curved ventrally in region of supplements. Spicules large, arcuate, 75 µm long, lateral guiding pieces 12 µm long (re-measured from the line drawing of Clark (1963a)). Gubernaculum not observed. Tail short, bluntly conoid, and dorsally convex, with two caudal pores present on each side. Supplements an adanal pair and a ventromedian series of 14 beginning anterior to the proximal end of the spicules.

Juveniles: Three juvenile stages found. A replacement odontostyle present in pharyngeal region in all juvenile stages. Tip of the replacement odontostyle situated near the base of functional odontostyle in the J1. In all juvenile stages the tail is broadly rounded (Figs 15–16).

Differential diagnosis. *Longidorus taniwha* is characterised by females of medium body size (4.3–4.7 mm long), the lip region continuous with body contour, 15–17 µm wide; amphidial fovea large, pocket-shaped, shallowly or distinctly bilobed, symmetrical; a medium odontostyle (119–128 µm), guide ring 51 µm from the anterior end; and a bluntly rounded tail (tail length=22–37 µm, *c*=128–197, *c'*=0.5–0.7). The male is 3.9–4.6 mm long, with 15 single ventromedian supplements, a short and bluntly conoid tail bearing two caudal pores on each side, and spicules 75 µm long. The polytomous key code of Loof & Chen (1999) is A34-B3-C45-D1-E2-F2-G12-H1-I2.

Material examined. Holotype and 7 paratype specimens. **Holotype** female. New Zealand: NNCNZ, slide No. 16. **Paratypes**: one female, six juveniles, NNCNZ, slide nos 359–364.

Table 5. Morphometrics of *Longidorus taniwha* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	HOLOTYPE	FEMALES	J1	J2	J3	MALES (CLARK 1963)
n	1	2	1	1	4	3
L	4370	4676, 4739	3096	2281	2981 ± 171 (2812–3201)	4200 ± 386 (3860–4620)
a	50.0	43.2, 59.4	45.7	41.8	43.2 ± 4.4 (40.4–48.3)	49.0 ± 3.6 (46.0–53.0)
b	11.8	11.2, 9.6	6.5	6.3	6.9 ± 0.5 (6.2–7.3)	8.2 ± 0.5 (7.7–8.7)
c	197	194, 128	106	?	89.1 ± 1.2 (88.2–89.9)	132 ± 23 (108–154)
c'	0.7	0.5, 0.7	0.7	?	0.7 ± 0.0 (0.7–0.7)	N/A
V/T	51.6	52.6, 48.8	–	–	–	N/A
Odontostyle	122	119, 128	93.1	78.6	97.0 ± 12.5 (81.1–111)	115 ± 9.3 (107–125)
Odontophore	81.8	82.2, 92.0	65.5	42.3	61.6 ± 20.4 (43.9–90.8)	N/A
Replacement odontostyle	–	–	142	91.5	117 ± 8.4 (109–129)	–
Pharynx length	369	418, 495	476	364.8	432 ± 33.1 (386–464)	N/A
Tail width	34.1	51.8, 56.1	43.0	?	48.7 ± 4.0 (45.9–51.5)	N/A
Tail length	22.2	24.1, 37.0	29.3	?	32.8 ± 1.3 (31.9–33.7)	N/A
Guide ring-anterior	51.1	50.6, 58.5	42.5	31.2	42.7 ± 5.6 (36.3–46.0)	N/A
Body width at: -guide ring	29.2	41.1, 42.0	29.5	23.3	32.4 ± 4.6 (27.5–36.7)	N/A
-lip region	?	17.1, 14.8	12.2	11.4	14.4 ± 2.3 (12.5–17.6)	N/A
-mid-body	63.8	117.4, 82.2	67.8	54.6	70.1 ± 7.8 (62.6–78.1)	N/A
-vulva	87.3	108.1, 79.8	–	–	–	N/A
-base of pharynx	?	85.6, 75.2	69.0	50.6	62.8 ± 14.3 (47.9–76.5)	N/A
Rectum	33.8	30.5, 28.4	–	–	–	N/A
Tail hyaline	9.9	13.3, 16.5	13.4	11.8	13.0 ± 1.1 (11.6–13.9)	N/A

?: the data not available from the specimens. N/A: not available in the original paper.

Distribution (Map 3). From material examined: New Zealand: **South Island:** Johnson's Scenic Reserve, Barrytown, BR; Runanga, BR; Westland, WD.

From literature: New Zealand: **North Island**: Wellington, WN; MB and SD; **South Isand**: Nelson district, NN; West Coast, WD; Southland, SL; WA and BR (the localities in the Map 3 were estimated from map provided by Sturhan *et al*. 1997, same below) (Sturhan *et al*. 1997; Yeates *et al*. 1992). For world distributions see Table 2.

Habitat and hosts. From material examined: New Zealand: *Agrostis capillaris, Carpodetus serratus*, *Holcus lanatus*, *Juncus* sp., Kamahi (*Leiospermum racemosum*), *Locus uliginosus* and *Ranunculus acris*.

From literature: New Zealand: kowhai (*Sophora microphylla*) and wet pasture (Sturhan *et al*. 1997).

Plant viruses association. Unknown.

Remarks. *Longidorus taniwha* was originally reported from the South Island by Clark (1963a). Subsequently, it was recorded from virgin forest in Wellington (Yeates *et al*. 1992), the West Coast and Nelson district, central South Island, and Southland; with a single record from the North Island (Sturhan *et al*. 1997). Attempts to re-collect this nematode in 2014 were not successful. In the present study, the holotype and paratypes

were re-examined, but two paratype males which had been deposited in the Nematode Collection, Entomology Division, D.S.I.R., Nelson, could not found.

Longidorus taniwha has been reported also from Egypt and France (Aboul-Eid 1970; Dalmasso 1969; Oteifa & Tarjan 1965; Tarjan 1964), but it is probable that there were other *Longidorus* species (Loof 1982; Sturhan *et al.* 1997). Loof (1982) thought that *L. taniwha* from Egypt was probably *L. orientalis* Loof, 1982, and Sturhan *et al.* (1997) reported that specimens from France were not *L. taniwha*.

Three developmental juvenile stages of *L. taniwha* present as reported by Yeates & Van Etteger (1991) and Robbins *et al.* (1995). Here, J1 juveniles had a much longer odontostyle and replacement odontostyle length (93 and 142 µm) than those of J2 (79 and 92 µm, respectively) and J3 (81–111 and 109–129 µm, respectively). Furthermore, the J1 has the typical characteristic of J1 of the genus *Longidorus*, i.e., the replacement odontostyle is inserted into the odontophore base.

***Longidorus waikouaitii* Yeates, Boag & Brown, 1997**

Figs 17–18. Map 4.

Measurements. Table 6.

Morphology. Females: Body ventrally curved to C shape when heat relaxed. Lip region rounded, continuous with body, 22–24 µm wide. Cuticle 3.3–4.3 µm thick near lip region, 5.0 µm at guide ring (only seen in one specimen), 4.8–5.0 µm at base of pharynx, 5.5–5.6 µm near vulva and 11–13 µm at the tail terminus. Body pores indistinct; three ventral pores in pharyngeal region, a few dorsal pores posterior to pharynx. Amphidial fovea funnel-shaped without lobes. Odontostyle slender, 116–120 µm long, odontophore base not flanged. Guide ring situated 60 µm from anterior end. Nerve ring posterior to base of odontophore. 'Mucro' not observed. Pharyngeal bulb cylindrical, 130–143 µm long, 42–48 µm wide, position of pharyngeal gland nuclei typical of the genus. Cardia at junction of pharyngeal bulb and intestine, simple, lacking obvious disc or projection into anterior intestine. Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 390–465 µm long, posterior reproductive system 409–424 µm long. Vulva a transverse slit situated at mid-body length. Vagina perpendicular to body axis with a thick cuticular layer, 36–37 µm long, occupying 36–37% of corresponding body diameter. Prerectum 333 µm long. Rectum 42–47 µm long. Tail short, bluntly conoid, two caudal pores present on each side.

Males: Not found.

Juveniles: Only pre-adult stages found. A replacement odontostyle present in the pharyngeal region, length of which correlated well with female odontostyle length. Thus, the stage found is a third or fourth developmental stages. Tail broadly rounded, with two caudal pores present on each side.

Differential diagnosis. *Longidorus waikouaitii* is characterised by having a large body size (7 mm long), a bluntly conoid lip region continuous with body contour, medium length odontostyle (116–120 µm), posteriorly situated guide ring 61 µm from the anterior end. Additional juvenile information was not collected. The polytomous key code of Loof & Chen (1999) is A4-B3-C5-D1-E4-F3-G12-H1-I2.

Material examined. Holotype and eight paratype specimens. **Holotype** female. New Zealand: NNCNZ, slide No. 171. **Paratypes**: one female and seven juveniles, NNCNZ, slide nos 2517–2520.

Distribution (Map 4). From the material examined. New Zealand; **South Island:** Goodwood Scenic Reserve, south east of Palmerston, DN. World distribution: only reported from New Zealand.

Habitat and hosts. From material examined: New Zealand: *Sophora microphylla* and *Melicytus ramiflorus*.

Plant viruses association. Unknown.

Remarks. *Longidorus waikouaitii* was named as a nationally critical species by Yeates *et al.* (2012), using the threat classification based on Yeates (2010) with the criteria of Townsend *et al.* (2008) and Stringer & Hitchmough (2012). Until now, *L. waikouaitii* was only collected from the type location in New Zealand. Attempts to re-collect it in 2014 were not successful, and the present study comprised only re-examination of the holotype and paratypes. Note that *L. waikouaitii* belongs to the group of *longidorus* with the guide ring at mid-odontostyle, as in *L. orongorongensis* (Xu *et al.* 2017).

Table 6. Morphometrics of *Longidorus waikouaitii* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

	HOLOTYPE	PARATYPES	
CHARACTERS	FEMALE	FEMALE	J3/J4
n	1	1	7
L	6961	6541	5448 ± 400 (4901–5989)
a	66.9	65.4	76.3 ± 8.7 (64.5–88.4)
b	12.1	11.2	10.4 ± 0.4 (9.6–10.9)
c	159.9	179.4	140 ± 9.3 (122–150)
c'	0.6	0.7	0.7 ± 0.0 (0.6–0.7)
V/T	50.9	51.9	–
Odontostyle	120.2	115.6	101 ± 1.8 (100–104)
Odontophore	104.5	75.2	79.4 ± 16.7 (63.4–105.2)
Replacement odontostyle	–	–	115 ± 2.1 (112–118)
Pharynx length	578	585	528 ± 54.6 (463–600)
Tail width	79.1	52.3	59.0 ± 7.7 (50.3–73.3)
Tail length	43.5	36.5	39.2 ± 4.4 (32.6–44.5)
Guide ring-anterior	60.6	?	51.9 ± 3.1 (47.4–55.7)
Amphid-anterior	14.5	11.5	12.3 ± 1.2 (11.2–14.1)
Body width at: -guide ring	58.6	?	39.0 ± 6.2 (31.4–47.8)
-lip region	24.1	21.8	17.8 ± 1.0 (15.8–18.9)
-mid-body	104.1	100.1	72.6 ± 13.0 (62.1–92.8)
-vulva	103.0	95	–
-base of pharynx	109.2	112.8	71.8 ± 14.6 (55.3–93.2)
Bulb length	130.5	143.0	128 ± 9.5 (116–140)
Bulb diameter	48.5	41.8	32.9 ± 3.2 (27.4–36.5)
Rectum	47.0	41.8	–
Cuticle at: -lip region	4.3	3.3	2.3 ± 0.2 (2.0–2.6)
-guide ring	5.0	?	3.1 ± 0.6 (2.1–4.0)
-base of pharynx	4.8	4.9	4.0 ± 0.4 (3.4–4.6)
-vulva	5.6	5.5	–
Tail hyaline	12.7	11.1	12.1 ± 0.5 (11.5–13.0)

?: the data not available from the specimens.

Subfamily XIPHINEMATINAE Dalmasso, 1969

Diagnosis: Adapted from Hunt (1993). Longidoridae. Body from 1.5 to 6 mm long. Amphidial apertures broad, transverse slits. Amphidial fovea stirrup-shaped. Odontostyle heavily sclerotized with a furcate base. Odontophore with heavily sclerotized, well developed basal flanges. Guide ring located near the odontostyle and odontophore junction, usually appearing 'double' when the odontostyle is retracted. Guide sheath extending anterior to guide ring when the odontostylet is retracted. Dilatores buccae present. Dorsal pharyngeal gland nucleus slightly oval in shape and larger than the ventrosublateral gland nuclei and located adjacent to its orifice. Female genital tracts may be amphididelphic or monodelphic with a concomitant shift in the vulval position. Male ventromedian copulatory supplements numbering up to seven; a gap present between adanal pair and beginning of series. Until now, only one genus (*Xiphinema* Cobb, 1913) is present in the subfamily Xiphinematinae Dalmasso, 1969 (Coomans 1985, 1996, Coomans *et al.* 2001).

Genus *Xiphinema* Cobb, 1913

Diagnosis: Adapted from Hunt (1993). Xiphinematinae. Body long to very long, 1.5–6.0 mm, and fairly stout. Heat relaxed form straight, ventrally arcuate, C-shaped or an open spiral. Cuticle smooth. Cephalic region rounded, continuous or offset. Lips fused with the usual 6 + 10 circlets of cephalic papillae. Amphidial apertures broad slits extending for almost the entire lip width. Amphidial fovea stirrup- or funnel- shaped. Odontostyle elongate, needle-like; heavily sclerotized. Guiding apparatus tubular with a strongly sclerotized posterior ring and, apparently, a lightly sclerotized anterior ring (really just a fold in the guiding sheath). The guide ring proper posteriorly located, near the odontostyle and odontophore junction. Proximal end of odontostyle appears forked at its junction with the flanged odontophore. Pharynx comprising a narrow, cylindrical anterior section, normally looped back on itself, leading to a cylindroid expansion containing the glands. Dorsal gland nucleus located close to dorsal gland orifice, larger than ventrosublateral nuclei. Nerve ring around anterior section of the pharynx. Hemizonid prominent. Intestine simple, prerectum well developed and several anal body diameter long. Anus a transverse slit. Vulva located anteriorly to post-median, in the form of a transverse slit. Vagina well developed, muscular; at right angles to the body axis or posteriorly directed in some forms with an anterior vulva. Ovijector prominent. Genital tract variable; often amphididelphic reflexed, but as the vulva migrates anteriorly, the anterior branch progressively regresses, first becoming non-functional, then a remnant and finally completely absent. Some species have sclerotized structures in the uterus. Rarely these sclerotizations are found in Z organ, a specialized structure with thick walls and circular muscles which is constricted at both ends by a sphincter. More commonly the sclerotizations take the form of spines or variously shaped structures in the uterus. Tail form variable, e.g. short hemispheroid, with or without a digitate process; medium to long conoid; initially conoid, attenuating to a filiform terminal section. Male genital tract diorchic, opposed. Spicules paired, massive, ventrally curved with distal accessory guiding pieces. Oblique copulatory muscles prominent and extending anteriorly from the cloaca. Copulatory supplements consisting of an adanal pair followed by a gap and then a ventromedian series of up to seven papillae. Tail similar to that of female.

Dagger nematodes of the genus *Xiphinema* comprise plant-parasitic species that damage a wide range of wild and cultivated plants through direct feeding on root cells or transmission of plant pathogenic viruses (Decraemer & Robbins 2007; Taylor & Brown 1997). They can cause root symptoms including darkening of tissues, cortical hyperplasia, lateral root proliferation, tip galling and necrosis (Hunt 1993). Owing to its large morphological diversity, the genus *Xiphinema* was divided into two different species groups: *Xiphinema americanum*-group and *Xiphinema* non-*americanum*-group (Coomans *et al*. 2001; Lamberti *et al*. 2000; Loof & Luc 1990). Some species of both groups are vectors of several important plant viruses that cause significant damage to a wide range of crops. This transmission is governed by a marked specificity between plant viruses and their *Xiphinema* spp. vectors. Among these species, nine of the approximately 260 known species of *Xiphinema* (Palomares-Rius *et al.* 2017) have been shown able to transmit nepoviruses (Decraemer & Robbins 2007).

Key to *Xiphinema americanum*-group and *Xiphinema* non-*americanum*-group

1 Female with two equally developed genital branches, usually with short uteri without uterine differentiation; short conoid tail (c'<2.5) with more or less acute terminus, sometimes subdigitate; female without sperm, male uncommon ..... *Xiphinema americanum*-group

\- Female anterior genital branch reduced or absent, with long uteri and uterine differentiation, including 'Z-organ', spines, or crystalloid structures; tail shape variable, including long filiform to conical shape or short rounded to hemispherical; female with sperm, male abundant..... *Xiphinema* non-*americanum*-group

Xiphinema americanum-group

The *Xiphinema americanum*-group of plant-parasitic nematodes is one of the most difficult dagger nematode species complexes for diagnosis because the morphology is very conservative and morphometric characters often overlap (Archidona-Yuste *et al.* 2016b). In addition, the existing keys (Lamberti *et al*. 2000, 2004) do not always allow species differentiation and identification, so species delimitation within this group is challenging even for experienced nematologists (Lazarova *et al*. 2016). The group is characterised by a spiral or C-shaped body, of

length less than 2.2 mm, odontostyle and odontophore together less than 150 µm long, vulva position postequatorial, female reproductive system with two equally developed genital branches, usually with short uteri without uterine differentiation, and short conical to broadly convex-conoid tail. Vulva at 42–65% of body length, amphidial fovea stirrup-shaped, short conoid tail (c'<2.5) with more or less acute terminus, sometimes subdigitate, females without sperm, males uncommon with posterior-most medioventral supplement close to paired precloacal papillae (Archidona-Yuste *et al.* 2016b; Lamberti & Ciancio, 1993; Lamberti *et al.* 2000).

The *Xiphinema americanum*-group has from 34 (Coomans *et al.* 2001; Luc *et al.* 1998) to more than 50 recognized species (Lamberti *et al.* 2000, 2004). Since 2004, ten species were added to this group (Archidona-Yuste *et al.* 2016b; Gozel *et al.* 2006; Gutiérrez-Gutiérrez *et al.* 2012; Lazarova *et al.*, 2016, 2019; Mobasseri *et al.* 2019). To date, 64 species of the *Xiphinema americanum*-group have been recorded worldwide. The distributions and the hosts of *Xiphinema americanum*-group species are listed in Table 7. Among the *X. americanum*-group, six putative species including *X. americanum* s. str., *X. bricolense* Ebsary, Vrain & Graham, 1989, *X. californicum* Lamberti & Bleve-Zacheo, 1979, *X. intermedium* Lamberti & Bleve-Zacheo, 1979, *X. rivesi* Dalmasso, 1969 and *X. tarjanense* Lamberti & Bleve-Zacheo, 1979, are known to transmit nepoviruses. The nepoviruses include *Tobacco ringspot virus* (TRSV), *Tomato ringspot virus* (ToRSV), *Cherry rasp leaf virus* (CRLV), and PRMV (Decraemer & Robbins 2007; Hunt 1993; Taylor & Brown 1997).

Two *Xiphinema americanum*-group species (*X. brevicolle* and *X. waimungui*) are reported here from New Zealand.

Table 7. Species, world distribution and hosts of *Xiphinema americanum*-group.

SPECIES	WORLD DISTRIBUTION	HOSTS
X. americanum Cobb, 1913=*Tylencholaimus americanus* (Cobb, 1913) Micoletzky, 1922	Australia, Brazil, Canada, Chile, China, French West Indies, India, Italy, Japan, Korea, Mexico, Pakistan, South Africa, Spain, Trinidad, Turkey, USA, Uzbekistan, Venezuela, Uruguay, USSR	*Acer negundo, Acer saccharum*, *Annona squamosa*, *Beaumontia grandiflora*, *Cerasus pseudocerasus, Citrus sinensis*, *Cocos nucifera, Cydonia oblonga, Dendrocalamus strictus, Elaeagnus angustifolia, Fragaria × ananassa*, *Glycine max*, grass, *Juniperus* sp., *Liquidambar styraciflua*, *Litchi chinensis, Lupinus angustifolius, Malus domestica*, *Mangifera indica*, *Manilkara zapota*, *Medicago sativa*, *Nicotiana tabacum, Panicum virgatum, Pittosporum tobira* , *Pinus ponderosa, Prunus persica*, *Psidium* sp., *Quercus indica*, *Quercus shumardii*, *Ribes nigrum, Rosa indica*, *Rubus caesius*, *Rubus vestitus*, *Saccharum officinarum*, *Solanum tuberosum*, *Vaccinium angustifolium*, *Vitis vinifera, Zea mays*
X. astaregiense Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	Graminaceae
X. bacaniboia Orton Williams, 1984	Fiji	*Alpinia boia*
X. bambusi Ganguly, Singh & Procter, 2000	Bhutan	*Bambusa* sp.
X. bhutanense Ganguly, Singh & Procter, 2000	Bhutan	*Pinus* sp.
X. brevicolle Lordello & Da Costa, 1961=*X. americanum* apud Carvalho (1955, 1962)=*X. saopaoloense* Khan & Ahmad, 1975	Africa, Belize, Brazil, Bulgaria, China, Czech Republic, Hungary, India, Italy, Japan, Kenya, Malawi, Malaysia, Martinique, Mauritius, New Zealand, Pakistan, Peru, Poland, Slovakia, South Africa, USA, Western Indian Ocean, Yugoslavia (former)	*Acer* sp., *Anacardium occidentale, Araucaria* sp., *Berberis* sp., bowling green grasses, *Citrus reticulate, Citrus* sp., *Citrus trifoliate, Coffea* sp., *Eriobotrya japonica, Ilex crenata*, *Juglans regia*, *Ligustrum* sp., *Litchi chinensis, Malus pumila, Mangifera indica, Musa acuminata, Musa* sp., *Neopanax arboreus*, *Nephelium lappaceum,Phormium* sp., *Platanus occidentalis, P. orientalis, Prunus armeniaca, Prunus persica*, *Prunus pseudocerasus*, *Prunus* sp., *Punica granatum, Pyrus* sp., *Ribes nigrum, Rosa rugosa, Rosa* sp., *Saccharum officinarum, Theobroma cacao, Trifoliata* sp., *Vitis vinifera*, *Zea mays*

..... *continued on the next page*

Table 7 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. brevisicum Lamberti, Bravo, Agostinelli & Lemos, 1994	Portugal	*Pinus* sp., *Vitis* sp., *Vitis vinifera*
X. bricolense Ebsary, Vrain & Graham, 1989	Canada	*Malus domestica*
X. browni Lazarova, Peneva & Kumari, 2016 =*Longidorus pachtaicus* Tulaganov, 1938=*X. mediterraneum* Martelli & Lamberti, 1967= *X. pachtaicum* (Tulaganov, 1938) Kirjanova, 1951=*X. neoelongatum* Bajaj & Jairajpuri, 1976	Brazil, Bulgaria, Caribbean sea, Chile, Czech Republic, Cyprus, France, Greece, India, Iran, Israel, Itlay, Jordan, Macedonia, Moldavia, Montenegro, Morocco, Portugal, Serbia, Slovakia, South Africa, Spain, Trinidad, Tunisia, Turkey, USA, Yoguslavia (former)	*Acer campestre*, *Allium cepa*, *A. schoenoprasum*, *Asclepias syriaca*, *Carpinus orientalis*, *Celtis australis*, *Cupressus sempervirens*, *Ficus carica*, grass, *Juglans regia, Lolium perenne*, *Malus domestica*, *Olea europaea*, *Pisum sativum, Prunus armeniaca, Prunus avium, Prunus persica*, *Prunus* sp., *Psidium guajava, Pteridium aquilinum, Quercus* sp., *Robinia pseudoacacia*, *Rosa canina*, *Rubus idaeus, Rubus* sp., *Solanum tuberosum, Tilia tomentosa, Vitis vinifera*
X. californicum Lamberti & Bleve-Zacheo, 1979	Brazil, Chile, Italy, Mexico, Peru, USA	*Canarium album, Canna* sp., *Citrus paradisi*, *Cocos nucifera, Ipomoea batatas*, *Malus domestica*, *Medicago sativa*, *Olea europaea*, *Persea americana*, *Sorghum* sp., *Zea mays*
X. citricolum Lamberti & Bleve-Zacheo, 1979	USA	*Celtis occidentalis*, *Citrus aurantium, Citrus jambhiri, Citrus limon, Citrus reticulate, Cleopatra mandarin*, *Coccoloba uvifera, Cynodon dactylon*, *Quercus robur*, *Schinus terebinthifolia*
X. diffusum Lamberti & Bleve-Zacheo, 1979	Africa, Brazil, Chile, France, Gambia, Israel, Ivory Coast. Jamica, Malawi, Madagascar, Mauritius, Portugal, South Africa, Sri Lanka, USA, Western Indian ocean	*Artocarpus altilis*, *Casuarina equisetifolia, Citrus* sp., *Cocos nucifera, Coffea arabica,* grasses, *Pelargonium* sp., *Saccharum officinarum*, *Vitis vinifera*
X. duriense Lamberti, Lemos, Agostinelli & d'Addabo, 1993	Spain, Portugal	Unidentified weeds, *Vitis vinifera*,
X. floridae Lamberti & Bleve-Zacheo, 1979	Peru, USA	*Canna edulis*, *Citrus aurantium*, *Citrus* sp., *Coccoloba uvifera*, *Monarda punctata*, *Persea americana*, *Pinus* sp., *Quercus robur*, *Uniola paniculata*
X. fortuitum Roca, Lamberti & Agostinelli, 1988	Italy	*Prunus persica*
X. franci Heyns & Coomans, 1994	Malaysia, Western Indian Ocean	*Cocos nucifera*, grasses and shrubs, *Musa acuminara Musa acuminata* cv. *rastali*
X. georgianum Lamberti & Bleve-Zacheo, 1979	Brazil, USA	*Juniperus* sp., *Magnolia* sp., *Pinus* sp., *Quercus robur*, *Saccharum officinarum*
X. himalayense Ahmad, Lamberti, Rawat, Agostinelli & Srivastava, 1998	India	Unidentified wild grasses
X. inaequale Khan & Abroad, 1977=*X. neoamericanum* Khan & Abroad, 1975=*X. neoamericanum* Saxena, Chabbra & Joshi, 1971	Chile, India, Peru	*Camellia sinensis, Mangifera indica, Vitis vinifera*
X. incertum Lamberti, Choleva & Agostinelli, 1983	Bulgaria, Croatia, Serbia, Spain, Yugoslavia (former)	*Ceratonia siliqua*, grasses, *Rubi coreanus, Rubus idaeus, Vitis vinifera*
X. incognitum Lamberti & Bleve-Zacheo, 1979	Egypt, Japan, South Africa	*Aphananthe aspera, Aucuba japonica, Callicarpa japonica, Camellia japonica, Carpinus tschonoskii, Castanea crenata, Celtis sinensis, Cercidiphyllum japonicum, Chamaecyparis pisifera, Cleyera japonica, Cornus controversa, Daphniphyllum macropodum, Euonymus hamiltonianus, Euonymus japonicus, Eurya japonica, Fatsia japonica, Idesia polycarpa, Ilex crenata, Ilex integra, Juniperus* sp.,

..... continued on the next page

Table 7 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. incognitum Lamberti & Bleve-Zacheo, 1979		*Kerria japonica, Ligustrum japonicum, Magnolia obovata, Pinus densiflora, Pinus thunbergii, Podocarpus macrophyllus, Prunus* × *yedoensis, Quercus glauca, Quercus salicina, Quercus serrata, Rhus succedanea, Styrax japonicus, Taonabo japonica, Viburnum odoratissimum* var. *awabuki, Zelkova serrata*
X. intermedium Lamberti & Bleve-Zacheo, 1979	Pakistan, USA	*Citrus* sp., *Vitis vinifera*
X. kesarii Salalia, Siddiqui & Parihar, 2002	India	*Ficus carica*
X. kosaigudense Quraishi & Das, 1984	India	*Vitis vinifera*
X. laevistriatum Lamberti & Bleve-Zacheo, 1979	USA	*Casuarina* sp., *Citrus* sp., *Pinus palustris*, *Pinus* sp., *Quercus robur*, *Quercus virginiana*
X. lambertii Bajaj & Jairajpuri, 1977	India	*Cajanus cajan, Mangifera indica*
X. longistilum Lamberti, Bravo, Agostinelli & Lemos, 1994	Portugal	Unidentified weeds
X. luci Lamberti & Bleve-Zacheo, 1979	Brazil, Senegal, USA	*Acer rubrum, Apium graveolens*, *Borrichia arborescens, Pandanus utilis*
X. madeirense Brown, Faria, Lamberti, Halbrendt, Agostinelli & Jones, 1993	Portugal	*Humulus lupulus*, *Laurus nobilis, Prunus persica*, *Vitis vinifera*, weeds
X. mali Ganguly, Singh & Kaushal, 2002	Nepal	*Malus domestica, Malus pumila*
X. mesostilum Lamberti, Bravo, Agostinelli & Lemos, 1994	Portugal	*Olea europaea*
X. microstilum Lamberti, Bravo, Agostinelli & Lemos, 1994	Portugal	Unidentified weeds
X. minor Ahmad, Lamberti, Rawat, Agostinelli & Srivastava, 1998	India	*Pinus roxburghii*
X. occiduum Ebsary, Potter & Allen, 1984	Canada	Grass
X. opisthohysterum Siddiqi, 1961	India, Portugal, Senegal, Spain	*Abutilon pannosum*, *Aegle marmelos*, *Boerhaavia diffusa*, *Citrus limon, Citrus sinensis*, *Eugenia jambolana,* grasses, *Mangifera indica, Saccharum officinarum, Tridax procumbens*
X. oxycaudatum Lamberti & Bleve-Zacheo, 1979	Brazil, Iran, Kenya, Nigeria, Pakistan	*Citrus* sp., *Elaeis guineensis, Prunus* sp.
X. pachydermum Sturhan, 1983	Pakistan, Portugal, Yugoslavia (former)	*Abies alba, Euphorbia cyparissias*, *Tilia tomentosa, Trifolium* sp., *Pteridium aquilinum, Populus* sp., *Robinia pseudoacacia*, *Vitis vinifera*
X. pacificum Ebsary, Vrain & Graham, 1989	Canada, USA	*Prunus persica, Vitis vinifera*
X. pakistanense Nasira & Maqbool, 1998	Pakistan	*Onosma hispida*
X. parabrevicolle Gutiérrez-Gutiérrez, Cantalapiedra - Navarrete, Decraemer, Vovlas, Prior, Rius & Castillo, 2012	Israel, Italy, Spain	*Ammophila arenaria, Pistacia lentiscus*
X. paramonovi Romanenko, 1981=*X. parameriсanum* Romanenko 1973 *nomen nudum*	Russia	*Malus domestica*, *Pyrus communis*
X. parapachydermum Gutiérrez-Gutiérrez, Cantalapiedra-Navarrete, Decraemer, Vovlas, Prior, Rius & Castillo, 2012	Spain	*Olea europaea*, *Vitis vinifera*
X. parasimile Barsi & Lamberti, 2004	Bulgaria, Serbia	*Carpinus betulus, Quercus* sp., *Vitis vinifera*
X. paratenuicutis Gutiérrez-Gutiérrez, Cantalapiedra- Navarrete, Decraemer, Vovlas, Prior, Rius & Castillo, 2012	Spain	Grasses
X. parvum Lamberti, Ciancio, Agostinelli & Coiro, 1992	Jamaica	*Artocarpus altilis*

..... *continued on the next page*

Table 7 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. penevi Lazarova, Peneva & Kumari, 2016	Morocco	*Quercus ilex*
X. peruvianum Lamberti & Bleve-Zacheo, 1979	Brazil, Chile, Peru	*Canna* sp., *Citrus* sp., *Coffea arabica, Olea europaea, Persea americana*, *Zea mays*
X. plesiopachtaicum Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
X. pseudoguirani Lamberti, Ciancio, Agostinelli & Coiro, 1992	Madagascar, Western Indian Ocean	*Trilisa odoratissima*
X. rivesi Dalmasso, 1969	Argentina, Australia, Canada, Chile, Egypt, France, Iran, Italy, Pakistan, Peru, Portugal, Spain, Slovenia, USA	*Acer palmatum*, *Allium sativum*, *Citrus sinensis*, *Citrus* sp., *Corylus Americana*, *Malus domestica*, *Malus pumila, Mangifera indica*, *Medicago sativa*, *Pinus strobus*, *Populus* sp., *Prunus avium*, *Prunus persica*, *Prunus pseudocerasus, Rubus* sp., *Salix* sp., *Vitis vinifera*
X. santos Lamberti, Lemos, Agostinelli & d'Addabo, 1993	Egypt, Portugal, Spain	*Humulus lupulus, Pinus pinea*, *Pinus* sp., *Vitis vinifera*
X. sheri Lamberti & Bleve-Zacheo, 1979	Thailand, USA	*Coffea* sp., *Gymnocladus dioica, Rubus* × *loganobaccus*
X. silvaticum Luc & Williams, 1978	Mauritius	*Saccharum officinarum*
X. simile Lamberti, Choleva & Agostinelli, 1983	Bulgaria, Hungary, Kenya, Montenegro, Serbia, Slovakia, Yugoslavia (former)	*Acer* sp., *Cornus sp.*, *Crataegus monogyna*, Poaceae, *Populus alba*, *Prunus cerasifera*, *Quercus robur* subsp. *pedunculiflora*, *Vitis vinifera, Zea mays*
X. tarjanense Lamberti & Bleve-Zacheo, 1979	USA	*Quercus robur*
X. taylori Lamberti, Ciancio, Agostinelli & Coiro, 1992	Bulgaria, Croatia, Hungary, Italy, Poland, Sebia, Slovakia, Yugoslavia (former)	*Crataegus* sp., *Dorycnium sericeum,* grass, *Prunus mahaleb*, *Rubus caesius*, *Sambucus nigra, Solanum tuberosum, Vitis vinifera*
X. tenuicutis Lamberti & Bleve-Zacheo, 1979	USA	Meadow grass
X. thornei Lamberti & Golden, 1986	China, Pakistan, USA	*Citrus* sp., *Medicago sativa, Prunus avium*, *Rosa* sp.
X. udaipurensis Salalia, Siddiqui & Parihar, 2002	India	*Punica granatum*
X. utahense Lamberti & Bleve-Zacheo, 1979	Chile, USA	*Avena sativa*, *Beta vulgaris, Rhus trilobata*
X. vallense Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Spain	*Olea europaea*
X. waimungui Yeates, Boag & Brown, 1997	New Zealand	*Beilschmiedia tawa*, *Cyphomandra betacea*, *Dicksonia squarrosa*, *Litsea calicaris, Melicytus ramiflorus*

Key to *Xiphinema americanum*-group species in New Zealand

1 Female body length 1.8–2.1 mm long; odontostyle length 88–98 µm.....*X. brevicolle*
- Female body length 2.7–3.3 mm long; odontostyle length 117–130 µm.....*X. waimungui*

Xiphinema brevicolle Lordello & da Costa, 1961

Figs 19–20. Map 5.

Syn: *X. americanum* apud Carvalho (1955, 1962)
X. saopaoloense Khan & Ahmad, 1975

Measurements. Table 8.

Morphology. Females: Body ventrally curved to C shape when heat relaxed. Lip region low, flattened, continuous with body contour, 9–12 µm wide. Body cuticle smooth, 1.8–2.7 µm thick at sheath of guide ring, 2.5–

4.2 µm at base of pharynx, 2.0–4.6 µm near vulva and 6.6–7.7 µm at the tail terminus. Amphidial fovea stirrup-shaped, just post-labial, with crescentic slits. Odontostyle slender, 88–98 µm long, distinctly furcate at base. Odontophore 48–54 µm long, with prominent tripartite basal flanges, greatest flange diameter 7–14 µm. Basal ring of guiding sheath 65–79 µm from anterior end. Nerve ring posterior to base of odontophore. Pharynx a narrow tube enlarging in its last quarter to form a muscular cylindrical bulb 61–84 µm long, 18–29 µm wide. Mucro 2–3 µm long, in anterior part of pharynx, 41–50 µm behind base of odontophore. Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 160 µm long, posterior reproductive system 162 µm long (only observed in one specimen). Uteri near vagina form a well-developed ovijector. Z organ absent. Vulva a transverse slit, at 48–51% of body length. Vagina perpendicular to body axis with a thick cuticular layer, 12–18 µm long, occupying 23–40% of corresponding body diameter. Rectum 18–27 µm long, shorter than anal body diameter. Tail conoid, 23–36 µm long, about one anal body diameter long; two pairs of lateral pores on tail.

Males: not found.

Differential diagnosis. *Xiphinema brevicolle* is characterised by body length 1.8–2.1 mm long, medium odontostyle (88–98 µm), vulva 48–50%, c=46–82, c'=0.9–1.4, lip region continuous with body profile, tail with rounded terminus, tail length 22–41 µm. The polytomous key code of Lamberti *et al.* (2004) is A5-B2-C1-D23-E23-F1-G12-H2-I12. No new juvenile information is provided here.

Molecular and phylogenetic relationships. The sequenced fragments of SSU rDNA of *X. brevicolle* are approximately 700 bp. The DNA sequence of New Zealand *X. brevicolle* is available in GenBank under the accession number MN103822 (SSU).

Table 8. Morphometrics of *Xiphinema brevicolle* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	FEMALES (THIS STUDY)	SHAH *ET AL.* (2009)
n	10	N/A
L	1865 ± 101 (1776–2066)	1.8 (1.7–1.9)
a	38.7 ± 4.6 (33.0–47.2)	45 (41–48)
b	6.4 ± 0.9 (5.0–7.8)	N/A
c	64.9 ± 11.4 (46.5–82.1)	68 (58–77)
c'	1.0 ± 0.2 (0.9–1.4)	0.9 (0.7–1.0)
V	49.3 ± 1.0 (48.0–50.4)	50 (44–54)
Odontostyle	93.5 ± 2.9 (88.4–97.9)	90 (84–100)
Odontophore	51.8 ± 1.5 (48.4–53.7)	52 (49–55)
Total spear length	145 ± 3.7 (140–152)	142 (135–155)
Pharynx length	296 ± 44.4 (234–362)	N/A
Tail width	29.0 ± 4.3 (23.4–36.5)	N/A
Tail length	29.7 ± 6.6 (21.6–41.2)	27 (25–30)
Basal ring of guide sheath-anterior	71.4 ± 4.7 (65.0–78.6)	75 (70–80)
Body width at:	49.1 ± 7.6 (40.6–62.4)	N/A
-mid-body	48.6 ± 6.5 (39.9–61.5)	N/A
-base of pharynx	41.6 ± 6.6 (33.0–52.3)	N/A
Bulb length	76.2 ± 7.3 (61.1–84.1)	N/A
Bulb diameter	21.8 ± 3.5 (17.8–28.7)	N/A
Rectum	23.3 ± 3.9 (18.2–26.8)	N/A
Tail hyaline	11.0 ± 3.1 (7.7–13.8)	N/A

N/A: not available in the original paper.

BLAST search revealed maximum scores in SSU with sequences for *Xiphinema brevicolle* (JX094443, AB604340, HM163212, 99% similarity) and ten other *X. americanum*-group species including *X. americanum*, *X. citricolum* Lamberti & Bleve-Zacheo, 1979, *X. diffusum* Lamberti & Bleve-Zacheo, 1979, *X. floridae* Lamberti & Bleve-Zacheo, 1979, *X. georgianum* Lamberti & Bleve-Zacheo, 1979, *X. inaequale* Khan & Ahmad, 1977, *X. incognitum* Lamberti & Bleve-Zacheo, 1979, *X. lambertii* Bajaj & Jairajpuri, 1976, *X. peruvianum* Lamberti & Bleve-Zacheo, 1979, *X. santos* Lamberti, Lemos, Agostinelli & D'Addabo, 1993 and *X. taylori* Lamberti, Ciancio, Agostinelli & Coiro, 1992. In the molecular phylogenetic analysis of *X. brevicolle* based on SSU under TrN+I+G, including 31 sequences and 1680 total characters (Fig. 21), *X. brevicolle* clustered with four species: *X. diffusum*, *X. inaequale*, *X. incognitum* and *X. taylori.*

Material examined. Ten females from NNCNZ; 28 females and 34 juveniles from Nematology Collection of AsureQuality.

Distribution (Map 5). From material examined: New Zealand: **North Island:** AgResearch, Ruakura Research Centre, Hamilton, WO; Taranaki, TK; Waitara, TK and Tauranga, BP.

From literature: New Zealand: **North Island:** Opononi, ND; Whangarei, ND; Auckland, AK; Albany, AK; Tauranga, BP; Gisborne, GB; Hamilton, WO and Waiuku, WO (Shah *et al.* 2009; Sturhan *et al.* 1997). For world distributions see Table 7.

Habitat and hosts. From material examined: *Acer* sp., *Phormium* sp. and lawn grasses.

From literature: *Araucaria* sp., bowling green grasses, *Citrus* sp., five finger (*Neopanax arboreus*), grape (*Vitis vinifera*), peach (*Prunus persica*), poncirus (*Citrus trifoliate*), *Prunus* sp., *Trifoliata* sp. and walnut (*Juglans regia*) (Shah *et al.* 2009; Sturhan *et al.* 1997).

Plant viruses association. Unknown.

Remarks. Use of the scientific name *X. brevicolle* is controversial. Luc *et al.* (1998) commented that the specific epithet of *X. brevicolle* should be modified from *brevicolle* (= short neck) to *brevicollum* to conform to Latin grammar. *Collum*, *i*, neuter substantive must remain as such; '*colle*' does not exist in Latin. After more than a decade, Monteiro (2010) argued that modifying the specific name of *X. brevicolle* to *brevicollum* proposed by Luc *et al.* was an "unjustified emendation". This is because the neuter Latin substantive (noun) *collum*, *i*, meaning neck, has been used in Zoology Nomenclature as an adjective of two terminations, *viz collis*, for masculine and feminine genders, and *colle*, for neuter gender, in the composition of specific name. The possibility of treating a noun as an adjective is supported by the International Code of Zoological Nomenclature (ICZN). Therefore, the original species name, *X. brevicolle* should be preserved unaltered (Monteiro 2010). We support the opinion of Monteiro (2010) and use the scientific name *X. brevicolle* in the present study.

Xiphinema brevicolle was included in the *X. americanum*-group, which still has ambiguities due to poorly defined species boundaries and overlapping morphometrics features (Luc & Baujard 2001), although polytomous and dichotomous keys, based on a combination of major diagnostic characters, have been published (Lamberti *et al.* 2000, 2004). Thus, species differentiation remains difficult and species diversity and taxonomic validity of species is controversial. Accurate identification of the *X. americanum*-group species is of economic importance because they can transmit several nepoviruses, including viruses (e.g. PRMV and strains of TRSV not in New Zealand) listed in BORIC by MPI database of New Zealand. Four species of this group are listed as A1 (*X. americanum*, *X. californicum*, *X. bricolense*) and A2 (*X. rivesi*) quarantine organisms by the EPPO[2]. *Xiphinema brevicolle* is a vector of ToRSV (Fritzsche & Kegler 1968), but the evidence for this transmission is inconclusive (Trudgill *et al.* 1983).

The identity of *X. americanum*, reported from grapes at Henderson, Auckland in New Zealand by Dale (1971), is uncertain. Sturhan *et al.* (1997) reported three species (labelled a-c) and said that *Xiphinema* species "b" in morphological characters was close to *X. brevicolle.* Subsequently, *Xiphinema* species "b" was confirmed as *X. brevicolle* based on morphological and molecular data from D2-D3 of LSU and ITS1 (Shah *et al.* 2009). The distribution of this species is concentrated in the North Island of New Zealand (Shah *et al.* 2009; Sturhan *et al.* 1997).

The SSU rDNA gene is useful for discriminating between some *X. americanum*-group species (Lazarova *et al.* 2006). The results of our phylogenetic analyses based on SSU rRNA sequence should be helpful in defining the

2. https://www.eppo.int/media/uploaded images/ACTIVITIES/plant quarantine/pm1-002-27-en.Pdf (last accessed 28 June 2019).

concept of the *X. brevicolle*-subgroup within the *X. americanum*-group, as discussed by Romanenko & Stegaresku (1985), Lamberti & Ciancio (1993) and He *et al.* (2005). Sakai *et al.* (2011) suggested that the *X. brevicolle*-subgroup includes at least *X. brevicolle*, *X. diffusum*, *X. inaequale*, *X. incognitum* and *X. taylori*. The phylogenetic relationships discussed here had a similar result to that of Sakai *et al.* (2011) and our specimens also belong to the *X. brevicolle*-subgroup.

***Xiphinema waimungui* Yeates, Boag & Brown, 1997**

Figs 22–25. Map 6.

Measurements. Table 9.

Description. Females: Body ventrally arcuate to C shape when heat relaxed. Lip region setoff by shallow constriction from body contour, 13–14 µm wide. Body cuticle smooth, 2.0–3.8 µm thick at basal of guide ring, 2.6–3.8 µm at base of pharynx, 2.8–4.7 µm near vulva and 10.9–15.2 µm at the tail terminus. No body pores observed. Amphidial fovea funnel-shaped, just post-labial, with slit-like aperture. Odontostyle slender, 118–129 µm long, distinctly furcate at base. Odontophore 60–73 µm long, with prominent tripartite basal flanges. Basal ring of guiding sheath 98–105 µm from anterior end. Nerve ring a little posterior to base of odontophore. Pharynx a narrow tube enlarging in last quarter to form a muscular cylindrical bulb 73–92 µm long, 20–26 µm wide. 'Mucro' in anterior part of pharynx 2–5 µm long, 20–36 µm behind flange base. Reproductive system amphididelphic, with reflexed ovaries. Anterior reproductive system 247–321 µm long, posterior reproductive system 200–248 µm long. Uteri near vagina form a well-developed ovijector. Each oviduct and uterus joined without a sphincter-Z or pseudo-Z organ. Vulva a transverse slit, at 51–54% of body length. Vagina perpendicular to body axis with a thick cuticular layer, 13–18 µm long, occupying 23–42 % of corresponding body diameter. Prerectum 130–197 µm long, 4–6 times body diameter; rectum 19–25 µm long, shorter than anal body diameter. Tail short, rounded, conical with terminus almost ventral, 30–40 µm long, about 0.9–1.2 times anal body diameter. Two pairs of body pores on tail.

Males: Not found.

Juveniles: Morphologically similar to adults in most aspects except for smaller size and undeveloped genital structures. All four juvenile stages were collected and distinguished by relative lengths of body and replacement odontostyle (Table 6; Figs 24–26). A replacement odontostyle present in pharyngeal region of all juvenile stages. The J1 is characterised by having the replacement odontostyle tip inserted into the odontophore base and elongate conoid tail (c'=2.4–2.9), without a peg. Replacement odontostyle of J2 is posterior to the odontophore base and correlated well with odontostyle length of the following J3. Replacement odontostyle of J3 correlated well with odontostyle length of the following J4. That of J4 correlated well with odontostyle length of females.

Differential diagnosis. *Xiphinema waimungui* is characterised by having a female 2.7–3.2 mm long, with odontostyle 117–130 µm, lip region setoff by shallow constriction, V=51–54%, c=75–106, c'=0.9–1.2, and tail short, 22–41 µm long, convex-conoid with rounded terminus. Males not found. Four juvenile stages distinguished. The polytomous key code of Lamberti *et al.* (2004) is A56- B2-C12-D123-E3-F12-G1-H2-I23 (OEPP/EPPO Bulletin 2017; Sturhan & Wouts 2008).

Material examined. Holotype and 46 paratype specimens. **Holotype** female. New Zealand: NNCNZ, slide No. 172. **Paratypes**: Nine females and 37 juveniles, NNCNZ, slide nos 2521–2531.

Distribution (Map 6). From material examined: New Zealand: Pareheru Scenic Reserve, BP.

From literature: New Zealand: **North Island**: Tauranga, BP; Kaingaroa Forest, BP; Coromandel Peninsula, CL; One Tree Hill and Titirangi Beach, Auckland, AK; Manukau Heads, AK; and Raoul Island (Sturhan *et al.* 1997; Yeates *et al.* 1997). World distribution: reported only from New Zealand.

Habitat and hosts. From material examined: *Beilschmiedia tawa* and *Litsea calicaris*.

From literature: mainly found in forests and native bush under trees, *Dicksonia squarrosa, Melicytus ramiflorus* and tamarillo (*Cyphomandra betacea*) (Sturhan *et al.* 1997).

Plant viruses association. Unknown.

Remarks. *Xiphinema waimungui* was originally described by Yeates *et al.* (1997). Sturhan & Wouts (2008) showed that *Xiphinema* species "c", previously designated by Sturhan *et al.* (1997), was conspecific with *X. waimungui.* Attempts to re-collect *X. waimungui* in 2014 were not successful.

Table 9. Morphometrics of *Xiphinema waimungui* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	HOLOTYPE	PARATYPES				
	FEMALE	FEMALES	J1	J2	J3	J4
n	1	12	12	12	10	2
L	3140	2978 ± 166 (2666–3233)	1018 ± 45.5 (958–1114)	1394 ± 76.5 (1271–1500)	1873 ± 89 (1658–2023)	2323, 2330
a	64.2	61.9 ± 5.1 (51.8–69.1)	43.5 ± 2.3 (40.6–46.9)	44.1 ± 2.7 (37.2–46.4)	48.8 ± 2.6 (44.0–52.2)	60.0, 59.1
b	7.8	7.9 ± 0.6 (6.6–8.6)	4.1 ± 0.4 (3.6–4.8)	5.1 ± 0.4 (4.1–5.6)	5.9 ± 0.3 (5.3–6.4)	6.4, 6.5
c	91.2	85.7 ± 9.5 (75.1–106)	23.8 ± 1.1 (21.9–25.3)	33.4 ± 2.4 (28.6–35.9)	46.1 ± 3.5 (41.2–51.3)	48.6, 58.5
c'	1.1	1.1 ± 0.1 (0.9–1.2)	2.6 ± 0.1 (2.4–2.9)	2.0 ± 0.2 (1.7–2.4)	1.6 ± 0.1 (1.5–1.7)	1.7, 1.4
V	52.8	52.9 ± 1.1 (51.4–54.1)	–	–	–	–
Odontostyle	126	123 ± 3.7 (119–129)	60.9± 3.4 (52.3–64.0)	75.3± 1.6 (73.0–77.7)	91.2 ± 3.6 (87.4–98.5)	107, 102
Odontophore	76.3	68.3 ± 3.9 (60.0–73.0)	44.2 ± 1.8 (41.7–47.9)	49.5 ± 2.7 (43.2–52.7)	53.4 ± 2.1 (50.9–58.4)	58.6, 61.0
Total spear length	202.3	191 ± 6.3 (179–200)	105 ± 2.7 (98.0–108)	125 ± 3.3 (119–129)	145 ± 4.2 (139–151)	165, 163
Pharynx length	404	378 ± 18.7 (353–417)	247 ± 16.4 (218–266)	277 ± 23.5 (246–330)	318 ± 12.0 (298–336)	364, 356
Tail width	32.7	30.8 ± 1.5 (28.7–33.0)	16.2 ± 1.2 (15.0–18.0)	21.0 ± 2.1 (17.9–24.8)	25.9 ± 1.9 (22.7–28.5)	27.9, 28.2
Tail length	34.4	35.0 ± 2.7 (29.8–39.9)	42.5 ± 3.1 (38.2–47.6)	41.9 ± 2.9 (38.1–46.3)	40.5 ± 3.0 (37.4–45.6)	47.8, 39.8
Guide ring-anterior	97.4	100 ± 1.9 (97.6–105)	49.4 ± 1.1 (47.2–51.0)	60.0 ± 1.4 (57.1–62.0)	72.4 ± 2.1 (70.6–76.5)	88.2, 85.6
Amphid-anterior	?	6.7 ± 1.6 (4.2–8.9)	4.1 ± 0.6 (3.2–5.0)	5.0 ± 0.7 (3.8–5.6)	5.3 ± 0.5 (4.4–6.1)	7.8, 5.4
Body width at: -guide ring	35.8	34.4 ± 2.6 (31.9–40.3)	19.5 ± 0.4 (19.0–20.5)	22.9 ± 1.1 (21.8–25.5)	27.4 ± 0.6 (26.7–28.4)	30.7, 28.6
-lip region	?	13.6 ± 0.4 (13.1–14.4)	9.9 ± 0.4 (9.3–10.6)	10.6 ± 0.3 (10.1–11.2)	11.5 ± 0.7 (9.9–12.4)	13.3, 12.6
-mid-body	48.9	48.9 ± 5.7 (41.1–61.1)	23.5 ± 2.0 (21.3–25.8)	31.8 ± 3.4 (27.7–39.4)	38.4 ± 2.4 (34.2–42.7)	38.7, 39.4
-vulva	44.5	47.0 ± 4.4 (40.6–57.9)	–	–	–	–
-base of pharynx	46.7	44.6 ± 5.0 (39.1–55.3)	23.0 ± 1.1 (21.0–24.7)	29.6 ± 2.4 (27.2–36.0)	35.9 ± 2.4 (30.5–38.8)	36.8, 36.7
Bulb length	92.0	84.2 ± 5.4 (72.7–91.7)	56.1 ± 5.6 (48.5–68.9)	56.9 ± 5.2 (45.7–68.0)	65.2 ± 2.8 (62.2–72.1)	77.1, 67.9
Bulb diameter	24.0	21.9 ± 2.4 (19.5–26.4)	13.8 ± 1.0 (12.4–15.8)	14.5 ± 1.7 (11.9–16.6)	16.1 ± 1.6 (13.9–18.7)	20.0, 18.3
Rectum	22.6	21.9 ± 1.8 (18.8–25.0)	–	–	–	–
Tail hyaline	?	13.4 ± 1.6 (10.9–15.2)	9.8 ± 0.6 (8.7–10.5)	8.9 ± 0.8 (7.2–9.9)	10.1 ± 1.2 (8.1–12.1)	11.5, 11.1

?: the data not available from the specimens.

In addition, Sturhan & Wouts (2008) described the male of *X. waimungui* and indicated that the species belongs to the *X. americanum*-group, based on the occurrence of bacteria associated with the genital tracts of the females and their morphological characters.

Xiphinema non-*americanum*-group

The *Xiphinema* non-*americanum*-group is characterised by having a longer body and odontostyle, the occurrence of different types of female genital tract resulting in variable development of the two genital branches as well as different types of structures in the genital branches, usually with long uteri and uterine differentiation, including 'Z-organ', spines, or crystalloid structures in the tubular part of the uterus (Archidona-Yuste *et al.* 2016b; Coomans 2001; Lamberti *et al.* 2000; Loof & Luc 1990; Luc *et al.* 1998; Peraza-Padilla *et al.* 2018).

The *Xiphinema* non-*americanum*-group comprises a complex of more than 220 species recorded worldwide (Table 10) (Archidona-Yuste *et al*. 2016b; Barsi *et al*. 2017; Cai *et al*. 2018; Coomans *et al.* 2001; Fouladvand *et al.* 2019; Gutiérrez-Gutiérrez *et al.* 2013b; Lamberti *et al*. 2000; Lazarova *et al*. 2016; Loof & Luc 1990; Luc *et al*. 1998; Maria *et al.* 2018; Peraza-Padilla *et al*. 2018; Varela-Benavides *et al*. 2018; Vazifeh *et al.* 2019; Zhao *et al.* 2017). Among these, three species, including *X. index* Thorne & Allen, 1950, *X. diversicaudatum* and *X. italiae* Meyl, 1953, are known to transmit *Arabic mosaic virus* (ArMV), *Grapevine fanleaf virus* (GFLV), *Strawberry latent ringspot virus* (SLRV), and *Cherry leaf roll virus* (CLRV) (Decraemer & Robbins 2007; Hunt 1993; Meyl 1953; Micoletzky 1927; Taylor & Brown, 1997; Thorne & Allen 1950). In New Zealand, only one species of the *X.* non-*americanum*-group, *X. diversicaudatum*, has been recorded and is included here.

Table 10. Species, world distribution and hosts of *Xiphinema non-americanum*-group.

SPECIES	WORLD DISTRIBUTION	HOSTS
X. aaba Heyns, 2000	South Africa	*Acacia xanthophloea,* indigenous grasses
X. abeokutae Luc & Coomans, 1993	Nigeria	*Theobroma cacao*
X. abrantinum Roca & Pereira, 1991	Portugal	*Prunus persica*
X. aceri Chizhov, Tiev & Turkina, 1986=*X. hispanum* Lamberti, Castiollo, Gomez-Barcina & Agosstinelli, 1992	Iberian Peninsula, Portugal, Russia, Spain	*Acer campestre*, *Cistus albidus*, *Quercus pyrenaica, Vitis vinifera*
X. adenohystherum Lamberti, Castillo, Gomez-Barcina & Agostinelli, 1992	Spain	*Ilex* sp.
X. aequum Roca & Lamberti, 1988	Italy	*Olea europaea*
X. afratakhtehnsis Fouladvand, Pourjam, Castillo & Pedram, 2019	Iran	*Pteridium aquilinum*
X. algeriense Luc & Kostadinov, 1982	Algeria, Senegal	*Pennisetum glaucum, Vitis vinifera*
X. arcum Khan, 1964	India	*Aegle marmelos*
X. artemisiae Chizhov, Tiev & Turkina, 1986	Russia	*Artemisia campestris*
X. arunachalense Singh & Khan, 1998= [*X. arunachalensis* emend.]	India	*Litchi chinensis*
X. arubreviensis Giribabu & Saha, 2006	India	*Coffea* sp.
X. bajaji Jairajpuri & Lamberti, 1981 =*X. luci* Bajaj & Jairajpuri, 1979=*X. luci* Lamberti & Bleve-Zacheo, 1979	India	*Vigna radiata*
X. bakeri Williams, 1961	Canada, Japan, Korea, Peru, USA	*Acer palmatum*, *Arbutus unedo, Carya* sp., *Celtis sinensis, Fagus crenata, Morus nigra*, *Rhododendron* sp., *Rubus idaeus, Rubus* sp.
X. barbercheckae Coomans & Heyns, 1985	South Africa	*Vitis vinifera*
X. barense Lamberti, Roca, Agostinelli & Bleve-Zacheo, 1986	Italy	*Olea europaea*, *Rubus vestitus*
X. barooghii Vazifeh, Niknam, Jabbari & Naghavi, 2019	Iran	*Triticum aestivum*
X. basilgoodeyi Coomans, 1965	Congo, Egypt	*Acalypha wilkesiana, Cocos nucifera, Coffea arabica*, *Sabal palmetto*
X. basiri Siddiqi, 1959 =*X. cobbi* Sharma & Saxena, 1981 =*X. hayati* Javed, 1983	Brazil, Cuba, France, India, Mexico, Mauritius, Nigeria, Pakistan, Sri Lanka, Sudan, Zimbabwe, USA	*Actinidia deliciosa, Adonidia merrillii, Annona* sp., *Azadira indica*, *Citrus limon, Citrus reticulata*, *Citrus sinensis, Cocos nucifera*, grass, *Leucaena leucocephala*, *Malpighia glabra*, *Malus pumila*,

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
		Mangifera indica, *Nicotiana tabacum*, *Persea americana*, *Phaseolus* sp., *Punica granatum*, *Rosa* sp., *Saccharum officinarum, Zingiber officinale*
X. baetica Gutiérrez-Gutiérrez, Cantalapiedra-Navarrete, Remesal, Palomares-Rius, Navas-Cortés & Castillo, 2013	Spain	Grass, *Pinus pinea, Vitis vinifera*
X. belmontense Roca & Pereira, 1992	Portugal, Spain	*Malus domestica*, *Quercus robur*
X. bergeri Luc, 1973	Ivory Coast, Nigeria, Pakistan	*Oryza sativa*
X. bernardi Robbins, Bae, Ye & Pedram, 2009	USA	*Acer palmatum*, *Halesia carolina*, *Tsuga canadensis*
X. bolandium Coomans & Heyns, 1985	Pakistan, South Africa	*Vitis vinifera*
X. bourkei Stocker & Kruger, 1987	South Africa	Grasses
X. brasiliense Lordello, 1951=*X. itanhaense* Carvalho, 1962; =*X. mammillocaudatum* Khan, 1981	Brazil, Colombia, Cuba, French guyana, India, Peru, Sao Tome and Principe	*Butia capitate*, *Camellia sinensis*, *Carica papaya*, *Citrus* sp., *Cocos nacifera*, *Euterpe edulis*, *Mangifera indica*, *Musa* sp., *Persea americana*, *Piper* sp., *Podocarpus* sp., *Prunus persica*, *Pyrus communis*, *Solanum tuberosum*
X. brevistylus Jairajpuri, 1982	Nigeria	*Saccharum officinarum*
X. cadavalense Bravo & Roca, 1995	Portugal, Spain	*Canarium album, Vitis vinifera*
X. capense Coomans & Heyns, 1985	South Africa	*Vitis vinifera*
X. capriviense Hutsebaut, Heyns & Coomans, 1989	India, South Africa	*Brassica napus*, indigenous vegetation
X. castilloi Roshan-Bakhsh, Pourjam, Pedram, Robbins & Decraemer, 2014	Iran	*Fraxinus* sp.
X. cavenessi Luc, 1973	Ivory Coast	*Oryza sativa*
X. chambersi Thorne, 1939	Canada, Japan, Korea, USA	*Camellia sinensis, Glycine max* subsp. *soja, Gossypium* sp., *Ligustrum japonicum, Pinus* sp., *Quercus rubra*, *Quercus phillyraeoides, Quercus salicina, Quercus serrata, Quercus virginiana,*
X. clavatum Heyns, 1965	South Africa	*Strelitzia* sp.
X. clavicaudatum Huang, Uesugi & Raski, 1987	Brazil, French Guyane, South America	*Anacardium occidentale*, *Annona muricata, Cocos nucifera, Rheedia* sp.
X. cohni Lamberti, Castillo, Gomez-Barcina & Agostinelli, 1992	Spain	*Pinus pinea*
X. colombiense Hunt, 1982	Colombia, South America	Unknown host
X. conurum Siddiqi, 1964	Spain, Tunisia	*Canarium album*, *Olea europaea, Prunus dulcis*
X. coomansi Kruger & Heyns, 1986	South Africa	Grasses
X. coronatum Roca, 1991	Italy	*Vitis vinifera*
X. costaricense Lamberti & Tarjan, 1974	Brazil, Costa Rica, French Guyane, Guatemala, Nigeria, Panama, Peru, Sri lanka, Trinidad	*Citrus sinensis*, *Coffea* sp., *Musa paradisiaca*, *Musa* sp., *Saccharum officinarum,Solanum tuberosum*
X. coxi coxi Tarjan, 1964	Germany, UK, USA	*Citrus aurantium*, *Cocos nucifera*, grass, *Magnolia grandiflora*, *Setaria magna*
X. coxi europaeum Sturhan, 1985	Italy, Portugal, Spain	*Ceratonia siliqua*, *Quercus suber*, *Quercus variabilis*, *Vitis vinifera*
X. cretense Tzortzakakis, Archidona-Yuste, Cantalapiedra- Navarrete, Nasiou, Lazanaki, Kabourakis & Castillo, 2014	Greece	*Olea europaea*, *Vitis vinifera*
X. cynodontis Nasira & Maqbool, 1994	Pakistan	*Cynodon dactylon*
X. densispinatum Barsi, Lamberti & Agostinelli, 1998	Bosnia-Herzegovina, Serbia, Yugoslavia (former)	Unknown plants

..... *continued on the next page*

Table 10 (continued)

SPECIES	WORLD DISTRIBUTION	HOSTS
X. dentatum Sturhan, 1978	Czech Republic, Germany, Slovakia, Poland, Yugoslavia (former)	*Carpinus betulus*, *Picea abies*
X. diannae Kruger & Heyns, 1987	South Africa	Grasses
X. digicaudatum Singh & Khan, 1998 [=*X. digicaudata* emend.]	India	*Citrus reticulata*
X. dihysterum Lamberti, Arias, Agostinelli & Espirito Santo, 1995=*X. nigeriense* in Bos & Loof (1984), in Sakwe & Coomans (1993)	Lesotho, Nigeria, São Tomé and Príncipe	Grasses
X. dimidiatum Loof & Sharma, 1979	Brazil	*Citrus sinensis*
X. dimorphicaudatum Heyns, 1966	South Africa	*Acacia* sp., *Ananas comosus*, *Citrus* sp.
X. dissimile Roca, Pereira & Lamberti, 1988	Portugal	*Cupressus* sp.
X. diversicaudatum (Micoletzky, 1927) Thorne, 1939=*X. paraelongamm* Altherr, 1958=*Dorylaimus elongatus* apud Micoletzky, 1923=*Dorylaimus (Longidorus) diversicaudatus* Micoletzky, 1927=*Longidorus diversicaudatus* (Micoletzky, 1927) Thorne & Swanger, 1936=*X. diversicaudamm* apud Luc (1958) (=*X. seredouense*)=*X. diversicaudatum* apud Cohn (1969) (= *X. israeliae*)	Argentina, Austria, Belgium, Bulgaria, Cuba, Croatia, Czechoslovakia, Czech Republic, Denmark, France, Germany, Greece, India, Ireland, Israel, Italy, Medeira, Moldavia, Netherlands, Norway, Poland, Portugal, Russia, South Africa, Slovenia, Slovakia, Spain, Sweden, Switerzerland, Trinidad, Turkey, New Zealand, UK, Ukraine, USA, Yugoslavia (former)	*Asparagus officinalis*, *Brassicas* sp., *Cyphomandra betacea*, *Citrus* sp.,*Corylus Americana*, *Cydonia oblonga, Daucus carota, Dianthus caryophyllus, Elaeagnus angustifolia, Fragaria* × *ananassa, Fragaria* sp., *Humulus lupulus*, *Lactuca sativa*, *Leptinella dioica*, *Leptinella maniototo*, *Leptinella* sp., *Malus domestica*, *Malus sylvestris*, *Olea europaea, Pinus ponderosa, Prunus armeniaca, Ptelea trifoliata*, *Ribes nigrum*, *Rosa* × *damascena, Rosa* sp., *Rubus idaeus, Rubus* sp., *Rubus ursinus, Rubus vestitus, Solanum tuberosum, Thuja sp., Tulipa gesneriana,* turf grass, *Vitis vinifera*
X. diversum Roca, Lamberti, Santos & Abrantes, 1989	Portugal	*Cupressus lusitanica*
X. dolosum Bos & Loof, 1984	Nigeria	Grass
X. douceti Luc, 1973	Ivory Coast	*Mapania baldwinii*
X. dracomontanum Hutsebaut, Heyns & Commans, 1989	South Africa	Grass
X. ebriense Luc, 1958	Ivory Coast, Nigeria	*Coffea canephora, Oryza sativa*
X. elitum Khan, Chawla & Saha, 1976	India	*Oryza sativa*
X. elongatum Schuurmans Stekhoven & Teunissen, 1938=*X. campinense* Lordello, 1951=*X. hydrabadense* Quraishi & Das, 1984=*X. nagarjunensis* Khan, 1981=*X. pratense* Loos, 1949=*X. uasi* Edward & Sharma, 1982	Algeria, Belize, Brazil, China, Congo, Cuba, Egypt, France, French Guyana, India, Israel, Kenya, Malaysia, Martinique, Mauritius, Pakistan, South Africa, Surinam, Swaziland, Trinidad, Kenya, USA, Vietnam	*Artocarpus integer, Brassica oleracea, Carissa* sp., *Citrus* sp., *Cocos nucifera*, *Coffea arabica*, *Glycine max, Hibiscus rosasinensis, Lycopersicon esculentum, Magnolia champaca*, *Mangifera indica, Mentha piperita*, *Nephelium lappaceum, Phaseolus vulgaris*, *Phoenix dactylifera, Prunus avium*, *Psidium guajava, Punica avium, Punica granatum, Saccharum officinarum, Zingiber officinale, Ziziphus jujuba*
X. enigmatum Siddiqi, 2000	Suriname	Jungle vegetation
X. ensiculiferum (Cobb, 1893) Thorne, 1937=*Tylencholaimus ensiculiferus* Cobb, 1893=*X. ensiculiferoides* Cohn & Sher, 1972=*X. ilyasi* Ahmad & Baqri, 1987=*X. ensiculiferum* apud Loos (1949) and Williams (1959) (=*X. krugi*) =*X. ensiculiferum* apud Luc (1961) (= *X. hygrophilum*)=*X. ensiculiferum* apud Carvalho (1955) (= *X. surinamense*)	Africa, Brazil, Egypt, Fiji, Israel, India, Ivory Coast, Malaysia, Philippines, Solomon Islands, USA	*Artocarprn heterophyllus, Bauhinia* sp., *Musa acuminata*, *Musa* sp., *Nephelium lappaceum*, *Pandanus* sp., *Paspalum notatum, Phaseolus vulgaris*, *Pinus* sp., *Ravenala madagascariensis, Sorghum bicolor, Zea mays*
X. erriae Hutsebaut, Heyns & Coomans, 1987	South Africa	Indigenous grasses

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. exile Roca, Lamberti, Santos & Abrantes, 1989	Portugal	*Pinus pinaster*
X. fagesi Germani, 1990	New Caledonia	*Schefflera* sp., *Tapeinosperma* sp.
X. fatikae eburnense Coomanse, Rashid & Luc, 1990	Ivory Coast	*Dioscorea alata* var. *bete*
X. fatikae fatikae Bos & Loof, 1985	Nigeria	*Sorghum* sp.
X. filicaudatum Loof & Maas, 1972	French Guyana, Surinam	*Elaeis guineensis*
X. filicaudatum labratum Luc & Commans, 1992	French Guyane	Ferns
X. flagellicaudatum Luc, 1961	South Africa, Togo	*Cocos nucifera,* grass and ferns
X. fluminense Huang, Uesugi & Raski, 1987	Brazil	*Zea mays*
X. fragariae Verma & Khan, 2012	India, Switzerland, UK	*Fragaria* × *ananassa*
X. gersoni Roca & Bravo, 1993	Spain	*Eucalyptus* sp.
X. globosum Sturhan, 1978	Spain, Slovenia	*Picea abies*
X. granatum Pedram, Pourjam, Palomares-Rius, Ghaemi, Cantalapiedra-Navarrete & Castillo, 2012	Iran	*Punica granatum*
X. gracilicaudatum Singh & Khan, 1998= [*X. gracilicaudatus* emend.]	India	*Citrus reticulata*
X. guillaumeti Germani, 1989	Brazil	Unknown host
X. guirani Luc & Williams, 1978=**X. guirani* apud Lamberti & BleveZacheo (1979)	Madagascar, Papua New Guinea	*Trilisa odoratissima*
X. hangzhouensis Cai, Maria, Barsalote, Subbotin & Zheng, 2018	China	*Magnolia grandiflora*
X. hallei Luc, 1958=*X. hallei* apud Heyns (1962, 1971) (= *X. mluci*)	Ivory Coast, South Africa	*Drypetes aylmeri, Zea mays*
X. hardingi Joubert, Kruger & Heyns, 1988	South Africa	*Saccharum officinarum*
X. herakliense Tzortzakakis, Archidona-Yuste, Cantalapiedra- Navarrete, Nasiou, Palomares-Rius & Castillo, 2015	Greece	*Olea europaea*, *Vitis vinifera*
X. heynsi Siddiqi, 1979	South Africa, Tanzania	*Medicago sativa*
X. hispidum Roca & Bravo, 1994	Portugal, Spain	*Prunus persica, Vitis vinifera*
X. histriae Lamberti, Coiro & Agostinelli, 1993	Italy	*Vitis vinifera*
X. horvatovicae Barsi & Lamberti, 1999	Croatia	*Pinus nigra*
X. hunaniense Wang & Wu, 1992	China, Thailand	*Buxus sinica, Camellia japonica*, *Camellia sasanqua*, *Citrus maxima*, *Citrus sinensis*, *Cycas revolute*, *Dimocarpus longan*, *Eriobotrya japonica*, *Hibiscus rosasinensis*, *Juniperus chinensis, Ligustrum quihoui*, *Litchi chinensis*, *Magnolia figo*, *Mangifera indica*, *Pinus* sp., *Pyrus pyrifolia* var. *yokoyama*, *Vitis vinifera*
X. hygrophilum Southey & Luc, 1974=*X. ensiculiferum* apud Luc (1961)	Fiji, Philippines, New Hebrides, Ivory Coast, USA	*Coffea arnisiana, Musa* sp., *Ravenala madagascariensis, Saccharum officinarum*
X. ifacolum Luc, 1961	Benin, Brazil, Cameroon, Colombia, Guinea, Ivory Coast, Liberia, Nigeria, São Tomé and Príncipe, Sierra Leone, Sri Lanka, Togo	*Acalypha* sp., *Citrus limon*, *Croton* sp., *Musa paradisiaca, Oryza sativa*, *Piper nigrum*, *Solanum lycopersicum, Theobroma cacao*
X. illyricum Barsi & Lamberti, 1999	Yugoslavia (former)	*Carpinus orientialis*
X. imambaksi Loof & Maas, 1972	Surinam	*Citrus* sp.

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. imitator Heyns, 1965	South Africa	*Acacia xanthophloea, Eucalyptus* sp.
X. index Thorne & Allen, 1950	Albania, Algeria, Argentina, Armenia, Austria, Australia, Azerbaijan, Brazil, Bulgaria, Chile, Croatia, Cyprus, Czech Republic, France, Germany, Georgia, Greece, Hungary, India, Iran, Iraq, Israel, Italy, Lebanon, Malta, Moldavia, Montenegro, Pakistan, Peru, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, South Africa, Spain, Switzerland, Tajikistan, Turkey, Turkmenistan, Urkaine, USA, Uzbekistan, Yugoslavia (former)	*Anacardium occidentale, Cydonia oblonga, Elaeagnus angustifolia, Ficus carica*, *Humulus lupulus, Malus domestica*, *Olea europaea, Prunus dulcis*, *Prunus persica*, *Pyrus malus, Vitis* sp., *Vitis vinifera*
X. ingens Luc & Dalmasso, 1964	Crprus, Israel, Italy, Spain	*Prunus* spp., *Vitis vinifera*
X. insigne Loos, 1949=*X. indicum* Siddiqi, 1959=*X. neodimorphicaudatum* Khan, 1981=*X. tugewai* Darekar & Khan, 1983	China, Sri Lanka, India, Israel, Japan, Korea, Malaysia, Malawi, Mauritius, Pakistan, Philippines, South Africa, Sri Lanka, Thailand, Trinidad, USA	*Ailanthus altissima*, *Albizia* sp., *Allium fistulosum*, *Annona muricata, Bambusa* sp., *Buxus sinica*, *Camellia japoica*, *Camellia sinensis*, *Cedrus deodara*, *Citrus sinensis*, *Cocos nucifera*, *Cynodon dactylon, Dimocarpus longan*, *Eriobotrya japonica*, *Eucommia ulmoides*, *Firmiana* sp., *Fragaria* × *ananassa*, *Glycine max*, grass, *Grewia asiatica*, *Ilex corunta*, *Ilex* sp., *Juniperus* sp., *Litchi chinensis, Magnolia grandiflora*, *Morus* sp., *Musa* sp., *Pinus densiflora*, *Pinus fenzeliana*, *Pinus granatum*, *Pinus tabulaeformis, Populus* sp., *Prunus persica*, *Prunus* sp., *Psidium guajava*, *Pyrus communis*, *Pyrus pyrifolia var. yokoyama, Rhus succedanea*, *Saccharum officinarum*, *Salix babylonica*, *Sanguisorba* sp., *Solanum lycopersicum, Solanum tuberosum*, *Styphnolobium japonicum*, *Syringa oblatam*, *Ulmus pumila*, *Vitis vinifera*, *Zea mays*, *Ziziphus jujuba*
X. iranicum Pedram, Niknam, Robbins, Ye & Karegar, 2009	Iran	*Rosa* sp.
X. israeliae Luc, Brown & Cohn, 1982=*X. diversicaudatum* apud Cohn (1969)	Greece, Israel	*Citrus* sp., *Olea europaea, Persea americana*, *Rosa* sp.
X. italiae Meyl, 1953=*X. arenarium* Luc & Dalmasso, 1964=*X. bulgariense* Stoyanov, 1964=*X. italiae* apud Chavez & Geraert (1977) (=*X. savanicola*)	Bulgaria, Cameroon, Cuba, Cyprus, Egypt, France, Greece, Hungary, Israel, Italy, Libya, Mediterranean, Moldavia, Nigeria, Portugal, Romania, Russia, Saudi Arabia, Serbia, Slovakia, South Africa, Slovakia, Spain, Tunisia, Turkey, Yugoslavia (former)	*Canarium album, Cicer arietinum, Citrus* sp., *Lens culinaris, Olea europaea* var. *sylvestris*, *Rosa damascena, Solanum tuberosum, Vitis vinifera*
X. jomercium Joubert, Kruger & Heyns, 1988	South Africa	*Acacia* sp., *Saccharum officinarum*
X. japonicum Zhao, Ye, Maria, Pedram & Gu, 2017	Japan	*Podocarpus macrophyllus*
X. judex Hutsebaut, Heyns & Coomans, 1989	South Africa	Grasses
X. karachiense Nasira, Firoza & Maqbool, 1992	Pakistan	*Citrus* sp.
X. kikuyense Heyns & Coomans, 1997	Kenya	*Adansonia digitata*

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. krugi Lordello, 1955=*X. denoudeni* Loof & Maas, 1972=*X. loosi* Southey & Luc, 1974=*X. ensiculiferum* apud Loos (1949) and Williams (1959)	Argentina, Brazil, Colombia, Fiji, Malaysia, Martinique, Mauritius, Paraguay, South Africa, Senegal, Sri Lanka, Surinam, Trinidad, Tunisia, Uruguay, USA, Venezuela	*Artocarpus heterophyllus*, *Corylus Americana, Citrus* sp., *Durio zihethinus*, *Ficus* sp., grass, *Lilium longiflorum*, *Musa acuminata* cv. *rastali*, *Persea americana*, *Prunus persica*, *Saccharum officinarum*, *Solanum melongena, Solanum tuberosum*
X. labiosum Swart & Quénéhervé, 1998	French Guyane	*Dicorynia guianensis*
X. lacrimaspinae Hutsebaut, Heyns & Coomans, 1988	South Africa	Indigenous grasses
X. lafoense Roca, Pereira & Lamberti, 1988	Portugal	*Vitis vinifera*
X. lanceolatum Roca & Bravo, 1993	Portugal	*Vitis vinifera*
X. lapidosum Roca & Bravo, 1993	Portugal	*Vitis vinifera*
X. larliani Singh & Khan, 1997=*X. filicaudatum* Singh & Khan, 1998	India	*Musa paradisiaca*
X. limbeense Brown, Luc & Saka, 1983	Malawi	*Citrus paradisi*
X. limpopoense Heyns, 1977	South Africa	*Pennisetum glaucum*, *Sorghum bicolor,* virgin grass, *Zea mays*
X. llanosum Siddiqi & Lenné, 1990	Colombia	Grass
X. longicaudatum Luc, 1961	Brazil, Cameroon, French Guyane, Ivory Coast, Nigeria, Sao Tome and Principe, Sri Lanka	*Capsicum annuum*, *Coffea* sp., *Musa* sp., *Piper nigrum*
X. longidoroides Luc, 1961	Ivory Coast	*Mapania macrantha*
X. loteni Heyns, 1986	South Africa	*Crassula* sp., grass
X. louisi Heyns, 1979	South Africa	*Ananas comosus,* grass, *Vitis vinifera*
X. lupini Roca & Pereira, 1993	Portugal, Spain	*Lupinus luteus, Vitis vinifera*
X. lusitanicum Sturhan, 1983	Portugal	*Vitis vinifera*
X. macedonicum Barsi & Lamberti, 1999	Macedonia	*Carpinus orientalis*, *Platanus orientalis*
X. machoni Hunt, 1980	Pakistan, Saint Lucia, South Africa, West Indies	*Coccoloba uvifera*
X. macroacanthum Lamberti, Roca & Agostinelli, 1989	Italy	*Olea europaea*
X. macrodora Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Iberian Peninsula	*Olea europaea*
X. macrostylum Esser, 1966	Colombia, Dominica, Ecuador, Martinique	*Musa* ×*paradisiaca* var. *sapientum*
X. magaliesmontanum Kruger & Heyns, 1986	South Africa	Grasses
X. majus Bos & Loof, 1984	Nigeria	Grass
X. malagasi Luc, 1973	Madagascar	*Saccharum officinale*
X. malawiense Brown, Luc & Saka, 1983	Malawi	*Citrus paradisi*
X. malutiense Heyns, 1976=*X. vanderlindei* Heyns, 1962 *partim*	South Africa	*Glycine max, Vigna unguiculata*, virgin veld, *Zea mays*
X. mammatum Siddiqi, 1979	Tanzania	*Medicago sativa*
X. mammillatum Schuurmans Stekhoven & Teunissen, 1938	Congo	Unknown host
X. mampara Heyns, 1979	Lesotho	*Solanum tuberosum*
X. manasiae Sen, Chatterjee & Manna, 2010	India	*Litchi chinensis*
X. manubriatum Luc, 1975	Central African, Nigeria	*Oryza sativa, Theobroma cacao*
X. maraisae Swart, 1994	South Africa	*Cedrus* sp.

..... *continued on the next page*

Table 10 (continued)

SPECIES	WORLD DISTRIBUTION	HOSTS
X. marsupilami Luc, 1973	Madagascar	*Ravenala madagascariensis*
X. masaiorum Heyns & Coomans, 1997	Kenya	Indigenous vegetation
X. mazandaranense Pedram, Pourjam, Robbins, Ye, Atighi & Decraemer, 2012	Iran	*Fagus orientalis*
X. melitense Lamberti, Bleve-Zacheo & Arias, 1982	Italy, Malta	*Ceratonia siliqua*
X. meridianum Heyns, 1971	Botswana, South Africa, Tunisia	*Erica* sp., *Malus domestica, Olea europaea, Prunus persica*, *Psidium guajava, Vitis vinifera*
X. michelluci Siddiqi, 1979	Malawi	*Ricinus communis*, *Solanum tuberosum*
X. miekeae Heyns, 1991	South Africa	Indigenous coastal forest
X. mluci Heyns, 1976=*X. hallei* apud Heyns (1962) and (1971)	Ivory Coast, South Africa, Swaziland	*Drypetes mutikoro,* grass, *Malus domestica*, *Prunus persica*, *Pyrus communis*, *Triticum aestivum*
X. monohysterum Brown, 1968	Australia, India	*Artocarpus heterophyllus, Vitis vinifera*
X. montenegrinum Barsi, Lamberti & Agostinelli, 1998	Yugoslavia (former)	*Carpinus orientalis*
X. mounporti Faye, Barsi & Decraemer, 2012	Senegal	*Oryza sativa*
X. mwanzianum Coomans & Heyns, 1997	Kenya	Pioneer vegetation
X. natalensis Heyns & Vermeulen, 1982	South Africa	*Rubus vestitus*
X. naturale Lamberti & De Luca, 2002	USA	*Pinus palustris*, *Quercus robur*
X. neobasiri Siddiqi, 1979	Malawi	*Solanum tuberosum*
X. neoradiciola Dhanam & Jairajpuri, 1997	India	*Oryza sativa*
X. neovuittenezi Dalmasso, 1969	Bulgaria, France, Spain	*Morus alba*, *Vitis vinifera*
X. nigeriense Luc, 1961	Cameroon, Ivory Coast, Lesotho, Nigeria	*Ananas comosus, Oryza sativa, Theobroma cacao*
X. oleae Archidona-Yuste, Navas-Cortés, Cantalapiedra-Navarrete, Palomares-Rius & Castillo, 2016	Iberian Peninsula	*Olea europaea*
X. orbum Siddiqi, 1964	India	*Zea mays*
X. ornativulvatum Kruger & Heyns, 1987	South Africa	Grasses
X. orthotenum Cohn & Sher, 1972	Thailand	*Litchi chinensis*
X. oryzae Bos & Loof, 1984	French Guyane, Nigeria	*Oryza sativa*
X. papuanum Heyns & Coomans, 1983	Papua New Guinea	Secondary rain forest
X. parachambersi Maria, Ye, Yu & Gu, 2018	Japan	*Euonymus hamiltonianus, Gardenia jasminoides*
X. paradentatum Barsi, Fanelli & De Luca, 2017	Serbia	Meadow
X. parasetariae Luc, 1958=*X. campinense* apud Luc (1958)=*X. attorodorum* Luc, 1961	Australia, Burkina Faso, Congo, Guinee Francaise, Ivory Coast, Mauritania, Niger, Senegal, Togo	*Arachis hypogaea, Cocos nucifera*, *Lupinus angustifolius, Oryza sativa*, *Saccharum officinarum, Setaria megaphylla*
X. parasimplex Kruger, Kilian & Heyns, 1992	South Africa	Grass
X. paritaliae Loof & Sharma, 1979	Brazil, French Guyana, Martinique, Peru	*Citrus* sp., *Passiflora edulis*
X. parvistilus Heyns, 1971	South Africa	*Acacia* sp., *Citrus* sp., *Malus domestica*, *Pinus* sp., *Prunus persica*
X. paulistanum Carvalho, 1965	Brazil	*Myrciaria* sp.
X. phoenicis Loof, 1983	Saudi Arabia	*Phoenix dactylifera*
X. pini Heyns, 1965	Israel, Korea, South Africa	*Acer palmatum, Paeonia suffruticosa, Pinus patula, Syringa oblata*
X. pinoides Joubert, Kruger & Heyns, 1988	South Africa	Grasses
X. pirinense Mincheva, Lazarova & Peneva, 2008	Bulgaria	*Alchemilla* sp., *Fragaria* sp.

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. poasense Varela-Benavides, Peraza-Padilla, Cantalapiedra-Navarrete, Palomares-Rius, Castillo & Archidona-Yuste, 2018	Costa Rica	*Cupressus* sp., *Eucalyptus* sp., *Pennisetum* sp.
X. pombalense Bravo & Lamberti, 1996	Iberian Peninsula, Portugal	*Rubus* sp.
X. pongolense Hutsebaut, 1989	South Africa	*Acacia xanthophloea*
X. porosum Roca & Agostinelli, 1986	Euromediterranea, Italy	Pasture
X. pruni Singh & Khan, 1998	India	*Prunus armeniaca*
X. pseudocoxi Sturhan, 1985	Portugal, Spain	*Vitis vinifera*
X. pseudokrugi Swart & Queneherve, 1998	French Guyane	*Dicorynia guianensis*, Maramaceae
X. pyrenaicum Dalmasso, 1969	France, Portugal, Spain	*Alnus glutinosa*, *Avena sativa*, *Buxus sempervirens*, *Calluna vulgaris*, *Castanea sativa*, *Chamaerops humilis*, *Cistus ladanifer*, *Corylus avellana*, *Hordeum vulgare*, *Ilex aquifolius*, *Juniperus oxycedrus*, *Malus sylvestris*, *Mespilus germanica*, *Olea europaea*, *Phaseolus vulgaris*, *Phoenix sylvestris*, *Phragmites australis*, *Pinus halepensis*, *Platanus orientalis*, *Prunus armeniaca*, *Prunus avium*, *Prunus dulcis*, *Quercus ilex*, *Q. pyrenaica*, *Q. rotundifolia*, *Q. suber*, *Retama sphaerocarpa*, *Robinia pseudoacacia*, *Salix* spp., *Typha angustifolia*, *Vicia sativa, Vitis vinifera*
X. radicicola Goodey, 1936=*X. australiae* McLeod & Khair, 1971=*X. pararadicicola* Phukan & Sanwal, 1982	Australia, Brunei, India, Korea, Malaysia, Sri Lanka	Bambuseae, *Cactus* sp., *Capsicum annuum, Cocos nucifera*, *Durio* sp., *Elaeagnus umbellata, Malus domestica, Musa* sp., *Phyllostachys edulis*, *Piper nigrum, Saccharum officinarum, Ulmus pumila*
X. rarum Heyns, 1979	South Africa	Grasses
X. riocaquetae Hunt, 1982	Columbia, French Guyana	Unknown host
X. riparium (*riparia* emend) Chizhov, Subbotin, Romanenko & Kruchina, 1991	Russia	*Ficus carica*
X. ripogranum Hutsebaut, Heyns & Coomans, 1988	South Africa	Indigenous plants
X. robbinsi Pedram, Niknam & Decraemer, 2008	Iran, Tunisia	*Olea europaea*, *Rhamnus catharica*
X. rotundatum Schuurmans Stekhoven & Teunissen, 1938	Congo, Nigeria, Pakistan	Unknown host
X. sahelense Dalmasso, 1969=*X. amarantum* Macara, 1970	Malawi, Portugal, Spain, USA	*Prunus persica, Vitis vinifera*
X. sandellum Heyns, 1966	South Africa	*Phaseolus vulgaris*
X. savanicola Luc & Southey, 1980=*X. italiae* apud Chavez & Geraert (1977)	Algeria, Bulgaria, Brazil, Cameroon, Cyprus, Egypt, France, Gambia, Greece, Israel, Italy, Ivory Coast, Libya, Malawi, Moldova, Nigeria, Portugal, Romania, Senegal, Slovakia, South Africa, Spain, Tunisia, Turkey, Yugoslavia (former),	*Arachis hypogaea, Canarium album, Citrus reticulate, Cynodon magennisii*, *Hyperthelia dissoluta, Imperata cylindrica, Rosa damascena,* savannah grasses, *Schizachyrium sanguineum, Solanum lycopersicum*, *Vitis vinifera, Zea mays*
X. savaryi Lamberti, Troccoli & Agostinelli, 1997	Thailand	*Ficus benjamina*
X. seinhorsti Swart & Quénéhervé, 1998	French Guyane	*Dicorynia guianense*
X. seredouense Luc, 1975= *X. diversicaudatum* apud Luc (1958)	Guinea	*Cinchona calisaya*, *Oryza sativa*

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. setariae Luc, 1958 =*X. vulgare* Tarjan, 1964	Argentina, Botswana, Brazil, Cameroon, French Guyana, French West Indies, Guadeloupe, India, Indonesia, Ivory Coast, Kenya, Malaysia, Martinique, Peru, Sao Tome and Principe, Santa lucia, South Africa, Surinam, Trinidad, Tobago, USA	*Citrus reticulata*, *Citrus* sp., *Cocos nucifera, Lansium parasiticum*, *Mangifera indica, Phaseolus vulgaris, Pinus* sp., *Prunus serotina*, *Quercus robur*, *Setaria megaphylla, Solanum lycopersicum, Theobroma cacao, Vitellaria paradoxa*
X. sharmai Luc, Loof & Brown, 1985=*X. indicum* Sharma & Saxena, 1981=*X. indicum* Siddiqi, 1959	India	*Coffea* sp., *Grewia asiatica*
X. sharonae Malan, Swart, Meyer & Heyns, 1997	South Africa	*Brunia albiflora*
X. siamense Lamberti, Troccoli & Agostinelli, 1997	Thailand	*Litchi chinensis*
X. silvesi Roca & Bravo, 1998	Portugal	*Vicia faba*
X. silvicola Swart, 1994	South Africa	Natural veld
X. simillimum Loof & Yassin, 1971	Cameroon, Congo, Egypt, India, Sudan	*Citrus sinensis, Delonix regia, Gossypium barbadense, Musa paradisiaca, Pinus parviflora*, *Quercus salicina*, *Rosa* sp.
X. simplex Hutsebaut, Heyns & Coomans, 1989	South Africa	Grass, shrubs and trees
X. simpliciforme Coomans & Heyns, 1997	Kenya	Grasses and herbaceous plants
X. smoliki Luc & Coomans, 1988	USA	Grassland
X. souchaudi Baujard, Luc & Reversat, 1998	Congo	*Eucalyptus alba* × *Eucalyptus* sp.
X. spaulli Heyns & Vermeulen, 1982	South Africa	*Saccharum officinarum*
X. spinosum Swart, 1994	South Africa	*Pinus taeda*
X. spinuterus Luc, 1973	Madagascar	*Ravenala madagascariensis*
X. stenocephalum Luc & Baujard, 1983	Bulgaria, Ivory Coast	*Alchemilla* sp., *Fragaria* sp., *Musa* sp.
X. stockeri Kruger & Heyns, 1985	South Africa	*Colophospermum mopane*
X. surinamense Loof & Maas, 1972=*X. ensiculiferum* apud Carvalho (1955)	Argentina, Brazil, French Guyana, Surinam	*Citrus* sp., *Passiflora* sp.
X. swartae Loof, Luc & Baujard, 1996=*X. swarti* Stocker & Kruger, 1988	South Africa	*Vigna unguiculata, Zea mays*
X. tarjani Luc, 1975	Ivory Coast	*Musa* sp.
X. tenue Joubert, Kruger & Heyns, 1988	South Africa	*Saccharum officinarum*
X. theresiae Stocker & Kruger, 1988	South Africa	*Moraea* sp.
X. thorneanum Luc, Loof & Coomans, 1986=*X. vuittenezi* apud Thorne (1974)	Australia, Austria, Bulgaria, Croatia, Czechoslovakia, France, Hungary, Iran, Italy, Moldova, Poland, Serbia, Slovakia, UK, USA, Uzbekistan, Yugoslavia (former)	*Cydonia oblonga, Elaeagnus angustifolia*, Native prairie sod, *Phlox drummondii*, *Rosa* × *damascena, Rubus idaeus*, *Solanum tuberosum, Vitis vinifera*
X. tica Peraza-Padilla, Cantalapiedra-Navarrete, Zamora-Araya, Palomares-Rius, Castillo & Archidona-Yuste, 2018	Costa Rica	*Annona muricata*, *Citrus* sp., *Coffeae* sp., *Cynodon nlemfuensis*, *Vitis vinifera*
X. torvum Siddiqi, 2000	Brazil	*Elaeis guineensis*
X. transkeiense Joubert, Kruger & Heyns, 1988	South Africa	*Begonia* sp.
X. tropicale Zullini, 1973	Mexico	Tropical rain forest
X. turcicum Luc & Dalmasso, 1964	Bulgaria, Israel, Italy, Moldavia, Spain	*Prunus dulcis*, *Prunus persica*, *Ribes nigrum, Vitis vinifera*

..... *continued on the next page*

Table 10 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
X. turdetanensis Gutiérrez-Gutiérrez, Cantalapiedra-Navarrete, Remesal, Palomares-Rius, Navas-Cortés & Castillo, 2013	Spain	*Pinus pinea*
X. umobae Heyns & Spaull, 1979	Brazil, South Africa	*Saccharum officinarum*
X. vanderlindei Heyns, 1962	South Africa	*Arachis hypogaea, Glycine max*
X. variabile Heyns, 1966*	Botswana, Nigeria, South Africa, Swaziland	*Elaeis guineensis,* grassland
X. variurum Barsi & Lamberti, 1998	Yoguslavia (former)	*Quercus petraea*
X. variegatum Siddiqi, 2000	Brazil	*Theobroma cacao*
X. vicarium Siddiqi, 2000	Brazil	*Elaeis guineensis*, *Musa* sp.
X. vitis Heyns, 1974	South Africa	*Vitis vinifera*
X. vuittenezi Luc, Lima, Weischer & Flegg, 1964=*X. vuittenezi* apud Thorne (1974) (= *X. thorneanum*)=*X. petersmithi* Malan, Swart, Meyer & Heyns, 1997	Australia, Austria, Bulgaria, Chile, Croatia, Czech Republic, Germany, Hungary, Iran, Italy, Moldavia, Poland, Serbia, Slovakia, South Africa, UK, USA, Uzbekistan, Yugoslavia (former)	*Cydonia oblonga, Elaeagnus angustifolia,* grass, *Malus domestica*, *Populus* sp., *Prunus armeniaca*, *Prunus avium*, *Prunus persica*, *Pyrus communis*, *Ribes nigrum*, *Rosa damascena, Rosa* sp., *Rubus idaeus, Solanum tuberosum, Vitis vinifera, Zea mays*
X. winotoi Razak & Loof, 1998	Malaysia	*Hevea brasiliensis*
X. xenovariabile Kruger & Heyns, 1985	South Africa	Grass, *Zea mays*
X. yapoense Luc, 1958	Ivory Coast	*Drypetes aylmeri*
X. zagrosense Ghaemi, Pourjam, Pedram, Robbins, Ye & Decraemer, 2012	Iran	Grasses
X. zulu Heyns, 1965	South Africa	*Acacia xanthophloea*
X. zyzy Heyns & Swart, 2002	South Africa	Grass

Species inquirendae:

X. chappuisi Loof & Luc, 1990 =*Dorylaimus* (*Longidorus*) *chappuisi* Schneider, 1935
X. dolichodorum (de Man, 1907) Thorne & Swanger, 1936 =*X. makrodorum* (Vanha, 1893) Thorne, 1939
=*Dorylaimus dolichodorus* de Man, 1907 = *Dorylaimus makrodorus* Vanha, 1893=*D. macrodorus* de Man, 1880
X. brevicaudatum Schuurmans Stekhoven, 1951 (Luc & Tarjan, 1963)
X. cubense Razjivin (in) O. Relly & Millan, 1973 (Loof & Luc, 1990)
X. cylindricaudatum Schuurmans Stekhoven & Teunissen, 1938 (Sturhan, 1963)
X. digiticaudatum Schuurmans Stekhoven, 1951 (Luc & Tarjan, 1963)
X. effilatum Schuurmans Stekhoven, 1951 (Luc & Tarjan, 1963)
X. grande Steiner, 1914 (Meyl, 1961)
X. lineum (Grube, 1849) Thorne, 1939 (Meyl, 1961)
X. makrodorum(Vanha, 1893) Thorne 1939 (Meyl, 1961)
X. neoamericanum Saxena, Chhabra & Joshi, 1973 (Luc, Loof & Brown, 1984)
X. obtusum Thorne, 1939 (Luc & Tarjan, 1963)
X. sharmai Sharma & Saxena, 1981 (Luc, Loof & Brown, 1984)
X. truncatum Thorne, 1939 (Luc & Dalmasso, 1975)

Note: *X. variabile* Heyns, 1966 was included in the *X. americanum*-group by Brown & Halbrendt (1997), but it excluded from the *X. americanum*-group by Loof & Luc (1990) and Luc *et al.* (1998), here the exclusion is maintained.

Xiphinema diversicaudatum (Micoletzky, 1927) Thorne, 1939

Figs 27–29. Map 7.

Syn: *Dorylaimus* (*Longidorus*) *diversicaudatus* Micoletzky, 1927
Longidorus diversicaudatus (Micoletzky, 1927) Thorne & Swanger, 1936
Xiphinema paraelongatum Altherr, 1958
Xiphinema (*Diversiphinema*) *diversicaudatum* (Micoletzky, 1927) Cohn & Sher, 1972
Dorylaimus (*Longidorus*) *elongatus* of Micoletzky (1923), nec de Man, 1876

Measurements. Table 11.

Table 11. Morphometrics of *Xiphinema diversicaudatum* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	FEMALES	MALES
n	7	3
L	4864 ± 279 (4465–5228)	4739 ± 356 (4458–5140)
a	70.4 ± 8.2 (62.9–84.4)	76.4 ± 10.2 (70.1–88.2)
b	9.4 ± 0.3 (9.0–10.0)	10.6 ± 2.3 (9.1–13.2)
c	96 ± 5.5 (87–102)	88.2 ± 6.4 (80.8–92.0)
c'	1.0 ± 0.1 (0.9–1.2)	1.1 ± 0.2 (1.0–1.4)
V/T	45.0 ± 1.4 (42.1–46.4)	53.0 ± 3.9 (48.6–56.4)
Odontostyle	140 ± 11.3 (116–150)	142 ± 10.4 (133–153)
Odontophore	86.5 ± 5.5 (80.5–93.4)	83.1 ± 2.1 (81.7–84.6)
Total spear length	226 ± 15 (196–242)	226 ± 16 (215–238)
Pharynx length	518 ± 27.5 (479–562)	461 ± 109 (337–541)
Tail width	50.3 ± 6.7 (42.0–56.5)	47.5 ± 7.1 (40.4–54.6)
Tail length	51.0 ± 4.5 (43.6–58.1)	53.8 ± 3.1 (50.2–56.0)
Guide ring-anterior	125 ± 12.2 (106–136)	117 ± 12.8 (102–126)
Amphid-anterior	6.1 ± 1.8 (4.5–9.2)	4.9 ± 0.1 (4.8–5.0)
Body width at: -guide ring	45.9 ± 4.2 (41.6–50.9)	44.8 ± 7.6 (38.6–53.2)
-lip region	14.5 ± 0.7 (13.4–15.4)	14.5 ± 0.9 (13.5–15.4)
-mid-body	69.7 ± 9.8 (54.1–78.5)	63.0 ± 11.3 (50.6–72.6)
-vulva	69.9 ± 9.1 (56.0–77.9)	–
-base of pharynx	62.1 ± 7.8 (50.0–69.6)	58.4 ± 12.9 (45.1–70.7)
Bulb length	112 ± 9.4 (98–124)	107 ± 21.5 (85–128)
Bulb diameter	32.7 ± 4.8 (27.4–41.9)	29.5 ± 8.8 (20.3–37.8)
Tail hyaline	15.3 ± 1.7 (11.9–16.9)	18.4 ± 2.7 (16.4–21.5)

Description. Females: Body ventrally arcuate to C shape when heat relaxed. Lip region low, smoothly rounded, continuous with body contour, 13–15 µm wide. Body cuticle smooth, 3.2–3.7 µm thick at second guide ring, 3.1–4.9 µm at base of pharynx, 3.2–5.2 µm near vulva and 7.6–8.9 µm at the tail terminus. Eight lateral dorsal body pores in region of odontostylet; eight lateral body pores from base of odontophore to pharyngeal base. Amphidial fovea stirrup-shaped, just post-labial, with crescentic slits. Odontostyle slender, 116–150 µm long, distinctly furcate at base. Odontophore 80–93 µm long, with prominent tripartite basal flanges. Basal ring of guiding sheath 106–136 µm from anterior end. Nerve ring a little posterior to base of odontophore. Pharynx a narrow tube enlarging in its last quarter to form a muscular cylindrical bulb 98–124 µm long, 27–42 µm wide. 'Mucro' in anterior part of pharynx 2–3 µm long, 30–150 µm behind base of stylet. Reproductive system amphidelphic, with reflexed ovaries. Anterior reproductive system 692–838 µm long, posterior reproductive system 760–1006 µm long. Uteri near vagina form a well-developed ovijector. Each oviduct and uterus joined through a sphincter-Z. A prominent pseudo-Z organ containing 10–12 irregular globular bodies, 5–8 µm in diameter present in each uterus. Vulva a transverse slit, at 42–46% of body length. Vagina perpendicular to body axis with a thick cuticular layer, 25–28 µm long, occupying 36–48% of corresponding body diameter. Prerectum 392–652 µm long, 5–9 times body diameter; rectum 35–46 µm long, shorter than anal body diameter. Tail short, about one anal body diameter long; tail peg variable in length from 4–11 µm; three to four pairs of lateral body pores on tail.

Males: Body ventrally curved to C shaped when heat relaxed. Lip region low, smoothly rounded, continuous with body contour, 13–15 µm wide. Body cuticle smooth, 2.7–4.0 µm thick at basal ring of guiding sheath, 3.5–4.6 µm at base of pharynx, 4.0–4.9 µm near middle and 5.9–7.2 µm at the tail terminus. Eight to ten dorsal body pores along the odontostyle, seven to nine body pores from base of odontophore to pharyngeal base. Amphidial fovea stirrup-shaped, just post-labial, with crescentic slits. Odontostyle slender, 133–153 µm long, distinctly furcate at base. Odontophore 82–85 µm long, with prominent tripartite basal flanges. Basal ring of guiding sheath 102–126 µm from anterior end. Nerve ring a little posterior to base of odontophore. Pharynx a narrow tube enlarging in its

last quarter to form a muscular cylindrical bulb 85–128 µm long, 20–38 µm wide. 'Mucro' in anterior part of pharynx 2–6 µm long, 21–77 µm behind base of stylet. Pharyngo-intestinal valve conoid-rounded. Testes two, one anteriorly outstretched, and other reflexed; vas deferens filled with spindle-shaped sperms. 4–6 submedian supplementary papillae located anterior to anus. Strong diagonal copulatory muscles present in region of supplements; causing strong curvature of tail end. Spicules robust, ventrally curved near middle, 71–75 µm along the mid-line; lateral guiding piece 16–19 µm long. Tail dorsally convex-conoid, ventrally somewhat flattened, with a terminal digitate, bluntly rounded 8–13 µm peg; slightly over one anal body diameter long, with five pairs of body pores; inner layer of cuticle bearing radial striations not extending into tail peg.

Juveniles: Not found.

Differential diagnosis. *Xiphinema diversicaudatum* is characterised by having 4.5–5.2 mm long, lip region separated by a weak depression or shallow constriction, medium odontostyle (116–150 µm), guide ring 106–136 µm from the anterior end, a prominent pseudo-Z organ present, the ventrally located terminal tail peg and males being common. According to the polytomous key by Loof & Luc (1990), *X. diversicaudatum* belongs to the *X.* non-*americanum* group 5 and has the following codes: A4-B2-C4-D56-E45-F5-G23-H2-I34. No juvenile information is provided here.

Molecular and phylogenetic relationships. The sequenced fragments of SSU (one population) and D2-D3 of LSU (two populations) were approximately 1600 bp and 800 bp respectively. The DNA sequences of the *X. diversicaudatum* New Zealand isolates are available in GenBank under the accession number MN103821 (SSU), MN123757-58 (D2-D3 of LSU).

A BLAST search revealed maximum scores in SSU with four sequences of *X. diversicaudatum* Czech Republic isolates (JQ780346-49, 100% similarity) and one sequence of *X. diversicaudatum* Slovakia isolate (EF538761, 99% similarity). The molecular phylogenetic analysis of *X. diversicaudatum* based on SSU under GTR + I + G, including 59 sequences and 1697 total characters (Fig. 30), showed that the *X. diversicaudatum* New Zealand isolate and the four *X. diversicaudatum* Czech Republic isolates and one Slovakia isolate are in the same clade with 100% PP support.

The BLAST search revealed maximum scores in D2-D3 of LSU with nine sequences of *Xiphinema diversicaudatum* Czech Republic isolate (JQ780359–JQ780367) and one *X. diversicaudatum* Slovakia isolate (EF538755) with 99% similarity. There are three nucleotide differences in 828 bp including one gap between the two New Zealand isolates. The molecular phylogenetic analysis of *X. diversicaudatum* based on D2-D3 of LSU under GTR + I + G, including 71 sequences and 838 total characters (Fig. 31), showed that the *X. diversicaudatum* New Zealand isolates clustered together with the nine *X. diversicaudatum* Czech Republic isolates (JQ780359–JQ780367) and one Slovakia isolate (EF538755), with 100% PP support.

Material examined. Fourteen females, five males and two juveniles from NNCNZ; one female and one male from Nematology Collection of AsureQuality.

Distribution (Map 7). From material examined: New Zealand: **North Island**: Otaki, WN; Te Horo beach Rd, WN; Woodhaven Gardens Co. Ltd, Levin, WN.

From literature: New Zealand: **North Island**: Te Puke, BP; Riverhead, AK; WN; HB; WI; ND; **South Island**: Alexandra, CO; Wanaka, OL; Christchurch, MC; Nelson, NN; Riwaka, NN; Marlborough area, SD; SL; WD (Brown & Topham 1985; Dale 1971; Hay & Close 1992; Knight 2001; Sturhan *et al.* 1997). For world distributions see Table 10.

Habitat and hosts. From material examined: blackberry (*Rubus vestitus*), lettuce (*Lactuca sativa*), roseberry (*Rubus idaeus*) and strawberry (*Fragaria* sp.).

From literature: apple tree (*Malus sylvestris*), apricot (*Prunus armeniaca*), citrus tree (*Citrus* sp.), carnation (*Dianthus caryophyllus*), cotula (*Leptinella* sp., *L. dioica*, *L. maniototo*), hops (*Humulus lupulus*), olive (*Olea europaea*), roses (*Rosa* sp.), California blackberry (*Rubus ursinus*), strawberry (*Fragaria* sp.), tamarillo (*Cyphomandra betacea*), *Thuja* sp., tulip (*Tulipa gesneriana*) and turf grass (Brown & Topham 1985; Dale 1971, 1972; Hay & Close 1992; Knight *et al.* 1997; Sturhan *et al.* 1997).

Plant viruses association. *Xiphinema diversicaudatum* vectors *Arabis mosaic virus* (AMV) and *Strawberry latent ring spot virus* (SLRSV) (Brown 1985, 1986; Brown *et al.* 2004; Brown & Trudgill 1983; Harrison & Winslow 1961; Jha & Posnette 1961; Lister 1964; Taylor & Thomas 1968; Valdez *et al.* 1974). The nematode was isolated from soil under celery and hops both hosting AMV (Hay & Close 1992; Mossop *et al.* 1983).

Remarks. Dale (1971) first reported *X. diversicaudatum* in New Zealand, associated with tamarillo (*Cyphomandra betacea*) at Te Puke and an apple orchard at Riverhead. Subsequently, it was reported from strawberry (*Fragaria* sp.), from an unknown site (Dale 1972); from apricot (*Prunus armeniaca*) in Alexandra (Brown & Topham 1985); hops (*Humulus lupulus*) in Riwaka (Hay & Close 1992); from tulip (*Tulipa gesneriana*) and cotula (*Leptinella* sp., *L. dioica*, *L. maniototo*), from sites unknown (Knight *et al.* 1997). Moreover, Sturhan *et al.* (1997) reported 99 records of *X. diversicaudatum* associated with roses, carnations, and other flowers, *Rubus ursinus, Thuja* and other ornamentals, turf, Cotula, strawberries, vegetables, hop, apple, apricot, olive, tamarillo, *Citrus* trees, and soil from bowling greens widely distributed in the North Island, and from Nelson, Marlborough, Christchurch, Wanaka and Alexandra in the South Island.

In the SSU phylogenetic tree, *X. diversicaudatum* grouped with *X. turdetanensis* Gutiérrez-Gutiérrez, Cantalapiedra-Navarrete, Remesal, Palomares-Rius, Navas-Cortés & Castillo, 2013b but with low PP value support (39%, not shown in Fig. 30). These two species both have the "pseudo-Z-organ" and dorsally convex-conoid tail with subdigitate or digitate terminus. The two species clustered with *X. bakeri* with 100% PP support. In the D2-D3 of LSU phylogenetic tree, *X. diversicaudatum* grouped with *X. bakeri* with 100% PP support. The topologys of the phylogenetic trees in this study are consistent with those of Gutiérrez-Gutiérrez *et al.* (2013b).

Family TRICHODORIDAE (Thorne, 1935) Siddiqi, 1961

Diagnosis: Adapted from Hunt (1993) and Decraemer (1995). Body 0.5–1.5 mm long, plump, female cigar-shaped, male straight or J-shaped on heat relaxation. Cuticle thick, smooth; may swell abnormally on death. Amphidial apertures wide, gaping ellipses; sensilla sac separated from the fovea only by a constriction. Onchiostyle relatively long, ventrally curved without basal knobs. Simple anterior guide ring present. Pharynx consisting of a narrow anterior section expanding into a posterior bulboid section of spathulate or pyriform shape, five gland nuclei present: one posterior ventrosublateral pair, one small anterior ventrosublateral pair, and a single large dorsal nucleus; dorsal nucleus position varies within the same species between anterior and posterior ventrosublateral pairs. Distinct excretory pore present, located either within pharyngeal region or slightly posterior. Prerectum absent. Vulva small, median to slightly postmedian or more posterior in position depending on whether the genital system is amphididelphic, reflexed, or monoprodelphic, reflexed. Uterus a simple tube; oviduct consisting of two cells. Spermatheca present or absent. Female anus almost terminal. Male with one testis, outstretched. Precloacal supplements (SP) well developed; poorly developed caudal alae present or absent. Spicules straight to ventrally curved, with or without ornamentation. Spicule protractor muscles form a capsule around proximal half of retracted spicules. Tail very short and rounded.

Nematodes of the family Trichodoridae belong to suborder Diphtherophorina Micoletzky, 1922 in the order Triplonchida (De Ley & Blaxter 2004; Zullini 2006). Six genera—*Allotrichodorus* Rodriguez-Montessoro, Sher & Siddiqi, 1978, *Ecuadorus* Siddiqi, 2002, *Monotrichodorus* Andrássy, 1976, *Nanidorus* Siddiqi, 1974, *Paratrichodorus* Siddiqi, 1974 and *Trichodorus* Cobb, 1913—are accepted in the Trichodoridae (Asghari *et al.* 2018; Decraemer 1995; Decraemer & Baujard 1998a; Decraemer & Geraert 2013; Decraemer & Robbins 2007; Heydari *et al.* 2014). Several species of *Trichodorus*, *Nanidorus* and *Paratrichodorus* are natural vectors of plant tobraviruses (Heydari *et al.* 2014).

Key to genera *Nanidorus*, *Paratrichodorus* and *Trichodorus*

Females:

1. Body cuticle non-swollen; female with a well-developed vagina (about 1/2 corresponding body diameter); well-developed sclerotized vaginal pieces; pharyngo-intestinal junction usually offset ..... *Trichodorus*
- Body cuticle swollen; female with short vagina (at most 1/3 of corresponding body diameter); poorly-developed sclerotized vaginal pieces; pharyngo-intestinal junction setoff or overlaps 2
2. Vulva transverse slit-like in ventral view; pharyngo-intestinal junction usually offset; hypodermal body pores including the caudal pores absent ..... *Nanidorus*
- Vulva a longitudinal slit in ventral view; pharyngo-intestinal junction overlaps; hypodermal body pores including the caudal pores present ..... *Paratrichodorus*

Males:

1. Bursa absent (few exceptions); body cuticle non-swollen; copulatory muscles extending far anteriorly beyond spicule region; spicules mostly curved, rarely elongated, diverse in shape..... *Trichodorus*
- Bursa present; body cuticle usually well swollen; copulatory muscles restricted to spicule region; spicules short to long, mainly straight..... 2
2. Body length short, 0.4–0.6 mm; a single ventromedian precloacal supplement..... *Nanidorus*
- Body length with wide range 0.4–1.7 mm; two to four ventromedian precloacal supplements..... *Paratrichodorus*

Genus *Nanidorus* Siddiqi, 1974

Diagnosis: Body plump, cigar-shaped, heat relaxed form more or less straight in both sexes. Body length usually short, 0.4–0.6 mm. Cuticle swollen strongly after heat relaxation or acid fixation. Lateral and caudal pores in female absent. Onchiostyle dorsally convex. Pharynx consisting of a narrow anterior section expanding posteriorly to form an offset pharyngeal bulb. Excretory pore near, or behind, base of pharynx. Female reproductive system didelphic. Spermatheca rarely with sperm at proximal end of genital branch. Vulva a small transverse slit in ventral view. Vagina and its sclerotization inconspicuous. Anus subterminal, tail rounded. Ventromedian cervical papillae absent. Lateral cervical pores absent or often difficult to observe. Caudal pores absent. Tail short, conoid, with subdigitate to obtusely rounded terminus, arched dorsally at anal level. Males rare or unknown. If present, spicules very long, more than 1.5 times onchiostyle length. No lateral cervical pores. One pair of large ventrosubmedian papillae near terminus. Testis single, outstretched. Bursa present, distinct in *N. mexicanus*. A single ventromedian precloacal supplement present. Tail short, conoid, with subdigitate to obtusely rounded terminus, arched dorsally at anal level (Decraemer 1980, 1995; Duarte *et al.* 2010; Siddiqi 1980, 2002).

To date, seven species of *Nanidorus* have been recorded worldwide (Asghari *et al.* 2018). The species distribution and host associations of *Nanidorus* are listed in Table 12. *Nanidorus minor* is the only species recorded in New Zealand.

Table 12. Species, world distribution and hosts of *Nanidorus*.

SPECIES	WORLD DISTRIBUTION	HOSTS
N. acutus (Bird, 1967) Siddiqi, 1974=*P. acutus* (Bird, 1967) Siddiqi, 1974=*T. acutus* Bird, 1967= *P.* (*N.*) *acutus* (Bird, 1967) Siddiqi, 1974	Portugal, South Africa, Spain, USA	*Rumohra adiantiformis*, *Sinningia speciosa*
N. minor (Colbran, 1956) Siddiqi, 1974=*P. minor* (Colbran, 1956) Siddiqi, 1974= *T. minor* Colbran, 1956= *P. (N.) minor* (Colbran, 1956) Siddiqi, 1974=*T. christiei* Allen, 1957=*P. (N.) christiei* (Allen, 1957) Siddiqi, 1974= *N. christiei* (Allen, 1957) Siddiqi, 1974=*T. obesus* Razjivin & Penton, 1975= *P. (N.) obesus* (Razjivin & Penton, 1975) Rodriguez-M &Bell, 1978=*P. obesus* (Razjivin & Penton, 1975) Rodriguez-Montessoro & Bell, 1978	Afghanistan, Argentina, Australia, Belgium, Brazil, Canary Islands, China, Chile, Cuba, Egypt, Ethiopia, Fiji, Germany, Greece, India, Iran, Israel, Italy, Ivory Coast, Japan, Java, Korea, Libya, Mauritania, Mauritius, Mediterranean, Mexico, Namibia, Netherlands, New Zealand, Nicaragua, Pakistan, Philippines, Portugal, Puerto Rico, Russia, Senegal, South Africa, Spain, Sweden, Switzerland, Upper Volta, USA, Venezuela, Vietnam	Over 100 known hosts: *Acacia caven*, *Acer* sp., *Actinidia deliciosa*, *Agrostis stolonifera, Allium cepa*, *Beta vulgaris*, *Carica papaya, Chamaecyparis obtusa*, *Citrus* × *aurantium, Citrus limon, Citrus reticulata*, *Citrus* × *paradisi*, *Citrus sinensis*, *Citrus* sp., *Cotula* sp., *Cryptomeria japonica*, *Cydonia oblonga, Cyphomandra betacea, Dahlia sp., Elaeagnus angustifolia, Glycine max, Gossypium hirsutum*, grasses and pastures, *Larix kaempferi*, lawn grasses, *Leptinella* sp., *Lilium* sp., *Lolium multiflorum*, *Lolium perenne*, *Lycopersicon esculentum*, *Malus domestica*, *Medicago sativa*, *Musa acuminata, Musa* sp., *Nicotiana tabacum*, *Oryza sativa, Passiflora edulis*, *Passiflora mollissima*, pasture, *Phaseolus vulgaris, Phormium tenax*, *Pinus densiflora*, *Pinus thunbergii*, *Poa annua,* pome trees, *Prunus persica*, *Rheum rhaponticum, Rhododendron* sp., *Saccharum officinarum, Solanum betaceum*, *Solanum lycopersicum*, *Solanum melongena*, *Solanum tuberosum, Trifolium repens*, turfgrass, *Vitis vinifera, Zea mays*

..... continued on the next page

Table 12 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
N. nanus (Allen, 1957) Siddiqi, 1974=*P. nanus* (Allen, 1957) Siddiqi, 1974=*T. nanus* Allen, 1957= *P. (N.) nanus* (Allen, 1957) Siddiqi, 1974	Afghanistan, Belgium, China, France, Germany, India, Italy, Niger, Netherlands, Pakistan, Portugal, Tunisia, UK	*Arachis hypogaea*, *Litchi chinensis, Oryza sativa, Saccharum officinarum*, *Setaria italica*, *Solanum tuberosum*, weeds
N. renifer Siddiqi, 1974=*P. renifer* Siddiqi, 1974=*P. (N.) renifer* Siddiqi, 1974	Australia, Belgium, Brazil, China, Germany, India, Malawi, Netherlands, Pakistan, UK, USA	*Camellia sinensis, Cynodon dactylon, Ilex glabra, Pinus* sp., *Rhododendron japonicum, Solanum tuberosum, Vitis vinifera*
N. westindicus Rodriguez-M, Sher & Siddiqi, 1978=*P. (N.) westindicus* Rodriguez-M, Sher & Siddiqi, 1978	West Indies	*Saccharum officinarum*, *Theobroma cacao*
N. tansaniensis Siddiqi, 1973=*P. (N.) tansaniensis* Siddiqi, 1973	Italy, South Africa, Tanzania	*Hordeum vulgare, Triticum aestivum*
N. mexicanus Siddiqi, 2002	Mexico	*Pinus* sp., *Quercus* sp.

Nanidorus minor (Colbran, 1956) Siddiqi, 1974

Figs 32–34. Map 8.

Syn: *Paratrichodorus minor* (Colbran, 1956) Siddiqi, 1974
Trichodorus minor Colbran, 1956
Paratrichodorus (*Nanidorus*) *minor* (Colbran, 1956) Siddiqi, 1974
Trichodorus christiei Allen, 1957
Paratrichodorus christiei (Allen, 1957) Siddiqi, 1974
Paratrichodorus (*Nanidorus*) *christiei* (Allen, 1957) Siddiqi, 1974
Nanidorus christiei (Allen, 1957) Siddiqi, 1974
Paratrichodorus obesus (Razjivin & Penton, 1975) Rodriguez-M & Bell, 1978
Trichodorus obesus Razjivin & Penton, 1975
Paratrichodorus (*Nanidorus*) *obesus* (Razjivin & Penton, 1975) Rodriguez-M & Bell, 1978

Measurements. Table 13.

Table 13. Morphometrics of *Nanidorus minor* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	TARANAKI	HAMILTON
n	8	10
L	539 ± 29 (514–607)	531 ± 27 (491–581)
a	14.4 ± 1.1 (13.1–16.0)	16.7 ± 1.8 (14.4–20.0)
b	5.9 ± 0.3 (5.6–6.5)	5.3 ± 0.5 (4.8–6.2)
c	144 ± 34.5 (109–199)	167 ± 21.3 (142–192)
c'	0.4 ± 0.1(0.3–0.5)	0.3 ± 0.0(0.3–0.4)
V/T	56.2 ± 1.5 (54.3–58.5)	57.0 ± 1.0 (55.4–58.2)
Onchistyle	28.0 ± 4.3 (20.5–33.2)	31.6 ± 1.9 (27.6–34.3)
Pharynx length	92.0 ± 2.6 (88.8–95.4)	101 ± 7.2 (90.7–111)
Tail width	10.0 ± 1.1 (8.2–11.6)	9.1 ± 0.7 (8.3–10.5)
Tail length	5.9 ± 0.3 (5.6–6.5)	3.1 ± 0.3 (2.8–3.6)
Excretory pore-anterior	93.5± 6.8 (85.9–98.7)	103
Bulb length	33.0 ± 3.4 (25.7–36.8)	31.9 ± 4.5 (26.5–39.7)
Bulb diameter	16.0 ± 1.3 (14.6–18.1)	13.4 ± 1.8 (10.5–16.7)
Nerve ring-anterior	44.3 ± 3.5 (38.1–48.2)	46.0 ± 2.0 (43.1–49.1)
Body width at: -lip region	14.5 ± 1.3 (12.9–16.2)	7.6 ± 0.7 (6.8–8.8)
-vulva	37.7 ± 2.0 (35.0–40.6)	30.8 ± 3.2 (25.5–36.4)
-base of pharynx	34.3 ± 1.1 (32.2–35.7)	26.7 ± 2.2 (24.0–29.5)
Cuticle at: -lip region	4.2 ± 0.6 (3.5–5.1)	1.3 ± 0.1 (1.2–1.5)
-base of pharynx	5.8 ± 0.5 (5.3–6.7)	2.8 ± 0.4 (2.4–3.7)
-vulva	6.6 ± 1.2 (4.1–7.7)	3.0 ± 0.4 (2.2–4.0)
Rectum	18.3 ± 2.4 (15.1–21.5)	17.0 ± 2.2 (12.6–19.2)

Morphology. Females: Body almost straight when heat relaxed, short, tapering slightly at both ends. Cephalic region rounded with slightly protruding papillae. Onchiostyle typical for the genus. The pharyngeal lumen, ventral to the onchiostyle, leads into the lumen of the narrow anterior part of the pharynx which gradually expands into a spathulate to pyriform basal bulb. Pharyngeal bulb offset. Narrow part of pharynx surrounded by a nerve ring. Excretory pore usually opposite the base of the pharynx. Lateral body pores and caudal pores absent. Anus subterminal and short bluntly rounded tail. Genital tracts amphididelphic, reflexed; no distinct spermatheca. Vulva a short transverse slit; vagina weakly developed, extending for only about one-third of body diameter. Refractive thickenings at vulva inconspicuous, almost rod-like and nearly parallel to the cuticle in lateral view.

Males: Not found.

Differential diagnosis. *Nanidorus minor* is characterised by females having a rather short onchiostyle with inner onchium in adults. Excretory pore usually near pharynx base. Pharyngeal glands usually overlapping the intestine ventrally and subventrally, pharyngeal bulb rarely offset. Females without lateral body pores. No spermatheca and sperm (when present) dispersed throughout uterus. Sperm cells very small, rounded to thread-like. Vaginal sclerotization rod-shaped, parallel to longitudinal body axis, close. Vagina quadrangular in side view. Vulva a short transverse slit. Caudal pores subterminal, obscure.

Molecular and phylogenetic relationships. The sequenced fragments of SSU (two populations), D2–D3 of LSU (two populations) and ITS rDNA (one population) are approximately 800 bp, 800 bp and 600 bp respectively. The DNA sequences of the *N. minor* New Zealand isolate are available in GenBank under the accession number MN103823-24 (SSU), MN123759-60 (D2-D3 of LSU) and MN191543 (ITS).

The BLAST search revealed maximum scores in SSU with seven sequences of *N. minor* including two Iranian isolates (JN123364–JN123365), one USA isolate (KJ934126), three Portuguese isolates (DQ345526, AJ438052 and AM269897) and one Brazilian isolate (AJ438054) with 99% similarity. There are three nucleotide differences in 686 bp between the two New Zealand isolates. The molecular phylogenetic analysis of *N. minor* based on SSU under TIM2 + I + G, including 72 sequences and 1720 total characters (Fig. 35), showed that the *N. minor* New Zealand isolate and ten other isolates of *N. minor* clustered in the same clade with 99% PP support.

The BLAST search revealed maximum scores in D2–D3 of LSU with three sequences of the *N. minor* Chinese isolates (GU645835, GU645836, GU645928) and one *N. minor* Iranian isolate (KJ513001) with 95% similarity. There are 37 nucleotides difference in 745 bp including 6 gaps between the two New Zealand isolates. The molecular phylogenetic analysis of *N. minor* based on D2–D3 of LSU under GTR + I + G, including 72 sequences and 801 total characters (Fig. 36), showed that New Zealand isolates (MN123759) clustered together with nine other *N. minor* isolates with 99% PP support.

The BLAST search revealed maximum scores in ITS1 with two sequences of *N. minor* Chinese isolate (GU645905 and GU645811) and one *N. minor* USA isolate (MG938572), with 99.7% similarity.

Material examined. Ten females from Hamilton deposited in NNCNZ; 41 females and eight juveniles from the Nematology Collection of AsureQuality.

Distribution (Map 8). From material examined: New Zealand: **North Island:** AgResearch, Ruakura Research Centre, Hamilton, WO; Taranaki, TK; Waitara, TK; Te Puke, BP; Massey, Auckland, AK. **South Island**: AMI stadium, Addington, Christchurch, MC.

From literature: New Zealand: **North Island**: Te Puke, BP; Auckland, AK; Turangi, TO; Wairakei, TO; Kerikeri, ND; CL; HB; TK; WN; WA; WO. **South Island:** Christchurch, MC; Nelson, NN (Dale 1971; Knight 2001; Knight *et al.* 1997; Sturhan *et al.* 1997; Yeates & Prestidge 1986). For world distributions see Table 12.

Habitat and hosts. From material examined: New Zealand: *Acer* sp., dahlia (*Dahlia* sp.), lawn grasses.

From literature: New Zealand: apple (*Malus domestica*), banana passionfruit (*Passiflora mollissima*), citrus (*Citrus* sp.), cotula (*Leptinella* sp.), grape (*Vitis vinifera*), grapefruit (*Citrus* × *paradise*), grasses, kiwifruit (*Actinidia deliciosa*), lemon (*Citrus limon*), lily (*Lilium* sp.), lucerne (*Medicago sativa*), passionfruit (*Passiflora mollissima*), pasture, peach (*Prunus persica*), pome trees, *Rhododendron* sp., rhubarb (*Rheum rhaponticum*), silver beet (*Beta vulgaris*), sweet orange (*Citrus sinensis*), tamarillos (*Cyphomandra betacea*), tangelo (*Citrus* × *aurantium*), tomato (*Lycopersicon esculentum*), tobacco (*Nicotiana tabacum*), New Zealand flax (*Phormium tenax*) and white clover (*Trifolium repens*) (Dale, 1971, 1972; Knight *et al.* 1997; Sturhan *et al.* 1997).

Plant viruses association. *Nanidorus minor* is a vector of TRV (the cause of corky ringspot disease of potato) and PepRSV (Ayala & Allen 1968; Brown & Trudgill 1998; Komuro *et al.* 1970; Salomao 1973; Walkinshaw *et al.* 1961). TRV is listed in BORIC by MPI in New Zealand.

Remarks. *Nanidorus minor* was first described as *Trichodorus minor* by Colbran (1956). In 1957, *T. christiei* was described by Allen. Siddiqi (1974) established the genus *Paratrichodorus* and established three new subgenera including *Nanidorus* (comprising several of the previously described *Trichodorus* species, including *Paratrichodorus* (*Nanidorus*) *christiei* and *P.* (*N.*) *minor*). The synonymisaton of *P.* (*N.*) *christiei* and *P.* (*N.*) *minor* was proposed by Loof (1975) and supported by Boutsika *et al*. (2004) and Hooper (1977). *Nanidorus* was raised to genus level by Siddiqi (1980). Subsequently it was synonymised with *Paratrichodorus* by Decraemer & de Waele (1981), a dicision accepted by several reviewers (e.g. Decraemer 1995; Decraemer & Geraert 2006, 2013).

However, *Nanidorus* was considered as a valid genus via molecular analysis of the SSU and D2-D3 of LSU rDNA (Duarte *et al.* 2010, 2011; Kumari & Subbotin 2012). The morphological characteristics differentiating *Paratrichodorus* were: vulva shape (transverse, slit-like in ventral view *vs* a pore, a transverse slit or a longitudinal slit in *Paratrichodorus*), the type of pharyngo-intestinal junction (offset pharyngeal bulb *vs* either an offset pharyngeal bulb, overlapping ventrosublateral pharyngeal glands or dorsal overlap of bulb by intestine or a combination of both type of overlaps), absence of cervical pores (CP) in male, lateral body pores and caudal pores in both sexes (body pores present, rarely absent in *Paratrichodorus*), spicule type (spicules greater than 1.5 times onchiostyle length *vs* spicules shorter), position of post-cloacal supplements (present on tail *vs* position variable), males rare or absent (males usually common in *Paratrichodorus*), a single ventromedian precloacal supplement (two to four supplements in *Paratrichodorus*) and body length (0.4–0.6 mm *vs* a wider range of length 0.4–1.7 mm). However, apart from the transverse slit-like vulva and the single precloacal SP in *Nanidorus* males (when present), some degree of variability is known for the other characters of the current *Nanidorus* species (Decraemer 1980, 1995; Duarte *et al.* 2010; Siddiqi 1980, 2002).

Because *Nanidorus* is accepted as a valid genus by most nematologists (Asghari *et al.* 2018; Hajihassani *et al.* 2018b; Marais *et al*. 2015; Pedram *et al*. 2015; van den Berg *et al*. 2017; Ye 2018), the terminology *N. minor* was used in the present study, but *P. minor* is still used by some (e.g. Daneel *et al.* 2015; Hajihassani *et al.* 2018a; Huang *et al.* 2018).

Nanidorus minor was reported as *Trichodorus christiei* in New Zealand by Dale (1971) and later as *Paratrichodorus minor* by Yeates & Prestidge (1986). It has been found associated with a wide variety of hosts, including tamarillos (*Cyphomandra betacea*), *Citrus* sp., apple and pasture at Te Puke, around passionfruit (*Passiflora mollissima*) at Auckland, around *Lilium* sp. at Turangi, and around tamarillos at Kerikeri, cotula, grape, grapefruit, grasses, kiwifruit, peach, pome trees, *Rhododendron* sp., silver beet, lucerne, tangelo, tomato, tobacco, New Zealand flax, white clover, and in bowling greens and pastures, and in sandy soil along a river bank (Dale, 1972; Knight *et al.* 1997; Sturhan *et al.* 1997). The population dynamics of *N. minor* in soil under pasture showed that it has neither seasonal periodicity nor a consistent vertical distribution pattern, and host assessment in the glasshouse confirmed that it had a wide host range (Bell 1999; Bell & Watson 2001; Watson & Bell 2001).

In addition, Kumari & Subbotin (2012) reported that the intraspecific sequence variations of *N. minor* were 0–0.6 % (0–7 bp in 1137 bp) for SSU and 0–1.6% (0–11 bp in 819 bp) for D2-D3 of LSU, respectively. In present study, the two New Zealand isolates had 0.6% (3 bp in 686 bp) differences for the SSU sequences and 5.0% (37 bp in 745 bp) differences for the D2–D3 of LSU sequences, respectively. Obviosely the New Zealand isolates have higher intraspecific sequence variations than those obseved by Kumari & Subbotin (2012). Further study on different populations of *N. minor* may shed more light on the intraspecific variations.

Genus *Paratrichodorus* Siddiqi, 1974

syn. *Paratrichodorus* (*Paratrichodorus*) Siddiqi, 1974
Paratrichodorus (*Atlantadorus*) Siddiqi, 1974
Paratrichodorus (*Nanidorus*) Siddiqi, 1974
Atlantadorus (Siddiqi, 1974) Siddiqi, 1980
Nanidorus (Siddiqi, 1974) Siddiqi, 1980

Diagnosis: Adapted from Hunt (1993) and Decraemer (1995). Body plump, cigar-shaped, heat relaxed form more or less straight in both sexes. Cuticle swollen strongly after heat relaxation or acid fixation. Onchiostyle dorsally convex. Pharynx comprising a narrow anterior section expanding posteriorly to form a bulb which usually overlaps the intestine ventrally. Female reproductive system didelphic. Spermatheca present, or absent with sperm throughout uterus, or few sperm at proximal end of genital branch. Vulva a minute median pore or small longitudinal slit. Vagina extending into the body for up to one third the corresponding diameter, musculature weakly developed and inconspicuous; sclerotization poorly developed. Anus subterminal, tail rounded. Males rare or unknown in about 26% of nominal species. Ventromedian cervical papillae absent or, if present, consisting of a single papilla near, and anterior to, excretory pore, exceptionally with two. Lateral cervical pores absent or, if present, usually represented by a single pair near the onchiostyle base or excretory pore. Testis single, outstretched. Sperm variously shaped, large, subcylindroid; small oval or rounded, or filiform. Spicules normally straight; transversely striated, except at extremities; gubernaculum present. Spicule suspensor muscles forming an inconspicuous elongate-oval capsule. Bursa present, but may be inconspicuous. Ventromedian copulatory supplements numbering one to three, exceptionally four; the first two supplements usually being within the range of bursa. Oblique copulatory muscles extending no further than proximal tips of retracted spicules. Tail short, rounded, with one or sometimes two, pairs of ventrosubmedian papillae. A pair of caudal pores present, rarely absent.

The genus *Paratrichodorus* was erected by Siddiqi (1974), with *Trichodorus tunisiensis* Siddiqi, 1963 being transferred into *Paratrichodorus* as its type species. Decraemer (1995) listed 31 species for the genus, while now four species were transferred into *Nanidorus*. Since 1995, three additional species have been described (de Almeida *et al.* 2005; Marasi *et al.* 1996; Marais & Botha-Greeff 1997; Decraemer *et al.* 2019b). Of these, *P. faisalabadensis* Nasira & Maqbool, 1994 and *P. psidii* Nasira & Maqbool, 1994 are junior synonyms of *P. mirzai* (Siddiqi, 1960) Siddiqi, 1974 by Decraemer & Baujard (1998a). The species distribution and host associations of the 30 *Paratrichodorus* recorded are listed in Table 14. Two *Paratrichodorus* species were found in New Zealand: *P. lobatus* and *P. porosus*.

Table 14. Species, world distribution and hosts of *Paratrichodorus*.

SPECIES	WORLD DISTRIBUTION	HOSTS
P. acaudatus (Siddiqi, 1960) Siddiqi, 1974=*T. acaudatus* Siddiqi, 1960=*P.* (*P.*) *acaudatus* (Siddiqi, 1960) Siddiqi, 1974	India	*Saccharum officinarum*
P. alleni (Andrássy, 1968) Siddiqi, 1974= *T. allen* Andrássy, 1968= *P.* (*P.*) *alleni* (Andrássy, 1968) Siddiqi, 1974	Congo	Unknown host
P. almadenensis Decraemer, Cantalapiedra-Navarrete, Archidona-Yuste, Varela-Benavides, Gutiérrez- Gutiérrez, Castillo & Palomares-Rius, 2019	Spain	*Olea europaea* var. *sylvestris*
P. allius (Jensen, 1963) Siddiqi, 1974= *T. allius* Jensen, 1963= *P.* (*P.*) *allius* (Jensen, 1963) Siddiqi, 1974= *P. tansaniensis* Siddiqi, 1974	China, Chile, Italy, Kenya, Portugal, Tanzania, USA	*Beta vulgaris*, *Ipomoea batatas, Malus domestica*, *Olea europaea*, *Populus* sp., *Solanum tuberosum*, *Triticum aestivum, Vitis vinifera*, *Zea mays*
P. anemones (Loof, 1965) Siddiqi, 1974= *T. anemones* Loof, 1965= *P.* (*A.*) *anemones* (Loof, 1965) Siddiqi, 1974= *Atlantadorus anemones* (Loof, 1965) Siddiqi, 1974	France, Netherlands, Poland, Potugal, UK, USA	*Beta vulgaris, Pinus taeda*
P. anthurii Baujard & Gennani, 1985	China, France	*Anthurium* sp., *Vitis vinifera*
P. atlanticus (Allen, 1957) Siddiqi, 1974= *T. atlanticus* Allen, 1957=*P.* (*A.*) *atlanticus* (Allen, 1957) Siddiqi, 1974=*A. atlanticus* (Allen, 1957) Siddiqi, 1974	USA	*Pinus clausa*

..... continued on the next page

Table 14 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
P. caribbensis Marasi, Decraemer & Quénéhervé, 1996	France	Rain forest
P. catharinae Vermeu1en & Heyns, 1983= *P.* (*A.*) *catharinae* Vermeu1en & Heyns, 1983	South Africa, USA	*Cucurbita maxima,* garden flowers, grasses, *Prunus caroliniana, Prunus laurocerasus, Pyrus communis*, *Zea mays*
P. delhiensis (Khan, Saha & Lal, 1993) Siddiqi, 1974 =*Atlantadorus delhiensis* Khan, Saha & Lal, 1993	Greece, Italy	*Cichorium intybus*, *Cynara cardunculus*, *Foeniculum vulgare*, *Solanum tuberosum*, weeds
P. divergens Almeida, Santos, Abrantes & Decraemer, 2005	Potugal	*Hedera canariensis*, *Zantedeschia aethiopica*
P. grandis Rodriguez-M. & Bell, 1978= *P. (A.) grandis* Rodriguez-M & Bell, 1978= *Atlantadorus grandis* (Rodriguez-M & Bell, 1978) Siddiqi, 1974	USA	*Arctostaphylos* sp.
P. hispanus Roca & Arias, 1986	Portugal, Spain	*Triticum aestivum*
P. lobatus (Colbran, 1965) Siddiqi, 1974= *T. lobatus* Colbran, 1965= *T. clarki* Yeates, 1967=*P.* (*P.*) *lobatus* (Colbran, 1965) Siddiqi, 1974	Australia, Chile, South Africa, New Zealand	*Ammophila arenaria, Cotula* sp., *Cucurbita maxima, Nicotiana tabacum, Oryza sativa*
P. macrostylus Popovici, 1989	Romania, Slovakia	*Fagus grandifolia*, *Picea* sp., *Quercus cerris*
P. meyeri De Wae1e & Kilian, 1992	South Africa	*Nicotiana tabacum*
P. mirzai (Siddiqi, 1960) Siddiqi, 1974=*T. mirzai* Siddiqi, 1960=*P.* (*P.*) *mirzai* (Siddiqi, 1960) Siddiqi, 1974= *T. musambi* Edward & Misra, 1970 =*P. faisalabadensis* Nasira & Maqbool, 1994=*P. psidii* Nasira & Maqbool, 1994	Caspian region, India, Iran, Pakistan	*Brassica oleracea*, *Citrus* sp., *Gossypium hirsutum*, *Psidium guajava, Saccharnm officinarnm*
P. namibiensis Marais & Botha-Greeff, 1997	Namibia	*Nicotiana tabacum*
P. orrae Decraemer & Reay, 1991	Australia	*Bossiaea bossiaeoides*, *Corymbia latifolia*, grasses, *Grevillea pyramidalis*, *Melaleuca* sp.
P. paramirzai Siddiqi, 1991	India	*Arachis hypogaea*, *Curcuma longa*
P. pachydermus (Seinhorst, 1954) Siddiqi, 1974= *T. pachydermus* Seinhorst, 1954=*P.* (*A.*) *pachydermus* (Seinhorst, 1954) Siddiqi, 1974= *A. pachydermus* (Seinhorst, 1954) Siddiqi, 1974	Belgium, Bulgaria, Chile, Czech Republic, Czechoslovakia (former), Denmark,Finland, France, Germany, Holland, Italy, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Sweden, Switzerland, UK, USA	*Beta vulgaris,* grasses, *Phaseolus vulgaris*, *Prunus caroliniana,* shrubs, *Solanum tuberosum*, *Vitis vinifera*
P. paraporosus Khan, Jairajpuri & Ahmad, 1989	India	*Oryza sativa*
P. porosus (Allen, 1957) Siddiqi, 1974=*T. porosus* Allen, 1957=*P.* (*A.*) *porosus* (Allen, 1957) Siddiqi, 1974=*A. porosus* (Allen, 1957) Siddiqi, 1974=*T. bucrius* Lordello & Zamith, 1958	Australia, Brazil, Chile, China, Costa Rica, India, Iran, Italy, Japan, Korea, Norfolk Island, Papua New Guinea, Portugal, Russia, South Africa, Sri Lanka, New Zealand, UK, USA, Uzbekistan, Vietnam	*Acacia mangium, Allium sativum,* bowling turf, *Brassica rapa*, *Camellia japonica, Citrus reticulata*, *Citrus* sp., *Cucurbita maxima*, *Cyphomandra betacea, Dioscorea batatus*, *Dioscorea opposita*, *Gleichenia linearis, Glycine max*, *Hordeum vulgare, Magnoliaceae glance, Malus domestica*, *Malus sylvestris*, *Prunus serrula, Solanum betaceum*, *Vitis vinifera*, *Zea mays*
P. queenslandensis Decraemer & Reay, 1991	Australia	*Acmena smithii*, *Alsophila australis*, *Archontophoenix cunninghamiana*, *Banksia aemula*, *Banksia oblongifolia*, *Eucalyptus umbra, Livistona drudei, Lophostemon suaveolens*, *Melaleuca quinquenervia*, *Toona australis*

..... continued on the next page

Table 14 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
P. ramblensis Decraemer, Cantalapiedra-Navarrete, Archidona-Yuste, Varela-Benavides, Gutiérrez- Gutiérrez, Castillo & Palomares-Rius, 2019	Spain	*Alnus glutinosa, Olea europaea*, *Vitis vinifera*
P. rhodesiensis (Siddiqi & Brown, 1965) Siddiqi, 1974=*T. rhodesiensis* Siddiqi & Brown, 1965=*P.* (*P.*) *rhodesiensis* (Siddiqi & Brown, 1965) Siddiqi, 1974	Cap Vert Isles, Ivory Coast, Rhodesia, Senegal	*Andropogon guayanus*, *Ceiba pentandra, Saccharum officinarum, Tectona grandis*
P. sacchori Vermeulen & Heyns, 1983=*P.* (*A.*) *sacchari* Vermeulen & Heyns, 1983	South Africa	*Saccharum officinarum*
P. teres (Hooper, 1962) Siddiqi, 1974=*T. teres* Hooper, 1962=*P.* (*P.*) *teres* (Hooper, 1962) Siddiqi, 1974=*T. flevensis* Kuiper & Loof, 1962	Australia, Belgium, Chile, Denmark, France, Germany, Greece, Holland, Iran, Italy, Netherlands, Poland, South Africa, Spain, Sweden, UK, USA	*Acer* sp., *Achillea* sp., *Allium cepa*, *Artemisia vulgaris*, *Beta vulgaris*, *Betula* sp., *Cichorium intybus*, *Citrus jambhiri, Cynodon dactylon, Lactuca sativa, Lathyrus*, *Lolium* sp., *Malus* sp., *Oenothera* sp., *Poa* sp., *Prunus armeniaca, Prunus mahaleb*, *Secale* sp., *Solanum tuberosum*, *Trifolium repens*, *Urtica* sp., *Vitis vinifera*
P. tunisiensis (Siddiqi, 1963) Siddiqi, 1974=*T. tunisiensis* Siddiqi, 1963=*P.* (*P.*) *tunisiensis* (Siddiqi, 1963) Siddiqi, 1974	Iran, Italy, Libya, Tunisia	*Alnus* sp., *Corylus americana, Cynara cardunculus*, *Juglans regia*, *Malus domestica*, *Olea europaea*, pastures, *Populus* sp., *Prunus persica*, *Quercus robur*, *Salix* sp., *Sesbania* sp., *Trifolium* sp., *Ulmus* sp., *Vitis vinifera*
P. weischeri Sturhan, 1985 =*P.* (*P.*) *weischeri* Sturhan, 1985	Germany	Fruit trees, grass, riverbank vegetation

Key to *Paratrichodorus* species in New Zealand

Males:

1 Male present; one ventromedian cervical papilla..... *P. lobatus*
- Male absent..... *P. porosus*

Females:

1 Ventromedian advulval body pores absent..... *P. lobatus*
- Four ventromedian advulval body pores present, two anterior to, and two posterior to the vulva..... *P. porosus*

Paratrichodorus lobatus (Colbran, 1965) Siddiqi, 1974

Figs 37–40. Map 9.

Syn: *Trichodorus lobatus* Colbran, 1965
Paratrichodorus (*Paratrichodorus*) *lobatus* (Colbran, 1965) Siddiqi, 1974
Trichodorus clarki Yeates, 1967

Measurements. Table 15.

Morphology. Males: Body cylindrical, anteriorly tapered in pharyngeal region, posteriorly the dorsal surface is twisted, i.e., tail lies on ventral line. Cuticle swollen strongly on fixation, with 1.1–2.5 µm thick at lip region, 5.3–9.1 µm at base of cardia and 5.1–9.7 µm at mid-body. Lip region rounded, 9.9–12.6 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 4.9–5.0 µm wide, 5.3–6.0 µm from anterior end. Onchiostyle well developed curved, onchium fine, 21–26 µm long, onchiophore not sclerotized, 19–26 µm long. Nerve ring located between base of pharyngostom and anterior extremity of pharynx, 58–65 µm from anterior end. Excretory pore situated between nerve ring and pharyngeal bulb, 107–113 µm from anterior end (only observed in only two specimens). No ventromedian or hypodermal pores in pharyngeal region. The intestine often overlaps pharyngeal bulb for some distance ventrally. No pharyngeal-intestinal valve seen. Testis single, outstretched. Small sperm cells with oval-shaped nucleus, may appear fibrillary. Spicules paired, 52–68 µm long, similar, proximally cephalated by slight constriction, marked with transverse striae; gubernaculum 8.6–9.9 µm, about one-quarter spicule length, slender

but distally thickened. Two precloacal, ventromedian supplementary papillae present, both lying within the bursa. In lateral view bursa extends about as far forward as spicules and does not extend posteriorly beyond cloaca; in form is a distinct bilobed flap. A pair of ventrolateral caudal papillae situated slightly posterior to cloaca. A pair of subterminal cuticular pores present.

Table 15. Morphometrics of *Paratrichodorus lobatus* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	HOLOTYPE	PARATYPES	
	MALE	MALES	FEMALES
n	–	11	5
L	897	853 ± 83 (732–1032)	854 ± 75 (779–970)
a	16.7	17.1 ± 2.9 (12.4–21.4)	13.7 ± 4.5 (10.1–18.7)
b	6.8	6.7 ± 0.4 (6.2–7.2)	5.0 ± 0.0 (4.9–5.0)
c	90.1	66.3 ± 13.8 (47.4–81.2)	–
V/T	67	59.2 ± 6.3 (52.2–65.5)	52.9 ± 1.2 (51.5–53.9)
Onchium	26.2	23.6 ± 1.7 (21.0–25.7)	26.4 ± 0.7 (25.7–27.1)
Onchiophore	24.1	22.1 ± 2.6 (19.0–25.7)	24.8 ± 3.5 (22.2–28.8)
Onchiostyle	50.3	45.6 ± 2.1 (42.7–48.9)	51.2 ± 4.2 (47.9–55.9)
Pharynx length	132	135 ± 14.1 (121–155)	165 ± 4.0 (162–168)
Pharyngeal bulb length	50.7	48.3 ± 8.0 (40.6–59.2)	68.1 ± 0.8 (67.6–68.7)
Pharyngeal bulb diam.	21.9	48.3 ± 8.0 (40.6–59.2)	34.1 ± 6.2 (29.7–38.5)
Excretory pore-anterior	?	113, 107	101
Nerve ring-anterior	64.4	61.7 ± 3.1 (57.5–64.8)	77.8 ± 2.2 (76.2–79.3)
Body diam. at cardia	51.3	53.1 ± 8.7 (44.7–67.3)	70.7 ± 10.5 (63.2–78.1)
Body diam. at mid-body	53.8	51.3 ± 7.8 (40.6–66.1)	62.3 ± 16.7 (44.0–76.7)
Anal body diam.	20.5	25.5 ± 6.3 (20.0–33.4)	–
Spicules length	69.2	60.2 ± 6.5 (52.0–68.2)	–
Gubernaculum	?	9.9, 8.6	–
Cloaca to SP1	32.0	28.5 ± 2.2 (26.2–31.5)	–
Cloaca to SP2	16.8	16.9 ± 2.8 (14.3–20.7)	–
Cloaca to SP3	5.5	4.5 ± 1.0 (3.7–6.1)	–
Anterior genital tract	–	–	162, 149
Posterior genital tract	–	–	164, 150
Tail length	10.0	13.9 ± 3.3 (10.6–17.7)	–

?: the data not available from the specimens.

Females: Body stout, cigar-shaped, body curved ventrally when heat fixed and pharyngeal overlap slightly greater. Cuticle swelling strongly on fixation, 1.6–2.1 µm thick at lip region, 2.6–13.1 µm at base of cardia and 3.3–10.3 µm at vulva. Lip region rounded, 10.5–11.6 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 5.1 µm wide, 5.2 µm from anterior end (only observed in one specimen). Onchiostyle well developed curved, onchium fine, 26–27 µm long, onchiophore not sclerotized, 22–29 µm long. Nerve ring located between base of pharyngostom and anterior extremity of pharynx, 76–79 µm from anterior end. Excretory pore between nerve ring and pharyngeal bulb, 101 µm from anterior end (only observed in one specimen). No ventromedian or hypodermal pores in pharyngeal region. The intestine often overlaps pharyngeal bulb for some distance dorsally. Reproductive system amphididelphic, with reflexed ovaries. Anterior genital tract 149–162 µm long, posterior reproductive system 150–165 µm long. Vulva a longitudinal slit at 52–54% of total body length. Vagina perpendicular to body axis with a thick cuticular layer, 12–17 µm long, occupying 25–26% of corresponding body diameter. Vaginal sclerotizations small oval, well separated: > 2.5 µm. Vagina wide, a rounded trapezoid when relaxed, sperm cells usually dispersed throughout uteri at some concentration near the oviduct. Tail short, 3 µm long, rounded; anus and a pair of caudal pores subterminal.

Differential diagnosis. *Paratrichodorus lobatus* is characterised by a pharynx with a short, moderate or most usually one body diameter long ventral overlap in males and females. Females are distinguished by having a vulva had a longitudinal slit; small oval, vaginal sclerotizations well separated more than 2.5 µm; vagina wide, a rounded trapezoid when relaxed. Tail short and rounded with a pair of subterminal cuticular pores with striated shafts. Males with cephalated, spicules, well developed bursa, two precloacal supplements and a pair of ventrolateral caudal papillae slightly posterior to the cloaca.

Material examined. Five females, 13 males and 12 juveniles from NNCNZ.

Distribution (Map 9). From material examined: New Zealand: Castlecliff Beach, Wanganui, Puke, WI.

From literature: New Zealand: **North Island:** Havelock North, HB; Orewa Beach, AK; Karekare Beach, AK; Waitakere Ranges, AK (Knight 2001; Sturhan *et al.* 1997). NN was listed by Knight (2001) without location details, therefore it is not shown in Map 9. For world distributions see Table 14.

Habitat and hosts. From material examined: New Zealand: *Ammophila arenaria*.

From literature: New Zealand: *Cotula* sp., marram grass (*Ammophila arenaria*), regenerated native bush and garden soil (Dale 1971; Sturhan *et al.* 1997; Yeates, 1967).

Plant viruses association. Unknown.

Remarks. *Paratrichodorus lobatus* was reported in New Zealand as *Trichodorus clarki* by Yeates (1967) from sand under *Ammophila arenaria* and characterised by the marked overlap of the pharyngeal bulb ventral to the intestine in both sexes and the presence of a flap over the cloaca in the male. Subsequently it was synonymised with *P. lobatus* by Yeates (1969) and Siddiqi (1974), who found no significant difference between these two species.

In addition, one pair of lateral postvulvar body pores was described by Yeates (1967), but not observed when the materials were re-examined in the present study.

Paratrichodorus porosus (Allen, 1957) Siddiqi, 1974

Figs 41–43. Map 10.

Syn: *Trichodorus porosus* Allen, 1957
Paratrichodorus (*Nanidorus*) *porosus* (Allen, 1957) Siddiqi, 1974
Nanidorus porosus (Allen, 1957) Siddiqi, 1974
Trichodorus bucrius Lordello & Zamith, 1958

Measurements. Table 16.

Morphology. Females: Body stout, cigar-shaped, almost straight on heat relaxation. Cuticle swelling strongly on fixation. Cuticle slightly swollen, 1.9–2.7 µm thick at lip region, 7.5–9.7 µm at base of cardia and 4.9–11 µm at vulva. Lip region rounded, 9–11 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 4.3–4.9 µm wide, 3.7–3.9 µm from anterior end. Onchiostyle well developed curved, onchium fine, 21–24 µm long, onchiophore not sclerotized, 10–13 µm long. Nerve ring located between base of pharyngostom and anterior extremity of the pharynx, 52–60 µm from anterior end. Excretory pore between nerve ring and pharyngeal bulb, 78–88 µm from anterior end. No ventromedian or hypodermal pores in pharyngeal region. The intestine often overlaps the pharyngeal bulb for some distance dorsally. Reproductive system amphididelphic, with reflexed ovaries. Anterior genital tract 99–134 µm long, posterior reproductive system 73–128 µm long. Lateral body pores absent within one body diameter of vulva. Vulva a longitudinal slit situated at 52–56% of total body length. Vagina perpendicular to body axis with a thick cuticular layer, 17–31 µm long, occupying 20–24 % of corresponding body diameter. Vaginal sclerotizations small in lateral view, clearly visible as slightly separated oval pieces. Four ventromedian advulval body pores present, two anterior and two posterior to the vulva. Few sperm in uteri; no differentiated spermatheca. Vagina short, wide, rounded rectangular to trapezoid, rarely barrel-shaped. Tail short, 2–4 µm long, rounded; anus subterminal.

Males: Not found in New Zealand.

Differential diagnosis. *Paratrichodorus porosus* is characterised by females having four ventromedian advulval body pores, two anterior and two posterior to the vulva. Vulva pore-like. Sperm rare and spermathecae absent.

Material examined. 36 females from the Nematology Collection of AsureQuality.

Distribution (Map 10). From material examined: New Zealand: **North Island**: Taranaki, TK; Katikati, BP; Bay of plenty, BP.

Table 16. Morphometrics of *Paratrichodorus porosus* females from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	BAY OF PLENTY	TARANAKI
n	9	10
L	570 ± 45 (505–637)	674 ± 72 (543–816)
a	11.4 ± 1.1 (9.8–13.4)	11.7 ± 1.0 (10.4–13.5)
b	5.3 ± 0.3 (4.8–5.8)	5.9 ± 0.8 (5.0–7.3)
c	146 ± 14.5 (133–173)	226 ± 71 (134–348)
V/T	56.1 ± 1.1 (54.4–57.9)	55.0 ± 1.4 (52.4–56.4)
Onchium	22.9 ± 0.8 (21.0–23.9)	24.3 ± 1.2 (21.7–25.5)
Onchiophore	11.5 ± 1.2 (10.0–13.4)	25.9 ± 0.5 (25.4–26.8)
Pharynx length	109 ± 8.3 (93.9–121)	116 ± 12.7 (95.8–133)
Pharyngeal bulb length	47.3 ± 5.8 (36.2–54.5)	43.0 ± 7.4 (32.6–53.4)
Pharyngeal bulb diameter	19.8 ± 1.1 (18.2–21.1)	20.2 ± 4.9 (13.5–26.5)
Excretory pore-anterior	84.3	83.2 ± 3.7 (78.1–87.7)
Amphid-anterior	3.8 ± 0.1 (3.7–3.9)	4.8 ± 0.7 (4.3–5.9)
Nerve ring-anterior	56.9 ± 3.0 (52.3–60.6)	62.4 ± 4.9 (53.6–66.7)
Body diam. at cardia	45.3 ± 3.4 (38.6–50.1)	50.5 ± 4.0 (42.9–56.4)
Body diam. at mid-body	50.1 ± 3.9 (44.8–55.2)	57.9 ± 6.3 (46.1–65.0)
Anal body diam.	21.9 ± 2.8 (17.5–24.9)	18.0 ± 2.0 (14.2–19.9)
Rectum	29.0 ± 2.9 (24.8–32.0)	23.5 ± 6.9 (15.8–33.3)
Anterior genital tract	116 ± 11.4 (98.6–134)	116 ± 19.4 (87.8–145)
Posterior genital tract	105 ± 15.9 (73.2–128)	96.4 ± 18.0 (70.6–128)
Tail length	3.9 ± 0.6 (3.2–4.8)	3.1 ± 0.8 (1.9–4.1)

From literature: New Zealand: **North Island**: One Tree Hill, Auckland, AK; Kerikeri, ND; Opotiki, BP; Tauranga, BP; New Plymouth, TK; Waitahanui (Lake Taupo), TO; Hawke's Bay, HB; Palmerston North, WI; Waiuku, WO; and Matamata, WO; WN (Dale 1971; Knight 2001; Sturhan *et al*. 1997). For world distributions see Table 14.

Habitat and hosts. From material examined: New Zealand: unknown host.

From literature: New Zealand: apple (*Malus sylvestris*), bowling turf grass, citrus (*Citrus* sp.), grapes (*Vitis vinifera*) and tamarillo (*Cyphomandra betacea*) (Dale 1971; Sturhan *et al*. 1997).

Plant Viruses association. *Paratrichodorus porosus* is a vector of TRV (Ayala & Allen 1968; Barriga 1965; Chevres-Roman *et al*. 1971).

Remarks. Dale (1971) first recorded this nematode as *T. porosus* in New Zealand, associated with tamarillo and citrus at Kerikeri. Hunt (1993) described the female as having "Vagina barrel-shaped, weakly developed and extending into the body for about one-third of the corresponding diameter"; however, it is only one-fifth of the corresponding diameter in the present study. It was noted that: 1) the onchiostyle remained intact and was easily observed in short-term storage specimens; 2) the onchiophore and excretory pore were not observed in some specimens. The latter is probably caused by long-term storage.

Genus *Trichodorus* Cobb, 1913

Diagnosis: Adapted from Hunt (1993) and Decraemer (1995). Heat relaxed females die ventrally arcuate, the males J-shaped with the tail region more sharply curved ventrad. Cuticle not swollen strongly on fixation. Onchiostyle dorsally convex with a simple, anterior, guide ring. Pharynx usually with offset bulb, but also with ventral overlap of pharyngeal glands or dorsal intestinal overlap. Excretory pore usually at level of isthmus or anterior region of pharyngeal bulb. Female reproductive system didelphic; spermathecae present, although weakly

developed in a few species, e.g., *T. nanjingensis*. Vulva a median pore, or a transverse slit, or rarely a longitudinal slit. Vagina extending into the body for about half the corresponding diameter. Vaginal musculature well developed and prominent and sclerotization usually strong. Anus subterminal; tail rounded. Caudal pores paired. Males usually with one to three ventromedian cervical papillae; exceptionally absent or as many as four present. Lateral cervical pores usually present, the pair (one pore on each side) being between the onchiostyle base and the nerve ring. Male genital tract monorchic, outstretched. Sperm large, subcylindroid, with a large elongate or, rarely, a rounded nucleus. Spicules ventrally arcuate, rarely straight; smooth or with ornamentation of bristles, striations or velum. Gubernaculum present. Spicule suspensor muscles forming a prominent oval capsule around spicules. Bursa absent (but regarded as present, although very small, in *T. cylindricus*). Three ventromedian copulatory supplements, rarely two, four or five; the first being within the range of the retracted spicules. Oblique copulatory muscles extending for several body diameters anterior to the retracted spicules. Tail short, rounded, with one pair of ventrosublateral papillae and a pair of caudal pores.

The genus *Trichodorus* was first erected by Cobb (1913) with *T. obtusus* Cobb, 1913 as its type species. Subsequently, *T. obtusus* was considered as a *species inquirenda* and *T. primitivus* was given as type species for the genus (Hunt 1993). Decraemer (1995) listed 47 species for the genus, and *T. variabilis* Roca, 1998 was added subsequently (Decraemer & Baujard 1998b). Since 1998, 19 additional species have been described (Asghari *et al*. 2018; Baek & Choi 1995; Carta & Skantar 2014; Decraemer *et al.* 2008, 2013; Decraemer & Marais, 2000; De Waele & Michal 1995; Heydari *et al*. 2014; Maafi & Decraemer 2002; Niknam *et al.* 2009; Pedram & Pourjam 2014; Siddiqi & Sharma 1995; Xie *et al.* 2000; Zahedi *et al*. 2009; Zhao *et al*. 2013). Among these, *T. golestanensis* Heydari, Maafi & Decraemer, 2014 is a junior synonym of *T. iranicus* Pedram & Pourjam, 2014 (Pedram *et al.* 2015). The species distribution and host associations of the 66 *Trichodorus* recorded are listed in Table 17. Two *Trichodorus* species were found in New Zealand: *T. cottieri* and *T. primitivus*.

Table 17. Species, world distribution and hosts of *Trichodorus*.

SPECIES	WORLD DISTRIBUTION	HOSTS
T. aequalis Allen, 1957	Japan, Spain, USA	*Erythrina crista-galli, Heteromeles arbutifolia*
T. altaicus De Waele & Michal, 1995	Russia	*Betula* spp., *Picea* spp.
T. andalusicus Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Olea europaea*
T. asturanus Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Castanea sativa*
T. aquitanensis Baujard, 1980	France	*Calluna vulgaris*, *Erica cinerea, E. scoparia, Pinus pinaster, Pteris aquilina, Quercus pyrenaica, Simethis mattiazzii, Ulex europaeus*
T. arasbaranensis Zahedi, Niknam, Decraemer & Karegar, 2009	Iran	*Carpinus betulus*
T. azorensis Almeida, De Waele, Santos & Sturhan, 1989	Portugal	Bryophyta, Leguminosae, grasses, *Myrica faya*, *Pittosporum* sp., *Plantago lanceolata*, *Pteridium aquilinum*, *Rubus* sp., *Selaginella kraussiana, Senecio* sp., *Ulex europaeus*
T. beirensis Almeida, De Waele, Santos & Sturhan, 1989	Portugal	*Humulus lupulus, Lolium multiflorum*, *Secale cereale*
T. borai Rahman, Jairajpuri & Ahmad, 1985	India	*Bambusa* sp.
T. borneoensis Hooper, 1962	Borneo, Vietnam	*Musa acuminata, M. textilis*
T. californicus Allen, 1957	USA	*Alnus* sp., *Betula glandulosa*, *Conus canadensis*, conifer, *Epilobium angustifolium*, *Equisetum* sp., grass, *Laurus nobilis*, *Mesembryanthemum*, *Picea sp., Pinus attenuata, Populus balsamifera*, *Quercus robur*, *Salix* sp., *Solanum tuberosum*, *Vaccinium* sp., *Vaccinium vitis-idaea*

..... continued on the next page

Table 17 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
T. carlingi Bernard, 1992	USA	*Betula papyrifera, Ledum decumbens*, *Picea mariana*, *Populus tremuloides*, *Salix* sp.
T. cedarus Yokoo, 1964= *T. kurumeensis* Yokoo, 1966;=*T. longistylus* Yokoo, 1964	China, Japan, Korea	*Abies homolepis, Abies sachalinensis, Acer palmatum, Brassica oleracea, Chamaecyparis obtusa, Cryptomeria japonica, Cunninghamia lanceolata*, *Diospyros kaki*, *Glycine max, Hordeum vulgare, Larix kaempferi, Malus domestica, Malus pumila, Picea jezoensis, Pinus densiflora, Pinus resinosa, Pinus strobus, Pinus sylvestris, Prunus armeniaca*, *Prunus persica*, *Pyrus pyrifolia*
T. complexus Rahman, Jairajpuri & Ahmad, 1985	India	*Calamus viminalis*
T. coomansi De Waele & Carbonell, 1983	Africa, Italy	*Adianthum poirettii*, *Alchemilla argyrophylla*, *Asplenium monanthes*, *Cheilanthes farinosa*, *Dendrosenecio keniodendron, Erica arborea*, *Hypericum revolutum* subsp. *keniense*, *Lobelia gregoriana, Podocarpus milanjianus*, *Polystichum setiferum*, *Pteris catoptera*, *Vitis Vinifera, Yushania alpina*
T. cottieri Clark, 1963	New Zealand, USA	*Carpodetus serratus, Myrsine* sp., *Nothofagus menziesii, N. solandri, Olearia* sp.
T. cylindricus Hooper, 1962	Belgium, Denmark, France, Germany, Netherlands, Poland, Spain, Switzerland, UK	*Beta vulgaris*, *Cupressus sempervirens*, *Lactuca sativa*, *Solanum tuberosum*
T. dilatatus Rodriguez-Montessoro & Bell, 1978	USA	*Arctostaphylos* sp., *Populus* sp.
T. eburneus De Waele & Carbonell, 1983	Senegal, Ivory Coast,	*Andropogon gayanus, Diospyros chevalieri*, *Hyperthelia* sp., *Loudetia simplex*, *Uapaca guineensis*
T. elefjohnsoni Bernard, 1992	USA	*Acer pensylvanicum*, *Aesculus glabra*, *Betula alleghaniensis*, *Halesia carolina*, *Liriodendron tulipifera*, *Magnolia acuminata*, *Quercus rubra*, *Rubus* sp., *Tsuga canadensis*
T. elegans Allen, 1957	Russia, USA	*Pinus* sp.
T. jeonjuensis Baek & Choi, 1995	Korea	*Pinus thunbergii*
T. giennensis Decraemer, Roca, Castillo, Pena-Santiago & Gomez-Barcina, 1993	Spain	*Alnus glutinosa*, *Asphodelus* sp., *Fraxinus anguslifolia*, grass, *Olea europaea*, *Quercus ilex*
T. gilanensis Maafi & Decraemer, 2002	Iran	*Quercus robur*, *Ulmus* sp.
T. guangzhouensis Xie, Feng & Zhao, 2000	China	*Lactuca sativa*
T. hooperi Loof, 1973	China, Germany, UK, USA	*Citrus sinensis,* woodland with herbaceous
T. iliplaensis Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Olea europaea*
T. intermedius Rodriguez-M & Bell, 1978	Spain, USA	*Ambrosia* sp., *Chenopodium* sp., grass, *Pinus* sp., *Quercus* sp., *Q. virginiana*, *Salix* sp., *Salvia leucophylla*
T. iranicus Pedram & Pourjam, 2014=*T. golestanensis* Heydari, Tanha Maafi & Decraemer, 2014	Greece, Iran	Grasses, *Olea europaea*, *Ulmus glabra, Vitis vinifera*
T. japonicus Zhao, Xie, Gu & Xu, 2013	Japan	*Acer palmatum*, *Camellia japonica*
T. kilianae Decraemer & Marais, 1993	South Africa	*Eucalyptus nitens*
T. lusitanicus Siddiqi, 1974	Portugal	*Lycopersicon esculentum*, *Olea europaea*, *Quercus suber*
T. magnus Decraemer & Marais, 1993	South Africa	Natural grass vegetation

..... *continued on the next page*

Table 17 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
T. minzi De Waele & Cohn, 1992	Iran	Grasslands
T. nanjingensis Liu & Cheng, 1990	China	*Bambusa multiplex* var. *riviereorum, Malus domestica*, *Morus cathayana, Prunus* sp.
T. obscurus Allen, 1957=*T. primitivus apud* Thorne, 1939; Goodey, 1951	China, Virginia	Fruit tree, grass sod
T. obtusus Cobb, 1913=*T. proximus* Allen, 1957	USA	*Andropogon gerardii*, *Bouteloua curtipendula*, *Cynodon dactylon*, *Cynodon dactylon* × *C. transvaalensis*, *Eucalyptus* sp., *Lycopersicon esculetum*, *Magnolia virginiana*, *Paspalum vaginatum, Poa pratensis*, *Rhododendron* sp., *Sabal palmetto*, *Solanum tuberosum*, *Sorghum bicolor* × *S. arundinaceum*, *Stenotaphrum secundatum, Tilia cordata*, *Zoysia japonica*
T. onubensis Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Pinus pinea*, *Quercus suber*, *Vitis vinifera*
T. orientalis De Waele & Hashim, 1984	Iran, Jordan, Portugal	*Lycopersicon esculentum*, *Phaseolus vulgaris*, *Vitis* sp.
T. pakistanensis Siddiqi, 1962=*T. litchi* Edward & Misra, 1970	China, India, Pakistan	*Bambusa multiplex* var. *riviereorum, Boehmeria nivea*, *Camellia japonica, Cucurbita maxima, Glycine max, Ligustrum lucidum, Litchi chinensis*, *Metasequoia glyptostroboides, Morus* sp., *Prunus serrula*
T. paracedarus Xu & Decraemer, 1995	China	*Lycopersicon esculentum*, *Prunus* × *yedoensis, Solanum lycopersicum*
T. paragiennensis Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Vitis vinifera*
T. parasilvestris Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Pinus pinea, Quercus suber*
T. parorientalis Decraemer & Kilian, 1992	South Africa	Unidentified grass
T. paucisetosus Bernard, 1992	USA	*Equisetum* sp., *Picea glauca*, *Rosa acicularis*
T. persicus De Waele & Sturhan, 1987	Iran	*Malus domestica*, *Oplismenus* sp., *Pyrus communis*
T. petrusalberti De Waele, 1988	South Africa	*Oryza sativa*
T. philipi De Waele, Meyer & Van Mieghem, 1990	South Africa	Native plants
T. primitivus (de Man, 1880) Micoletzky, 1922=*Dorylaimus primitivus* de Man, 1880=*T. castellanensis* Arias, Jiminez & Lopez, 1965=*T. mirabilis* Ivanova, 1977	Belgium, Bulgaria, Canada, Chile, Czech Republic, Denmark, France, Germany, Iran, Ireland, Italy, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, UK, USA	*Apium graveolens, Beta vulgaris, Brassica oleracea, Citrus limon*, *Fragaria* × *ananassa, Ginkgo biloba*, grass, *Mentha* sp., *Myoporum laetum, Olea europaea*, *Phormium tenax, Pisum sativum, Plantago lanceolata*, *Poa trivialis*, *Prunus persica*, *Ribes nigrum, Rumex* sp., *Solanum tuberosum*, *Trifolium pratense, Ulmus* sp., *Vitis vinifera*
T. pseudobursatus Decraemer, Radivojević & de la Peña, 2008	Serbia	*Corylus avellana*, *Crataegus* sp., *Rosa* sp., *Rubus* sp.
T. reduncus Siddiqi & Sharma, 1995	Vietnam	*Arachis hypogaea*
T. rinae Vermeulen & Heyns, 1984	South Africa	*Rubus ludwigii*, *Thalictrum* sp.
T. sanniae Vermeulen & Heyns, 1984	South Africa	Virgin veld
T. similis Seinhorst, 1963	Belgium, Bulgaria, Czech republic, Denmark, France, Germany, Greece, Italy,	*Capsicum annuum*, *Carica papaya, Cynara cardunculus,* grass, *Juglans* sp., *Malus domestica,* pasture, *Picea* sp., *Prunus* sp.

..... *continued on the next page*

Table 17 (continued).

SPECIES	WORLD DISTRIBUTION	HOSTS
T. similis Seinhorst, 1963	Netherlands, Norway, Poland, Russia, Slovakia, Sweden, Turkey, UK	*Solanum tuberosum*, *Vitis vinifera*
T. silvestris Decraemer, Palomares-Rius, Cantalapiedra-Navarrete, Landa, Duarte, Almeida, Vovlas & Castillo, 2013	Spain	*Quercus canariensis*
T. sparsus Szczygiel, 1968	Belgium, Bulgaria, Czech Republic, Denmark, Germany, Greece, Hungary, Italy, Netherlands, Poland, Slovakia, Sweden, Switzerland, UK	*Alnus* sp., *Castanea* sp., *Fragaria* × *ananassa, Olea europaea*, *Pyrus communis*, *Solanum tuberosum, Vitis vinifera*
T. taylori De Waele, Mancini, Roca & Lamberti, 1982	Italy	*Olea europaea, Pinus strobus, Vitis* sp.
T. tricaulatus Shishida, 1979	Japan	*Cleyera japonica, Ilex crenata*, *Neolitsea sericea, Quercus acutissima*, *Q. serrata, Sambucus racemosa, Styrax japonicus*
T. vandenbergae De Waele & Kilian, 1992	South Africa	*Apodytes dimidiata*
T. variabilis Roca, 1998	Greece	*Cynara cardunculus*
T. variopapillatus Hooper, 1972	Belgium, Germany, Italy, Netherlands, Poland, Slovakia, UK	*Olea europaea*, pasture, *Populus* sp., *Quercus robur*, *Sambucus nigra, Vitis vinifera*
T. velatus Hooper, 1972	Belgium, Bulgaria, France, Germany, Poland, UK, USA	*Picea sitchensis*, *Phlox* sp., *Pisum sativum, Quercus* sp.
T. viruliferus Hooper, 1963	Belgium, Bulgaria, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Poland, Slovakia, Spain, Sweden, Switerzerland, UK, USA	*Beta vulgaris, Capsicum annuum*, *Citrus* × *limon, Citrus* × *sinensis, Corylus americana*, *Cynara cardunculus*, *Ficus carica*, *Fragaria* × *ananassa, Hordeum vulgare, Juglans regia*, *Malus domestica*, *Malus pumila, Olea europaea*, pasture, *Pisum sativum, Populus* sp., *Prunus persica*, *Pyrus communis*, *Quercus robur*, *Secale cereale*, *Solanum lycopersicum*, *Solanum tuberosum, Triticum aestivum, Vitis vinifera*, *Zea mays*
T. yokooi Eroshenko & Tep1yakov, 1975	Russia	*Abies nephrolepis, Picea jezoensis*
T. zanjanensis Asghari, Eskandari, Maafi & Decraemer, 2018	Iran	*Prunus scoparia*
*Trichodorus sp.** Carta & Skantar, 2014	Border Crossing (Canada to Blaine)	*Caliothrips* sp.

Species inquirendae: T. henanica Wang & Wu, 1991; *T. reduneus* Siddiqi & Sharma, 1995
* The name of the new species not provided in the original paper.

Key to *Trichodorus* species in New Zealand

Males:

1 One ventromedian cervical papilla located anterior to excretory pore; three precloacal supplements, with the posterior-most (SP1) located anterior to proximal end of spicules; spicule shaft widened posteriorly, spicule length 48–59 µm ..... *T. cottieri*

- Three ventromedian papillae located anterior to excretory pore; three precloacal supplements, one pair of small subventral papillae situated just posterior to the cloacal opening and a pair of subterminal caudal cuticular pores also present; spicule shaft very slender in distal half with constriction at mid-spicule, spicule length 24 µm .... *T. primitivus*

Females:

1 Body length 871–1049 µm; a=18.3–26.8; b=4.8–5.9; onchiostyle length 54–66 µm ..... *T. cottieri*
- Body length 652–706 µm; a=17.6–17.7; b=4.3–4.5; onchiostyle length 50–53 µm ..... *T. primitivus*

***Trichodorus cottieri* Clark, 1963**

Figs 44–47. Map 11.

Measurements. Table 18.

Morphology. Males (n=13, 8 males measured): Body cylindrical, tapering slightly anteriorly, J-shaped after heat relaxation. Cuticle slightly swollen, 0.6–4.5 µm thick at base of cardia, 0.5–5.6 µm at mid-body, 1.1–1.3 µm at tail terminus. Lip region rounded, 6–11 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 4.1–4.9 µm wide, 3.9–5.1 µm from anterior end. Onchiostyle well developed curved, 60–66 µm long. Nerve ring posterior to base of pharyngostom, 64–91 µm from anterior end. Excretory pore only observed in one specimen, 108 µm from anterior end. No cervical papillae observed. No overlap between base of pharynx and anterior end of intestine. One ventromedian cuticular pore just anterior to excretory pore, and a lateral hypodermal pore slightly posterior to level of the excretory pore. Testis single, sperm cells with large elongate nuclei. Spicules large, arcuate, 48 µm long. Gubernaculum straight, 18–25 µm long. Three precloacal supplements, with posterior-most supplement located anterior to proximal end of spicules. Tail short, rounded, length less than one body diameter at cloacal region, one pair of small postcloacal subventral papillae situated just posterior to the cloacal opening and a pair of subterminal caudal cuticular pores also present.

Table 18. Morphometrics of *Trichodorus cottieri* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	HOLOTYPE	PARATYPES	
	MALE	MALES	FEMALES
n	1	8	10
L	905	916 ± 70 (843–1046)	949 ± 53 (871–1049)
a	23.1	23.9 ± 5.5 (17.1–31.5)	21.5 ± 2.4 (18.3–26.8)
b	5.5	5.4 ± 0.7 (4.8–6.5)	5.4 ± 0.4 (4.8–5.9)
c	66.2	79.4 ± 14.5 (63.2–97.4)	–
V/T	56.0	56.7 ± 2.5 (53.5–59.3)	55.6 ± 3.3 (49.9–60.1)
Onchiostyle	50.86	62.8 ± 2.5 (60.1–65.6)	60.7 ± 3.9 (53.7–65.7)
Pharynx length	164	171 ± 22.3 (136–204)	177 ± 14.2 (154–195)
Pharyngeal bulb length	44.67	55.5 ± 8.6 (44.6–63.2)	52.5 ± 6.4 (44.3–65.6)
Pharyngeal bulb diam.	17.0	18.7 ± 4.6 (15.1–25.4)	21.0 ± 5.3 (16.2–31.7)
Excretory pore-anterior	?	109	102 ± 15.9 (88.7–126)
Nerve ring-anterior	79.2	73.9 ± 12.0 (64.4–90.9)	89.2 ± 7.1 (80.1–96.2)
Body diam. at cardia	34.7	33.6 ± 7.4 (25.0–42.1)	35.3 ± 4.9 (27.1–42.2)
Body diam. at mid-body	39.2	40.1 ± 9.0 (27.4–51.8)	42.1 ± 6.9 (28.8–50.0)
Anal body diam.	27.5	24.2 ± 4.7 (19.3–28.6)	–
Spicules length	50.8	51.3 ± 3.7 (47.6–59.0)	–
Gubernaculum	22.2	21.9 ± 2.9 (18.1–25.1)	–
Cloaca to SP1	?	20.5 ± 0.5 (20.1–21.1)	–
Cloaca to SP2	?	61.2 ± 3.2 (59.4–65.0)	–
Cloaca to SP3	?	93.3 ± 5.6 (88.7–99.6)	–
Anterior genital tract	–	–	182 ± 22.8 (156–205)
Posterior genital tract	–	–	168 ± 15.4 (151–187)
Tail length	13.7	12.0 ± 2.1 (10.2–14.2)	–

? : the data not available from the specimens.

Females: Body straight, cigar-like. General morphology similar to that of male, except for the reproductive system and the posterior body region straight not ventrally curved. Cuticle slightly swollen, 1.9–3.9 µm thick at lip

region, 1.0–5.5 µm at base of cardia, 2.1–6.6 µm at mid-body, 2.0–2.3 µm at tail terminus. Lip region rounded, 6–14 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 4.9–5.8 µm wide, 4.3–6.3 µm from anterior end. Onchiostyle well developed, curved, 54–66 µm long. Nerve ring posterior to base of pharyngostom, 80–96 µm from anterior end. Excretory pore 89–126 µm from anterior end. No ventromedian or hypodermal pores in pharyngeal region. No overlap between base of pharynx and anterior end of intestine. Reproductive system amphididelphic, with reflexed ovaries. Anterior genital tract 156–205 µm long, posterior reproductive system 151–187 µm long. Vulva a transverse slit situated 50–60% of total body length. Vagina perpendicular to body axis with a thick cuticular layer, 17–31 µm long, occupying 56–69% of corresponding body diameter. A single pair of lateral hypodermal pores present less than half the body diameter posterior to level of the vulva. Tail short, 6–10 µm long, rounded; anus subterminal.

Differential diagnosis. The male of *T. cottieri* is characterised by spicule shape (largely straight except for the slightly curved ends, with an enlarged distal third of the shaft and shaft largely striated), position of three precloacal supplements with the posterior supplement just posterior to mid-shaft of retracted spicules, terminal tail cuticle not widened, presence of a single ventromedian cervical papilla just anterior to excretory pore and the position of lateral cervical pore (slightly posterior to excretory pore). The female is characterised by the shape of vagina (almost cylindrical), shape of the vaginal sclerotizations in lateral view (large, more or less rectangular, parallel to longitudinal body axis), the transverse slit-like vulval opening and one pair of post-advulval lateral body pores. The pharyngeal bulb is offset in males and females.

Material examined. Holotype and 37 paratype specimens. **Holotype** female. New Zealand: NNCNZ, slide No. 27. **Paratypes**: 18 females, 13 males and six juveniles, NNCNZ, slide nos 542–562.

Distribution (Map 11). From material examined: New Zealand: Westland, WD.

From literature: New Zealand: **North Island**: Mt Ruapehu, TO; Kaingaroa Forest, BP; Waiiti, TK; **South Island:** Nelson, NN; Ngatimoti, NN; Brooklyn, NN; Rai Saddle, NN; Tennyson Inlet, SD; Hokitika, WD; Westland, WD (Sturhan *et al.* 1997). For world distributions see Table 17.

Habitat and hosts. From material examined: New Zealand: regenerating scrub (*Carpodetus serratus*).

From literature: New Zealand: *Carpodetus serratus, Nothofagus menziesii, N. solandri, Myrsine* sp., *Olearia* sp., grasses, and other vegetation in native bush or forests (Sturhan *et al.* 1997).

Plant viruses association. Unknown.

Remarks. *Trichodorus cottieri* was originally reported from *Carpodetus serratus* in regenerating shrubland, Westland, New Zealand by Clark (1963b). This species was the first Trichodorid described in New Zealand. Subsequently, Sturhan *et al.* (1997) reported it under the rhizosphere of *C. serratus, Nothofagus menziesii, N. solandri, Myrsine* sp., *Olearia* sp., grasses and other vegetation in native bush or forests. The localities include South Island: Hokitika, Westland, and at Brooklyn, Ngatimoti, Waiiti, Rai Saddle, Tennyson Inlet, Nelson and North Island: Kaingaroa Forest and near Whakapapa, Mt Ruapehu.

Trichodorus primitivus (de Man, 1880) Micoletzky, 1922

Figs 48–51. Map 12.

Syn: *Dorylaimus primitivus* de Man, 1880
Trichodorus castellanensis Arias, Jimenez & Lopez, 1965
Trichodorus mirabilis Ivanova, 1977

Measurements. Table 19.

Morphology. Male (n=1): Body rather stout, cigar-shaped, curved ventrally after heat relaxation; tapers anteriorly to the slightly offset cephalic region. Cuticle slightly swollen, 1.4 µm thick at base of cardia, 3.3 µm at mid-body length, 8.6 µm at tail terminus. Lip region rounded, 8.5 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 2.2 µm wide, 4.4 µm from anterior end. Onchiostyle well developed, curved; onchium fine, 24 µm long; onchiophore not sclerotized, 28 µm long. Nerve ring posterior to base of pharyngostom, 83 µm from anterior end. Excretory pore posterior to nerve ring, 93 µm from anterior end. Three ventromedian papillae located anterior to excretory pore; one about opposite middle of onchiostyle; one towards base of onchiostyle and one just anterior to, or opposite nerve ring. A pair of lateral cervical pores also present at basal of third of the onchiostyle. Pharyngeal bulb offset. Testis single, sperm cells with large elongate nuclei. Three precloacal supplements present at tail end; the first opposite proximal end of spicules, the second about one and three quarter body diameters

anterior to the first and the third, which is slightly less conspicuous, about two body diameters anterior to the second. Spicules large, paired, arcuate, 24 µm long, without transverse striations, about 4 µm wide at proximal end and gradually narrowing to a shaft about 1 µm wide in the middle and continuing very narrow, and curved ventrally, to distal end. Gubernaculum straight, 8 µm long. Tail short, rounded, its length less than one body diameter at cloacal region. Three precloacal supplements, one pair of small subventral papillae situated just posterior to the cloacal opening, and a pair of subterminal caudal cuticular pores also present.

Table 19. Morphometrics of *Trichodorus primitivus* from New Zealand. All measurements are in µm and in the form: mean ± s.d. (range).

CHARACTERS	MALE	FEMALES
n	1	2
L	720	706, 652
a	21.6	17.6, 17.7
b	4.5	4.3, 4.5
c	40.9	–
V/T	62.2	56.8, 59.0
Onchiostyle	52.5	52.5, 50.5
Pharynx length	158	163, 145
Pharyngeal bulb length	40.2	51.0, 44.6
Pharyngeal bulb diam.	17.9	22.1, 22.8
Excretory pore-anterior	93	92, 101
Nerve ring-anterior	83.3	82.6, 86.9
Body diam. at cardia	29.0	33.8, 32.4
Body diam. at mid-body	33.4	40.1, 36.4
Anal body diam.	23.8	–
Spicules length	24.5	–
Gubernaculum	8.2	–
Cloaca to SP1	25.9	–
Cloaca to SP2	57.6	–
Cloaca to SP3	97.3	–
Anterior genital tract	–	153, 158
Posterior genital tract	–	159, 140
Tail length	17.6	–

Females (n=2): Body straight, cigar-like. General morphology similar to that of male, except for the reproductive system and posterior body region not ventrally curved. Cuticle slightly swollen, 1.8–2.1 µm thick at lip region, 1.9–2.5 µm at base of cardia, 1.9–2.1 µm at mid-body, 2.5–5.8 µm at tail terminus. Lip region rounded, 8–9 µm wide. Amphidial fovea cup-shaped, its opening a wide slit, 2.6–3.0 µm wide, 6.4–6.5 µm from anterior end. Onchiostyle well developed, curved, onchium fine, 22–23 µm long, onchiophore not sclerotized, 28–30 µm long. Nerve ring posterior to base of pharyngostom, 83–87 µm from anterior end. Excretory pore posterior to nerve ring, 92–101 µm from anterior end. One ventromedian or hypodermal pore was observed in the pharyngeal region. No overlap between base of pharynx and anterior end of intestine. Reproductive system amphididelphic, with reflexed ovaries. Anterior genital tract 153–158 µm long, posterior tract 140–159 µm long. Vulva a transverse slit at 57–59% of total body length. Vagina perpendicular to body axis with a thick cuticular layer, no measurements available because both specimens in ventral view. Vaginal scleotizaions large. A single pair of lateral hypodermal pores present less than half body diameter posterior to level of vulva. Tail short, rounded; anus subterminal.

Differential diagnosis. *Trichodorus primitivus* is characterised by males having three ventromedian cervical papillae anterior to the excretory pore, one ventromedian cervical papillae in the onchiostyle region, excretory pore in the anterior two-thirds of the pharyngeal bulb; spicule proximally wide, tapering distally to a slender shaft; and three precloacal supplements present at the tail end. There is no overlap between the base of the pharynx and the anterior end of intestine in male and females. The female has one pair of post-advulval lateral body pores, a

transverse slit-like vulval opening, and large vaginal sclerotizations, which are more or less rectangular, and parallel to the longitudinal body axis in lateral view.

Material examined. Two females, one male and eight juvenile specimens from Nematode Collection of MPI, Slide No. 3-2316.

Distribution (Map 12). From material examined: New Zealand: **North Island:** Hastings, Hawkes Bay, HB.

From literature: New Zealand: **North Island**: Napier, HB; Gisborne, GB; **South Island**: Nelson area, NN (Sturhan *et al.* 1997). For world distributions see Table 17.

Habitat and hosts. From material examined: New Zealand: peach tree (*Prunus persica*).

From literature: New Zealand: grass, cabbage (*Brassica oleracea*), *Myoporum laetum,* maidenhair tree (*Ginkgo biloba*), celery (*Apium graveolens*), New Zealand flax (*Phormium tenax*) (Sturhan *et al.* 1997).

Plant viruses association. *Trichodorus primitivus* causes direct damage to plant roots by its feeding (Whitehead & Hooper 1970) and can transmit TRV and PEBV (Brown & Trudgill 1998; De Pelsmaeker *et al.* 1985; Gibbs & Harrison 1964; Harrison 1961, 1966; Hoek *et al.* 2006; Hooper & Siddiqi 1972; Mowat & Taylor 1962; Ploeg *et al.* 1992b).

Remarks. The presence of *T. primitivus* in New Zealand was first recorded by Decraemer (1995) but with no details. Subsequently, Sturhan *et al.* (1997) reported it under grass in Napier and cabbage at Gisborne in the North Island, and around the roots of *Myoporum laetum*, maidenhair tree (*Ginkgo biloba* in arboretum), celery (*Apium graveolens*), and New Zealand flax (*Phormium tenax*) in the Nelson area in the South Island. Knight *et al*. (1997) reported it from celery, maidenhair tree, New Zealand flax and grass.

The vulva shape of *T. primitivus* was described as pore-like in the description of *T. mirabilis* Ivanova, 1977 (now *T. primitivus*). From several speciemens in ventral view, Decraemer (1995) described the vulva as a minute transverse slit. In this study, an obvious transverse slit, with some attachment on the surface of the vulva, was observed.

ACKNOWLEDGEMENTS

We thank the following colleagues/organisations for the loan of specimens for study: Mr Graeme Page, AsureQuality New Zealand; MPI, Auckland, New Zealand for supplying permanent specimens; Dr Nigel L. Bell and Mrs Lee T. Aalders (AgResearch, Hamilton, New Zealand). We thank Dr Qing-Hai Fan and Dr Dongmei Li (Ministry for Primary Industries, Auckland, New Zealand) for helping in nematode sampling; and Dr Jian-Feng Liu (Landcare Research, Auckland, New Zealand) for checking the format of the references. We would like to thank Dr Zhi-Qiang Zhang (Landcare Research, Auckland, New Zealand) for his advice and valuable comments. We are extremely grateful to Dr Kerrie A. Davies (the University of Adelaide, Adelaide, Australia) and Dr Wei-min Ye (North Carolina Department of Agriculture and Consumer Services, Raleigh, USA) for reviewing the paper, the valuable and supportive comments that greatly improved the accuracy of this contribution.

This project was supported by core funding for the Crown Research Institutes from the Ministry of Business, Innovation and Employment's Science and Innovation Group. We thank the College of Agriculture, Shanxi Agricultural University for providing facilities during the early stages of this study, and Shanxi Scholarship Council of China for funding Yu-Mei Xu's visit to New Zealand.

REFERENCES

Aboul-Eid, H. Z. 1970: Systematic notes on *Longidorus* and *Paralongidorus* 1. *Nematologica 16*: 159–179.

Allen, M. W. 1957: A review of the nematode genus *Trichodorus* with descriptions of ten new species. *Nematologica 2*: 32–62.

Allen, W. R. 1986: Effectiveness of Ontario populations of *Longidorus diadecturus* and *L. breviannulatus* as vectors of peach rosette mosaic and tomato blackring viruses. *Canadian Journal of Plant Pathology 8*: 49–53.

Allen, W. R.; Ebsary, B. A. 1988: Transmission of raspberry ringspot, tomato black ring, and peach rosette mosaic viruses by an Ontario population of *Longidorus elongatus*. *Canadian Journal of Plant Pathology 10*: 1–5.

Altherr, E. 1953: Nématodes du sol du Jura vaudois et français (I). *Bulletin de la Société vaudoise des Sciences naturelles 65*: 429–460.

Andrássy, I. 1976: Evolution as a basis for the systematization of nematodes. *Pitman Publishing Ltd., London (U.K.), San Francisco, and Melbourne,* 288 pp.

Archidona-Yuste, A.; Navas-Cortés, J. A.; Cantalapiedra-Navarrete, C.; Palomares-Rius, J. E.; Castillo, P. 2016a: Unravelling the biodiversity and molecular phylogeny of needle nematodes of the genus *Longidorus* (Nematoda: Longidoridae) in olive and a description of six new species. *PLoS One 11*: DOI: 10.1371/journal.pone.0147689.

Archidona-Yuste, A.; Navas-Cortés, J. A.; Cantalapiedra-Navarrete, C.; Palomares-Rius, J. E.; Castillo, P. 2016b: Cryptic diversity and species delimitation in the *Xiphinema americanum*–group complex (Nematoda: Longidoridae) as inferred from morphometrics and molecular markers. *Zoological Journal of the Linnean Society* 176: 231–265.

Arias Delgado, M.; Jiménez Millan, F.; López Pedregal, J. M. 1965: Tres nuevas especies de nematodos posibles fitoparásitos en suelos españoles. *Publicaciones del instituto de Biologia Aplicada 38*: 47–58.

Asghari, R.; Eskandari, A.; Maafi, Z. T.; Decraemer, W. 2018: Characterisation of a new species of *Trichodorus* Cobb, 1913 (Triplonchida: Trichodoridae) from Iran based on morphological and molecular data. *Systematic Parasitology 95*: 257–269.

Ayala, A.; Allen, M. 1968: Transmission of the California tobacco rattle virus (CTRV) by three species of the nematode genus *Trichodorus*. *Journal of Agriculture of the University of Puerto Rico 52*: 101–125.

Baek, H. S.; Choi, Y. E. 1995: Taxonomic studies of Trichodoridae (Nematoda: Trichodoroidea) from Korea, with descriptions of a new species. *Korean Journal Applied Entomology 34:* 206–217.

Bajaj, H. K.; Jairajpuri, M. S. 1976: Two new species of *Xiphinema* from India. *Nematologia Mediterranea 4*: 195–200.

Barriga, R. 1965: Parasitism of camellias by some nematode species. Abstract. *Nematologica 11*: 34.

Barsalote, E. M.; Pham, H. T.; Lazarova, S.; Peneva, V.; Zheng, J. 2018: Description of *Longidorus cheni* sp. n. (Nematoda, Longidoridae) from China. *ZooKeys 744*: 1–18.

Barsi, L.; Fanelli, E.; De Luca, F. 2017: A new record of *Xiphinema dentatum* Sturhan, 1978 and description of *X. paradentatum* sp. n. (Nematoda: Dorylaimida) from Serbia. *Nematology 19*: 925–949.

Bell, N. L. 1999: The biology of the plant parasitic nematodes *Paratylenchus nanus* and *Paratrichodorus minor* in soil under pasture: a thesis presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Massey University. Doctoral dissertation, Massey University.

Bell, N.; Watson, R. 2001: Identification and host range assessment of *Paratylenchus nanus* (Tylenchida: Tylenchulidae) and *Paratrichodorus minor* (Triplonchida: Trichodoridae). *Nematology 3*: 483–490.

Brown, D. J. F. 1985: The transmission of two strains of strawberry latent ringspot virus by populations of *Xiphinema diversicaudatum* (Nematoda: Dorylaimoidea). *Nematologia Mediterranea 13*: 217–223.

Brown, D. J. F. 1986: The transmission of two strains of arabis mosaic virus from England by populations of *Xiphinema diversicaudatum* (Nematoda: Dorylaimoidea) from ten countries. *Revue de Nématologie 9*: 83–87.

Brown, D. J. F.; Trudgill, D. L. 1983: Differential transmissibility of arabis mosaic and strains of strawberry latent ringspot viruses by three populations of *Xiphinema diversicaudatum* (Nematoda: Dorylaimida) from Scotland, Italy and France. *Revue de Nématologie 6*: 229–238.

Brown, D. J. F.; Topham P. J. 1985: Morphometric variability between populations of *Xiphinema diversicaudatum* (Nematoda Dorylaimoidea). *Revue de Nematologie 8*: 15–26.

Brown, D. J. F.; Halbrendt, J. M. 1992: The virus vector potential of *Xiphinema americanum* and related species. *Journal of Nematology 24*: 584.

Brown, D. J. F.; Trudgill, D. L. 1998: Nematode transmission of plant viruses–a 30 year perspective. *Host Pathogen Interactions & Crop Protection, SCRI Annual Report*: 121–125.

Brown, D. J. F.; Ploeg, A. T.; Robinson, D. J. 1989: The association between serotypes of tobraviruses and *Trichodorus* and *Paratrichodorus* species. *European and Mediterranean Plant Protection Organization Bulletin 19*: 611–617.

Brown, D. J. F.; Halbrendt, J. M.; Robbins, R. T.; Vrain, T. C. 1993: Transmission of nepoviruses by *Xiphinema americanum*-group nematodes. *Journal of Nematology 25*: 349.

Brown, D. J. F.; Halbrendt, J. M.; Jones, A. T.; Vrain, T. C.; Robbins, R. T. 1994a: Transmission of three North American nepoviruses by populations of four distinct species of the *Xiphinema americanum* group. *Phytopathology 84*: 646–649.

Brown, D. J. F.; Grunder, J.; Hooper, D. J.; Klingler, J.; Kunz, P. 1994b: *Longidorus arthensis* sp. n. (Nematoda: Longidoridae) a vector of cherry rosette disease caused by a new nepovirus in cherry trees in Switzerland. *Nematologica 40*: 133–149.

Brown, D. J. F.; Robertson, W. M.; Trudgill, D. L. 1995: Transmission of viruses by plant nematodes. *Annual Review of Phytopathology 33*: 223–249.

Brown, D. J. F.; Robertson, W. M.; Neilson, R.; Bem, F.; Robinson, D. J. 1996: Characterization and vector relation of a serologically distinct isolate of tobacco rattle tobravirus (TRV) transmitted by *Trichodorus similis* in Northern Greece. *European Journal of Plant Pathology 102*: 61–68.

Brown, D.; Macfarlane, S.; Furlanetto, C.; Oliveira, C.; Ferraz, L. 2004: Transmissão de vírus por nematóides parasitos de plantas. *Revisão Anual de Patologia de Plantas 12*: 201–242.

Boutsika, K.; Blok, V. C.; Phillips, M. S.; Lewis, S. A.; Robbins, R. T.; Ferraz, L.C.C.B.; Brown, D.J.F. 2004: Confirmation of the synonymy of *Paratrichodorus christiei* (Allen, 1957) Siddiqi, 1974 with *P. minor* (Colbran, 1956) Siddiqi, 1974 (Nematoda: Triplonchida) based on sequence data obtained for the ribosomal DNA 18s gene. *Nematology 6:* 145–151.

Cadman, C. H. 1963: Biology of soil-borne viruses. *Annual Review of Phytopathology 1*: 142–143.

Cai, R.; Maria, M.; Barsalote, E. M.; Subbotin, S. A.; Zheng, J. 2018: Description of *Xiphinema hangzhouense* sp. n. (Nematoda: Longidoridae) from the rhizosphere of *Magnolia grandiflora* in Hangzhou, Zhejiang Province, China. *Nematology 20:* 67–80.

Carta, L. K.; Skantar, A. M. 2014: A *Trichodorus* (Triplonchida: Trichodoridae) nematode from thrips (Thysanoptera: Panchaetothripinae). *Journal of Nematology 46*: 302–308.

Caveness, F. E.; Gilmer, R. M.; Williams, R. J. 1975: Short report transmission of cowpea mosaic by *Xiphinema basiri* in Western Nigeria. Pp. 289–290 In *Nematode Vectors of Plant Viruses*, Springer, Boston, MA.

Chen, Q.; Hooper, D.; Loof, P.; Xu, J. 1997: A revised polytomous key for the identification of species of the genus *Longidorus* Micoletzky, 1922 (Nematoda: Dorylaimoidea). *Fundamental and Applied Nematology 20*: 15–28.

Chevres-Roman, R.; Gross, H. D.; Sasser, J. N. 1971: The influence of selected nematode species and number of consecutive plantings of corn and sorghum on forage production, chemical composition of plant and soil, and water use efficiency. *Nematropica 1*: 4041–4046.

Clark, W. C. 1963a: A new species of *Longidorus* (Micol.) (Dorylaimida, Nematoda). *New Zealand Journal of Science 6:* 607–611.

Clark, W. C. 1963b: A new species of *Trichodorus* (Nematoda: Enoplida) from West-land, New Zealand. *New Zealand Journal of Science 6*: 414–417.

Clark, W. C. 1963c: A review of plant-parasitic nematodes in New Zealand. *Proceedings of the New Zealand Weed Control Conference 16*: 91–95.

Cobb, N. A. 1913: New nematode genera found inhabiting fresh water and non–brackish soils. *Journal of the Washington Academy of Sciences 3*: 432–444.

Cobb, N. A. 1920: One hundred new nemas. *Contributions to the Science of Nematology 9*: 217−343.

Cohn, E.; Sher, S. A. 1972: A contribution to the taxonomy of the genus *Xiphinema* Cobb, 1913. *Journal of Nematology 4:* 36–65.

Cohn, E.; Tanne, E.; Nitzany, F. E. 1970: *Xiphinema italiae*, a new vector of grapevine fanleaf virus. *Phytopathology 60*: 181–182.

Colbran, R. C. 1956: Studies of plant and soil nematodes. 1. Two new species from Queensland. *Queensland Journal of Agricultural Science 13*: 123–126.

Colbran, R. C. 1965: Studies of plant and soil nematodes. 9. *Trichodorus lobatus* n. sp. (Nematoda: Trichodoridae), a stubby-root nematode associated with citrus and peach trees. *Queensland Journal of Agricultural Science 22*: 273–276.

Cooke, D. A. 1973: The effect of plant parasitic nematodes, rainfall and other factors on docking disorder of sugar beet. *Plant Pathology 22*: 161–170.

Coomans, A. 1985: A phylogenetic approach to the classification of the Longidoridae (Nematoda: Dorylamida). *Agriculture, Ecosystems and Environment 12*: 335–354.

Coomans, A. 1996: Phylogeny of the Longidoridae. *Russian Journal of Nematology 4*: 51–59.

Coomans, A. 2001: *Character analysis, phylogeny and biogeography of the genus* Xiphinema *Cobb, 1913 (Nematoda: Longidoridae)*. Koninklijk Museum voor Midden-Afrika.

Coomans, A.; Chaves, E. 1995: *Paraxiphidorus michelluci* n. g., n. sp. from Argentina (Nematoda: Longidoridae). *Fundamental and Applied Nematology 18*: 303–306.

Coomans, A.; Huys, R.; Heyns, J.; Luc, M. 2001: Character analysis, phylogeny, and biogeography of the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae). *Annales du Musée Royal de l'Afrique Centrale (Zoologie), Tervuren, Belgique 287*: 1–239.

Coomans, A.; Olmos, I.; Casella, E.; Chaves, E. 2004: *Australodorus enigmaticus* n. g., n. sp. (Nematoda: Longidoridae) from Uruguay. *Nematology 6*: 183–191.

Cooper, J. I.; Thomas, P. R. 1970: *Trichodorus nanus*, a vector of tobacco rattle virus in Scotland. *Plant Pathology 19*: 197.

Crosby, T.; Dugdale, J.; Watt, J. 1998: Area codes for recording specimen localities in the New Zealand subregion. *New Zealand Journal of Zoology 25*: 175–183.

Dale, P. S. 1971: New records of nematode vectors of plant viruses. *New Zealand Entomologist 5*: 94–95.

Dale, P. S. 1972: List of plant hosts of nematodes in New Zealand. *New Zealand Journal of Science 15*: 442–448.

Dalmasso, A. 1969: Anatomical studies and taxonomy of the genera *Xiphinema*, *Longidorus* and *Paralongidorus* (Nematoda: Dorylaimidae). *Memoires du Museum Nationale d'Histoire Naturelle, Série A, Zool. 61*: 33–82.

Daneel, M.; DeJager, K.; Van den Bergh, I.; De Smet, M.; De Waele, D. 2015: Occurrence and pathogenicity of plant-parasitic nematodes on commonly grown banana cultivars in South Africa. *Nematropica 45:* 18–127.

Darriba, D.; Taboada, G. L.; Doallo, R.; Posada, D. 2012: jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods 9*: 772.

Davies, K. A.; Giblin-Davis, R. M. 2004: The biology and association of *Fergusobia* (Nematoda) from the *Melaleuca leucadendra*-complex in eastern Australia. *Invertebrate Systematics 18*: 291–319.

de Almeida, M. T. M.; de Almeida Santos, M. S. N.; de Oliveira Abrantes, I. M.; Decraemer, W. 2005: *Paratrichodorus divergens* sp. n., a new potential virus vector of tobacco rattle virus and additional observations on *P. hispanus* Roca & Arias, 1986 from Portugal (Nematoda: Trichodoridae). *Nematology 7*: 343–361.

De Waele, D.; Michal, W. 1995: *Trichodorus altaicus* sp. n. (Nematoda: Trichodoridae) and a key to the species of the genus *Trichodorus*. *Fundamental and Applied Nematology 18*: 181–187.

Decraemer, W. 1980: Systematics of the Trichodoridae (Nematoda) with keys to their species. *Revue de Nématologie 3*: 81–99.

Decraemer, W. 1995: *The family Trichodoridae: Stubby root and virus vector nematodes*. Dordrecht, Boston & London, Kluwer Academic Publishers, 360 pp.

Decraemer, W.; De Waele, D. 1981: Taxonomic value of the position of oesophageal gland nuclei and of oesophageal gland overlap in the Trichodoridae (Diphtherophorina). *Nematologica* 27: 82–94.

Decraemer, W.; Baujard, P. 1998a: Taxonomic status of *Paratrichodorus faisalabadensis* Nasira & Maqbool, 1994 and *P. psidii* Nasira & Maqbool, 1994 (Nematoda: Triplonchida). *Fundamental and Applied Nematology 1*: 33–36.

Decraemer, W.; Baujard, P. 1998b: Additions and corrections to: Decraemer: The family Trichodoridae. *Fundamental and Applied Nematology 2:* 207–212.

Decraemer, W.; Marais, M. 2000: A new *Trichodorus* species from South Africa with notes on *T. vandenbergae* (Triplonchida: Diphtherophorina). *Annales Zoologici 50*: 193–203.

Decraemer, W.; Eisendle-Flöckner, U.; Abebe, E. 2019a: Phylum Nematoda. Pp 269-299 *in* Rogers, D. C.; Thorp, J. H. (Eds) *Thorp and Covich's Freshwater Invertebrates* (*Fourth Edition*). Academic Press, 920 pp.

Decraemer, W.; Cantalapiedra-Navarrete, C.; Archidona-Yuste, A.; Varela-Benavides, I.; Gutiérrez-Gutiérrez, C.; Castillo, P.; Palomares-Rius, J. E. 2019b: Integrative taxonomy unravels cryptic diversity in the *Paratrichodorus hispanus*-group complex and resolves two new species of the genus and the molecular phylogeny of the family (Nematoda: Trichodoridae). *Zoological Journal of the Linnean Society 185*: 656–692.

Decraemer, W.; Chaves, E. 2012: Longidoridea and Trichodoridae. Pp. 579–617 *in* Manzanilla-López R. H.; Marbán-Mendoza, N. (Eds), *Practical Plant Nematology*. México: Fundacion Colegio de Postgraduados and Mundi Prensa.

Decraemer, W.; Geraert, E. 2006; Ectoparasitic Nematodes. Pp. 174–180 *in* Perry, R. N., Moens, M. (Eds). *Plant Nematology*. Wallingford, UK: CAB International.

Decraemer, W.; Geraert, E. 2013: Ectoparasitic nematodes. Pp. 179–214 *in* Perry, R. N., Moens, M. (Eds), *Plant Nematology 2nd Edition*. Wallingford, UK: CAB International.

Decraemer, W.; Palomares-Rius, J. E.; Cantalapiedra-Navarrete, C.; Landa, B. B.; Duarte, I., Almeida, T., Vovlas, N.; Castillo, P. 2013: Seven new species of *Trichodorus* (Diphtherophorina, Trichodoridae) from Spain, an apparent centre of speciation. *Nematology 15*: 57–100.

Decraemer, W.; Robbins, R. 2007: The who, what and where of Longidoridae and Trichodoridae. *Journal of Nematology 39*: 295–297.

Decraemer, W.; Radivojević, M.; de la Peña, E. 2008: Trichodoridae (Nematoda: Triplonchida) from the Tara National Park, Serbia, and proposal of *Trichodorus pseudobursatus* n. sp. *Nematology 10*: 405–431.

De Ley, P.; Blaxter, M. L. 2004: A new system for Nematoda: combining morphological characters with molecular trees, and translating clades into ranks and taxa. Pp. 633–653 *in* Cook, R. & Hunt, D.J. (Eds) Proceedings of the fourth international congress of Nematology, 8–13 June 2002, Tenerife, Spain. *Nematology monographs and perspectives 2*. Leiden, the Netherlands: Brill.

De Man, J. G. 1876: Onderzoekingen over vrij in de aarde levende Nematoden. *Tijdschrift der Nederlandsche dierkundige Vereeniging 2*: 78–196.

De Man, J. G. 1880: Die Einheimischen, frei in der reinen Erde und im siissen Wasser lebende Nematoden. Vorlaufiger Bericht und descriptiv-systematischer Theil. *Tijdschrift der Nederlandsche dierkundige Vereeniging 5*: 1–104.

De Pelsmaeker, M.; Calus, A.; Coomans, A. 1985: Vertical distribution of *Trichodorus* and TVR. *Mededelingen van de Faculteit Landbouwwetenschappen, Rijksuniversiteit Gent 50/3a*: 769–775.

Doucet, M. E.; Ferraz, L. C. C. B.; Magunacelaya, J. C.; Brown, D. J. F. 1998: The occurrence and distribution of Longidoridae (Nematoda) in Latin America. *Russian Journal of Nematology 6*: 111–128.

Duarte, I. M.; De Almeida, M. T. M.; Brown, D. J. F.; Marques, I.; Neilson, R.; Decraemer, W. 2010: Phylogenetic relationships, based on SSU rDNA sequences, among the didelphic genera of the family Trichodoridae from Portugal. *Nematology 12*: 171–180.

Duarte, I. M.; Almeida, M. T. M.; Duarte, M. M.; Brown, D. J. F.; Neilson, R. 2011: Molecular diagnosis of trichodorid species from Portugal. *Plant Pathology 60*: 586–594.

Ebsary, B. A.; Vrain, T. C.; Graham, M. B. 1989: Two new species of *Xiphinema* (Nematoda: Longidoridae) from British Columbia vineyards. *Canadian Journal of Zoology 67*: 801–804.

Esmaeili, M.; Heydari, R.; Archidona-Yuste, A.; Castillo, P.; Palomares-rius, J. E. 2017: A new needle nematode, *Longidorus persicus* n. sp. (Nematoda: Longidoridae), from Kermanshah province, western Iran. *European Journal of Plant Pathology 147*: 27–41.

European and Mediterranean Plant Protection Organization. 2017: PM 7/95 (2): *Xiphinema americanum* sensu lato. *Bulletin OEPP/EPPO Bulletin* 47: 198–210.

Eveleigh, E. S.; Allen, W. R. 1982: Description of *Longidorus diadecturus* n. sp. (Nematoda: Longidoridae), a vector of the peach rosette mosaic virus in peach orchards in southwestern Ontario, Canada. *Canadian Journal of Zoology 60*: 112–115.

Forer, L. B.; Stouffer, R. F. 1981: *Xiphinema rivesi* associated with tomato ringspot virus-incited diseases in Pennsylvania. *Phytopathology 71*: 767–767.

Forer, L. B.; Powell, C. A.; Stouffer, R. F. 1984: Transmission of tomato ringspot virus to apple rootstock cuttings and to cherry and peach seedlings by *Xiphinema rivesi*. *Plant Disease 68*: 1052–1054.

Fouladvand, Z. M.; Pourjam, E.; Castillo, P.; Pedram, M. 2019: Genetic diversity, and description of a new dagger nematode, *Xiphinema afratakhtehnsis* sp. nov., (Dorylaimida: Longidoridae) in natural forests of southeastern Gorgan, northern Iran. *PloS One 14*: e0214147.

Fritzsche, R. 1968: Beitrag zum Wanderverhalten von *Xiphinema diversicaudatum* (Mikoletzky) Thorne, *X. coxi* Tarjan and *Longidorus macrosoma* Hooper sowie der Ausbreitung des Rhabarbermosaik-Virus im Feldbestand. *Biologisches Zentralblutt 87*: 481–488.

Fritzsche, R.; Kegler, H. 1968: Nematoden als vektoren von viruskrankheiten der obstgewachse. *Deut Akad Landwirtschaftswiss Tagungsber 97*: 289–295.

Fritzsche, R.; Schmelzer, K. 1967: Transmissibility of the carnation ringspot virus by nematodes. *Die Naturwissenschaften 54*: 498–499.

Fritzsche, R.; Tfiiele, S. 1979: Eignung von *Xiphinema*-Herkunften aus der USSR und der DDR zur Übertragung des Arabis-Mosaic-Virus. *Nachrichtenbl. Pflanzenschuts DDR 33*: 103–104.

Fritzsche, R.; Kegler, H.; Thiele, S.; Gruber, G. 1979: Beitrag zur Epidemiologie und Übertragung des Nelkenringflecken–Virus in Obstbeständen. *Archives of Phytopathology & Plant Protection 15*: 177–180.

Gharibzadeh, F.; Pourjam, E.; Pedram, M. 2018: Description of *Longidorus azarbaijanensis* n. sp. (Dorylaimida: Longidoridae) from Iran. *Journal of Nematology 50*: 1–12.

Gibbs, A. J.; Harrison, B. D. 1964: A form of pea early–browning virus found in Britain. *Annals of applied Biology 54*: 1–11.

Goodey, T. 1936: A new Dorylaimid nematode *Xiphinema radicicola* n. sp. *Journal of Helminthology 14*: 69–72.

Gozel, U.; Lamberti, F.; Duncan, L.; Agostinelli, A.; Rosso, L.; Nguyen, K.; Adams, B. J. 2006: Molecular and morphological consilience in the characterisation and delimitation of five nematode species from Florida belonging to the *Xiphinema americanum*-group. *Nematology 8:* 521–532.

Graham, M. B.; Ebsary, B. A.; Vrain, T. C.; Webster, J. M. 1988: Distribution of *Xiphinema bricolensis* and *X. pacificum* in vineyards of the Okanagan and Similkameen valleys, British Columbia. *Canadian Journal of Plant Pathology 10*: 259–262.

Grandison, G. S. 1991: Nematode virus vectors of New Zealand. *Nematologica 39:* 354.

Guindon, S.; Gascuel, O. 2003: A simple, fast and accurate method to estimate large phylogenies by maximum-likelihood. *Systematic Biology 52*: 696–704.

Gutiérrez-Gutiérrez, C.; Palomares-Rius, J. E.; Cantalapiedra-Navarrete, C.; Landa, B. B.; Esmenjaud, D.; Castillo, P. 2010: Molecular analysis and comparative morphology to resolve a complex of cryptic *Xiphinema* species. *Zoologica Scripta 39:* 483–498.

Gutiérrez-Gutiérrez, C.; Cantalapiedra-Navarrete, C.; Decraemer, W.; Vovlas, N.; Prior, T.; Rius, J. E. P.; Castillo, P. 2012: Phylogeny, diversity, and species delimitation in some species of the *Xiphinema americanum*-group complex (Nematoda: Longidoridae), as inferred from nuclear and mitochondrial DNA sequences and morphology. *European Journal of Plant Pathology 134*: 561–597.

Gutiérrez-Gutiérrez, C.; Cantalapiedra-Navarrete, C.; Montes-Borrego, M.; Palomares-Riu, J. E.; Castillo, P. 2013a: Molecular phylogeny of the nematode genus *Longidorus* (Nematoda: Longidoridae) with description of three new species. *Zoological Journal of the Linnean Society 167*: 473–500.

Gutiérrez-Gutiérrez, C.; Cantalapiedra-Navarrete, C.; Remesal, E.; Palomares-Rius, J. E.; Navas-Cortés, J. A.; Castillo, P. 2013b: New insight into the identification and molecular phylogeny of dagger nematodes of the genus Xiphinema (Nematoda: Longidoridae) with description of two new species. *Zoological Journal of the Linnean Society 169:* 548 -579.

Hajihassani, A.; Hamidi, N.; Dutta, B.; Tyson, C. 2018a: First report of stubby-root nematode, *Paratrichodorus minor*, on onion in Georgia, USA. *Journal of Nematology 50*: 453–455.

Hajihassani, A.; Lawrence, K. S.; Jagdale, G. B. 2018b: Plant parasitic nematodes in Georgia and Alabama. Pp. 357–391 *in* Subbotin, S. A.; Chitambar, J. J. (Eds.). *Plant Parasitic Nematodes in Sustainable Agriculture of North America*, Cham, Springer.

Harrison, B. D. 1961: Soil-borne viruses. Tobacco rattle virus. *Rothamsted Experimental Station Annual Report for 1960*, 118 pp.

Harrison, B. D. 1964: Specific nematode vectors for serologically distinctive forms of raspberry ringspot and tomato black ring viruses. *Virology 22*: 544–550.

Harrison, B. D. 1966: Further studies on a British form of pea early-browning virus. *Annals of Applied Biology 57*: 121–129.

Harrison, B. D.; Cadman, C. H. 1959: Role of a dagger nematode (*Xiphinema* sp.) in outbreaks of plant diseases caused by arabis mosaic virus. *Nature 184*: 1624.

Harrison, B. D.; Winslow, R. D. 1961: Laboratory and field studies on the relation of arabis mosaic virus to its nematode vector *Xiphinema diversicaudatum* (Micoletzky). *Annals of Applied Biology 49*: 621–633.

Harrison, B. D.; Mowat, W. P.; Taylor, C. E. 1961: Transmission of a strain of tomato black ring virus by *Longidorus elongatus* (Nematoda). *Virology 14*: 480–485.

Hay, F. S.; Close, R. C. 1992: Distribution of *Xiphenema diversicaudatum* (Micoletzky, 1927) Thorne, 1939 in commercial hop (*Humulus lupulus* L.) gardens in New Zealand and implications for the spread of arabis mosaic virus. *New Zealand Journal of Crop and Horticultural Science 20*: 367–370.

Hewitt, W. B.; Raski, D. J.; Goheen, A. C. 1958: Nematode vector of soil borne virus of grapevines. *Phytopathology 48*: 586–595.

He, Y.; Subbotin, S. A.; Rubtsova, T. V.; Lamberti, F.; Brown, D. J.; Moens, M. 2005: A molecular phylogenetic approach to Longidoridae (Nematoda: Dorylaimida). *Nematology 7*: 111–124.

Heydari, R.; Maafi, Z. T.; Decraemer, W. 2014: Morphological and molecular characterisation of *Trichodorus golestanensis* (Nematoda: Trichodoridae), a new species from Iran. *European Journal of Plant Pathology 140*: 329–340.

Heyns, J.; Coomans, A.; Hutsebaut, M.; Swart, A. 1987: *Longidorus fursti* n. sp. from South Africa with a discussion of its relationships (Nematoda: Longidoridae). *Fundamental and applied Nematology 10*: 381–385.

Hoek, J.; Zoon, F.; Molendijk, L. 2006: Transmission of tobacco rattle virus (TRV) via seed potatoes. *Communications in Agricultural and Applied Biological Sciences 71*: 887–896.

Holterman, M.; Van Der Wurff, A.; van den Elsen, S.; van Megen, H.; Bongers, T.; Holovacgov, O.; Bakker, J.; Helder, J. 2006: Phylum-wide analysis of SSU rDNA reveals deep phylogenetic relationships among nematodes and accelerated evolution toward crown clades. *Molecular Biology and Evolution 13*: 1792–1800.

Hooper, D. J. 1977: *Paratrichodorus* (*Nanidorus*) *minor*. Pp: 3 *in CIH Descriptions of Plant-Parasitic Nematodes* 7, No. 103.

Hooper, D. J. 1986: Handling, fixing, staining and mounting nematodes. Pp. 59–80 *in:* Southey, J.F. (Ed). *Laboratory methods for work with plant and soil nematodes. Reference Book 402,* HMSO, London, UK, MAFF.

Hooper, D. J.; Siddiqi, M. R. 1972: *Trichodorus primitivus*. In *CIH Descriptions of plant-parasitic nematodes* Set I, 15: 3.

Howlett, B. J.; Brownlee, A. G.; Guest, D. I.; Adcock, G. J.; McFadden, G. I. 1992: The 5S ribosomal RNA gene is linked to large and small subunit ribosomal RNA genes in the oomycetes, *Phytophthora vignae, P. cinnamomi, P. megasperma* f. sp. *glycinae* and *Saprolegnia ferax. Current Genetics 22:* 455–461.

Hoy, J. W.; Mircetich, S. M.; Lownsbery, B. F. 1984: Differential transmission of *Prunus* tomato ringspot virus strains by *Xiphinema californicum. Phytopathology 74*: 332–335.

Huang, D.; Yan, G.; Gudmestad, N.; Whitworth, J.; Frost, K.; Brown, C.; Ye, W.; Agudelo, P.; Crow, W. 2018: Molecular characterization and identification of stubby root nematode species from multiple states in the United States. *Plant Disease 102*: 2101–2111.

Huff, D. E.; Davis, R. F.; Myers, R. F. 1987: *Longidorus breviannulatus* as a vector for brome mosaic virus. *Journal of Nematology 19*: 143.

Hunt, D. J. 1993: *Aphelenchida, Longidoridae & Trichodoridae: Their systematics and bionomics.* Wallingford, UK: CABI Publishing, 352 pp.

Inglis, W. G. 1983: An outline classification of the phylum Nematoda. *Australian Journal of Zoology 31*: 243–255.

Ilieva-Makulec, K.; Rybarczyk-Mydłowska, K.; Winiszewska, G.; Flis, Ł.; Tereba, A.; Kowalewska, K.; Malewski, T. 2017: Morphological and molecular analysis of *Paratrichodorus teres* (Hooper 1962) (Nematoda: Trichodoridae): a groundwork for discussion on the phylogeny and pathogenicity of *Paratrichodorus* species. *European Journal of Plant Pathology 148*: 907–917.

Ivanova, T. S. 1977: *Root nematodes–carriers of viruses–of the suborder Diphtherophorina (Keys to the nematodes of plants, soil and insects, No. 4)*. Leningrad, Nauka. 96 pp.

Iwaki, M.; Komuro, Y. 1974: Viruses isolated from Narcissus species in Japan. V. Arabis mosaic virus. *Annals of the Phytopathological Society of Japan 40*: 344–353.

Jensen, H. J. 1963: *Trichodorus allius*, a new species of stubby-root nematode from Oregon (Nemata: Dorylaimoidea). *Proceedings of the Helminthological Society of Washington 30*: 157–159.

Jensen, H. J.; Allen, T. C. 1964: Transmission of tobacco rattle virus by a stubby–root nematode, *Trichodorus allius*. *Plant Disease Reporter 48*: 333–334.

Jha, A.; Posnette, A. F. 1959: Transmission of a virus to strawberry plants by a nematode (*Xiphinema* sp.). *Nature 184*: 962–963.

Jha, A.; Posnette, A. F. 1961: Transmission of arabis mosaic virus by the nematode *Xiphinema diversicaudatum* (Micol.). *Virology 13*: 119–123.

Jones, A. T.; Brown, D. J. F.; McGavin, W. J.; Rüdel, M.; Altmayer, B.1994: Properties of an unusual isolate of raspberry ringspot virus from grapevine in Germany and evidence for its possible transmission by *Paralongidorus maximus*. *Annals of Applied Biology 124*: 283–300.

Kegler, H.; Kleinhempel, H.; Verderevskaja, T. D. 1976: Investigations on pear stony pit virus. *In X International Symposium on Fruit Tree Virus Diseases 67*: 209–218.

Khan, S. H.; Ahmad, S. 1975: Longidoroidea (Thorne, 1935) n. rank (Nematoda: Dorylaimina) with the description of *Xiphinema neoamericanum* n. sp. from India and proposal of a new name for *X. americanum sensu* Carvalho (1956) non Cobb, 1913. *Nematologia Mediterranea 3:* 23–27.

Khan, S. H.; Ahmad, S. 1977: *Xiphinema inaequale* non. nov. (syn.: *X. neoamericanum* Khan et Ahmad, 1975). *Nematologia Mediterranea 5*: 93.

Khan, E.; Chawla, M. L.; Saha, M. 1978: Comments on the classification of the Longidoroidea (Nematoda) with description of three new species. *Indian Journal of Nematology 6*: 47–62.

Knight, K. W. L. 2001: Plant parasitic nematodes associated with six subtropical crops in New Zealand. *New Zealand Journal of Crop and Horticultural Science 29*: 267–275.

Knight, K. W. L; Barber, C. J.; Page, G. D. 1997. Plant-parasitic nematodes of New Zealand recorded by host association. *Journal of Nematology 29*: 640–656.

Komuro, Y.; Yoshino, M.; Ichinohe, M. 1970: Tobacco rattle virus isolated from aster showing ringspot syndrome and its transmission by *Trichodorus minor* Colbran. *Japanese Journal of Phytopathology 36*: 17–26.

Konicek, D. E.; Jensen, H. J. 1961: *Longidorus menthasolanus,* a new plant parasite from Oregon (Nematoda: Dorylaimoidea). *Proceedings of the Helminthological Society of Washington 28:* 216–218.

Kumari, S.; Subbotin, S. A. 2012: Molecular characterization and diagnostics of stubby root and virus vector nematodes of the family Trichodoridae (Nematoda: Triplonchida) using ribosomal RNA genes. *Plant Pathology 61*: 1021–1031.

Lamberti, F.; Bleve-Zacheo, T. 1977: Two new species of *Longidorus* (Nematoda: Longidoridae) from Italy. *Nematologia Mediterranea 5*: 73–83.

Lamberti, F.; Bleve-Zacheo, T. 1979: Studies on *Xiphinema americanum sensu lato* with descriptions of fifteen new species (Nematoda, Longidoridae). *Nematologia Mediterranea 7*: 51–106

Lamberti, F.; Ciancio, A. 1993: Diversity of *Xiphinema americanum*-group species and hierarchical cluster analysis of morphometrics. *Journal of Nematology 25*: 332–343.

Lamberti, F.; Choleva, B.; Agostinelli, A. 1983: Longidoridae from Bulgaria (Nematoda, Dorylaimida) with description of three new species of *Longidorus* and two new species of *Xiphinema*. *Nematologia Mediterranea 11*: 49–72.

Lamberti, F.; Ciancio, A.; Agostinelli, A.; Coiro, M. I. 1992: Relationship between *Xiphinema brevicolle* and *X. diffusum* with a redescripiton of *X. brevicolle* and descriptions of three new species of *Xiphinema* (Nematoda: Dorylaimida). *Nematologia Mediterranea 19*: 311–326.

Lamberti, F.; Lemos, R.; Agostinelli, A.; D'Addabo, T. 1993: The *Xiphinema americanum*-group in the vineyards of the Dao and Douro regions (Portugal) with description of two new species (Nematoda, Dorylaimida). *Nematologia Mediterranea 21*: 215–225.

Lamberti, F.; Molinari, S.; Moens, M.; Brown, D. J. 2000: The *Xiphinema americanum* group. I. Putative species, their geographical occurrence and distribution, and regional polytomous identification keys for the group. *Russian Journal of Nematology 8*: 65–84.

Lamberti, F.; Hockland, S.; Agostinelli, A.; Moens, M.; Brown, D. 2004: The *Xiphinema americanum* group. III. Keys to species identification. *Nematologia Mediterranea 32*: 53–56.

Larget, B.; Simon, D. L. 1999: Markov chain Monte Carlo algorithms for the Bayesian analysis of phylogenetic trees. *Molecular Biology and Evolution 16*: 750–759.

Lazarova, S. S.; Malloch, G.; Oliveira, C. M. G.; Hübschen, J.; Neilson, R. 2006: Ribosomal and mitochondrial DNA analyses of *Xiphinema americanum*-group populations. *Journal of Nematology 38*: 404–410.

Lazarova, S.; Peneva, V.; Kumari, S. 2016: Morphological and molecular characterisation, and phylogenetic position of *X. browni* sp. n., *X. penevi* sp. n. and two known species of *Xiphinema americanum*-group (Nematoda, Longidoridae). *ZooKeys 574*: 1–42.

Lazarova, S. S.; Elshishka, M.; Radoslavov, G.; Lozanova, L.; Hristov, P.; Mladenov, A.; Zheng, J. W.; Fanelli, E.; De Luca, F.; Peneva, V. K. 2019: Molecular and morphological characterisation of *Longidorus polyae* sp. n. and *L. pisi* Edward, Misra & Singh, 1964 (Dorylaimida, Longidoridae) from Bulgaria. *ZooKeys 830*: 75–98.

Lister, R. M. 1964: Strawberry latent ringspot: a new nematode–borne virus. *Annals of Applied Biology 54*: 167–176.

Loof, P. A. A. 1975: Taxonomy of Trichodoridae. Pp. 103–127. In Lamberti, F.; Taylor, C. E.; Seinhorst, J. W. (Eds.), *Nematode vectors of plant viruses*, Plenum Press, London.

Loof, P. A. A. 1982: Two new species of Longidoridae (Dorylaimida) from Saudi Arabia. *Nematologica 28*: 307–317.

Loof, P. A. A.; Luc, M. 1990: A revised polytomous key for the identification of species of the genus *Xiphinema* Cobb, 1913 (Nematoda: Longidoridae) with exclusion of the *X. americanum*-group. *Systematic Parasitology 16*: 35–66.

Loof, P. A. A.; Chen, Q. W. 1999: A revised polytomous key for the identification of species of the genus *Longidorus* Micoletzky, 1922 (Nematoda: Dorylaimoidea). Supplement 1. *Nematology 1*: 55–59.

Lordello, L. G. E. 1955: *Xiphinema krugi* n. sp. (Nematoda, Dorylaimidae) from Brazil with a key to the species of *Xiphinema*. *Proceedings of the Helminthological Society of Washington 22*: 16–21.

Lordello, L. G. E.; Da Costa, C. P. 1961: A new nematode parasite of coffee roots in Brazil. *Revista Brasileira de Biologia 21*: 363–366.

Lordello, L. G. E.; Zamith, A. P. L. 1958: Nota sôbre o gênero *Trichodorus* Cobb, 1913, com descrição de *Trichodorus bucrius* sp. n. (Nematoda, Dorylaimoidea). *Anais da Academia Brasileira de Ciencias 30*: 103–105.

Luc, M.; Baujard, P. 2001: On specific determination within the *Xiphinema americanum* group (Nematoda: Longidoridae). *Nematology 3*: 727–728.

Luc, M.; Coomans, A.; Loof, P. A.; Baujard, P. 1998: The *Xiphinema americanum*-group (Nematoda: Longidoridae). 2. Observations on *Xiphinema brevicollum* Lordello & da Costa, 1961 and comments on the group. *Fundamental and Applied Nematology 21*: 475–490.

Maafi, Z. T.; Decraemer, W. 2002: Description of *Trichodorus gilanensis* n. sp. from a forest park in Iran and observations on *Paratrichodorus tunisiensis* (Siddiqi, 1963) Siddiqi, 1974 (Nematoda: Diphtherophorina). *Nematology 4*: 43–54.

Maafi, Z. T.; Subbotin, S. A.; Sturhan, D.; Barooti, S.; Taheri, Z. M. 2015: Characterisation of *Longidorus iranicus* Sturhan & Barooti, 1983 (Nematoda: Longidoridae) from Iran and synonymisation of *L. moesicus* Lamberti, Choleva & Agostinelli, 1983. *Russian Journal of Nematology 23*: 21–28.

Macfarlane, S. A. 2003: Molecular determinants of the transmission of plant viruses by nematodes. *Molecular Plant Pathology 4*: 211–215.

Mali, V. R.; Hooper, D. J. 1973: Observations on *Longidorus euonymus* n. sp. and *Xiphinema vulttenezi* Luc *et al*., 1964 (Nematoda: Dorylaimida) associated with spindle trees infected with euonymus mosaic virus in Czechoslovakia. *Nematologica 19*: 459–467.

Mali, V. R.; Vanek, G.; Bojnansky, V. 1975: Transmission by nematodes of some grapevine viruses occurring in Czechoslovakia and Hungary. *Polnohspo Darska Veda 3*: 1–133.

Marais, M.; Botha-Greeff, M. S. 1997: A new species of *Paratrichodorus* Siddiqi (Nemata: Trichodoridae) from Namibia, with a note on males of *P. minor* (Colbran) Siddiqi from South Africa. *African Plant Protection 3:* 17–22.

Marais, M.; Decraemer, W.; Quénéhervé, P. 1996: Three Trichodoridae from French Guiana and Martinique (Nemata: Diphtherophorina). *Nematropica 26:* 121–128.

Marais, M.; Swart, A.; Knoetze, R.; Pofu, K. 2015: Plant nematodes in South Africa. 13. A checklist of nematodes associated with potatoes. *Nematology 15*: 233–250.

Maria, M.; Ye, W.; Yu, Q.; Gu, J. 2018: Description of *Xiphinema parachambersi* sp. n. (Nematoda: Longidoridae) from imported ornamental plants in Japan with a key to *Xiphinema* species in Group 1. *Journal of Nematology 50:* 369–386.

Mcelroy, F.; Brown, D. J. F.; Boag, B. 1977: The virus-vector and damage potential, morphometrics and distribution of *Paralongidorus maximus*. *Journal of Nematology 9*: 122–130.

Meyl, A. H. 1953: Beitrage zur Kenntnis der Nematodenfauna vulkanisch erhitzter Biotope. 1. Mitt., Die Terrikolen Nematoden in Bereich von Fumarolen auf der Insel Ischia. *Zeitschrift fuer Morphologie und Okologie der Tiere 42*: 67–116.

Meyl, A. H. 1961: Die freilebenden Erd-und Siisswassernematoden (Fadenwurmer) In Die Tierwelt Mitteleuropas. *Quelle and Meyer, Leipzig*, 164 pp.

Micoletzky, H. 1922: Die freilebenden Erd-Nematoden. *Archiv für Naturgeschichte Berlin 89*: 1–650.

Micoletzky, H. 1927: Neue und seltene freilebende Nematoden aus dem Wolgagebiet (Kama). *Zoologischer Anzeiger 73*: 113–123.

Mobasseri, M.; Hutchinson, M. C.; Afshar, F. J.; Pedram, M. 2019: New evidence of nematode-endosymbiont bacteria coevolution based on one new and one known dagger nematode species of *Xiphinema americanum*-group (Nematoda, Longidoridae). *PloS One 14*: e0217506.

Monteiro, A. R. 1976: *Xiphidorus yepesara* n. g., n. sp. (Nemata: Longidoridae), from Brazil. *Nematologia Mediterranea 4*: 1–6.

Monteiro, A. R. 2010: Nomenclatorial note on *Xiphinema brevicolle* Lordello & Costa, 1961 (Nematoda: Longidoridae). *Nematologia Brasileira 34*: 1–2.

Mossop, D. W.; Fry, P. R.; Young, B. R. 1983: New plant disease records in New Zealand: arabis mosaic virus in celery, lettuce, and Chinese cabbage; tomato spotted wilt virus in celery. *New Zealand Journal of Agricultural Research 26*: 257–259.

Mowat, W. P.; Taylor, C. E. 1962: Nematode-borne viruses. Scottish Horticultural *Res*earch Institute, Dundee. *Annual Report for 1961* 62: 68–68.

Nasira, K. A. Z. I.; Maqbool, M. A. 1994: Two new species of *Paratrichodorus* Siddiqi, 1974 (Nematoda: Trichodoridae) with observation on *P. mirzai* (Siddiqi, 1960) Siddiqi, 1974 and *P. renifer* Siddiqi, 1974 from Pakistan. *Fundamental and Applied Nematology 17:* 323–332.

Niknam, G.; Karegar, A.; Zahedi, E.; Decraemer, W. 2009: *Trichodorus arasbaranensis* n. sp. (Nematoda: Trichodoridae) from a natural forest in Arasbaran, north-west Iran. *Nematology 11*: 243–252.

Nunn, G. B. 1992: Nematode molecular evolution. Ph.D. Thesis. *University of Nottingham, UK.*

Oliveira, C. M.; Hübschen, J.; Brown, D. J.; Ferraz, L. C.; Wright, F.; Neilson, R. 2004: Phylogenetic relationships among *Xiphinema* and *Xiphidorus* nematode species from Brazil inferred from 18S rDNA sequences. *Journal of Nematology 36*: 153–159.

Oteifa, B. A.; Tarjan, A. C. 1965: Potentially important plant-parasitic nematodes present in established orchards of newly-reclaimed sandy areas of the United Arab Republic. *Plant Disease Reporter 49*: 596–597.

Palomares-Rius, J. E.; Cantalapiedra-Navarreste, C.; Archidona-Yuste, A.; Subbotin, S. A.; Castillo, P. 2017: The utility of mtDNA and rDNA for barcoding and phylogeny of plant-parasitic nematodes from Longidoridae (Nematoda, Enoplea). *Scientific Reports 7*: 10905.

Pearse, A. S. 1942: *Introduction to Parasitology*. Springfield, Illinois, USA, 375 pp.

Pedram, M.; Pourjam, E. 2014: Description of *Trichodorus iranicus* sp. n. (Diphtherophorina, Trichodoridae) from Iran. *Zootaxa 3795*: 431–440.

Pedram, M.; Pourjam, E.; Panahandeh, Y.; Soleymanzadeh, M.; Atighi, M. R.; Roshan-Bakhsh, A.; Ehsani, A. 2015: Additional data on Iranian trichodorids (Triplonchida: Trichodoridae) and proposal for a new synonymy. *Nematology 17*: 1185–1191.

Peneva, V. K.; Urek, G.; Lazarova, S.; Širca, S.; Knapič, M.; Elshishka, M.; Brown, D. J. F. 2012: Longidoridae and nepoviruses in Bulgaria and Slovenia. *Helminthologia 49*: 49–56.

Peneva, V. K.; Lazarova, S. S.; De Luca, F.; Brown, D. J. F. 2013: Description of *Longidorus cholevae* sp. n. (Nematoda, Dorylaimida) from a riparian habitat in the Rila Mountains, Bulgaria. *ZooKeys 330*: 1–26.

Peraza-Padilla, W.; Cantalapiedra-Navarrete, C.; Zamora-Araya, T.; Palomares-Rius, J. E.; Castillo, P.; Archidona-Yuste, A. 2018: A new dagger nematode, *Xiphinema tica* n. sp. (Nematoda: Longidoridae), from Costa Rica with updating of the polytomous key of Loof and Luc (1990). *European Journal of Plant Pathology 150*: 73–90.

Ploeg, A. T.; Brown, D. J. F.; Robinson, D. J. 1992a: The association between species of *Trichodorus* and *Paratrichodorus* vector nematodes and serotypes of tobacco rattle tobravirus. *Annals of Applied Biology 121*: 619–630.

Ploeg, A. T.; Brown, D. J. F.; Robinson, D. J. 1992b: Acquisition and subsequent transmission of tobacco rattle virus isolates by *Paratrichodorus* and *Trichodorus* nematode species. *Netherlands Journal of Plant Pathology 98*: 291–300.

Ploeg, A. T.; Brown, D. J. F. 1995: Trichodorid nematodes and their associated viruses. In Santos, M. S. Oe; O. Abrantes, I. M. Oe; Brown, D. F J.; Lemlos, R. 1. V. C. (Eds.) *An introduction to virus–vector nematodes and their associated viruses. Chapter 3. Coimbra University,* 426 pp.

Putz, C.; Stocky, G. 1970: First observations on a str. of Strawberry latent ringspot virus transmitted by *X. coxi* and associated with a disease of raspberry in Alsace. *In Annales de Phytopathologie, Institut National de la Recherche Agronomique 2*: 329–347.

Rana, G. L.; Roca, F. 1973: Nematode transmission of *artichoke Italian latent virus*. *2nd Congresso internazionale Studi Carciofo, Bari, Italy*: 139–140.

Robbins, R. T.; Brown, D. J. F. 1991: Comments on the taxonomy, occurrence and distribution of Longidoridae (Nematoda) in North America. *Nematologica 37*: 395–419.

Robbins, R. T.; Brown, D. J. F.; Halbrendt, J.; Vrain, T. 1995: Compendium of *Longidorus* juvenile stages with observations on *L. pisi*, *L. taniwha* and *L. diadecturus* (Nematoda: Longidoridae). *Systematic Parasitology 32*: 33–52.

Roca, F. 1998: Description of *Trichodorus variabilis* n. sp. (Nemata: Diphterophoroidea) from Greece. *Fundamental and Applied Nematology 21*: 173–176.

Roca, F.; Lamberti, F. 1981: *Longidorus fasciatus* sp. n. from Greece and Italy. *Nematologia Mediterranea 9*: 175–179.

Roca, F.; Rana, G. L. 1981: *Paratrichodorus tunisiensis* (Nematoda, Trichodoridae) a new vector of tobacco rattle virus in Italy. *Nematologia Mediterranea 9*: 217–218.

Roca, F.; Conti, M.; Lamberti, F. 1977: *Trichodorus viruliferus* (Nematoda: Trichodoridae), vettore del virus "rattle" del tabacco (TRV) nell'Astigiano. *Nematologia Mediterranea 5*: 185–194.

Rodriguez-M, R.; Bell, A. H. 1978: Three new species of Trichodoridae (Nematoda: Diphtherophorina) with observations on the vulva in *Paratrichodorus*. *Journal of Nematology 10*: 132–141.

Rodriguez-M, R.; Sher, S. A.; Siddiqi, M. R. 1978: Systematics of the monodelphic species of Trichodoridae (Nematoda: Diphtherophorina) with descriptions of a new genus and four new species. *Journal of Nematology 10*: 141–152.

Romanenko, N.; Stegaresku, O. 1985: The problem of the taxonomy of nematodes of the *Xiphinema-americanum*-group (Nematoda, Dorylaimoidea). *Parazitologiya 19*: 434–442.

Ronquist, F.; Huelsenbeck, J. P. 2003: MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics 19*: 1572–1574.

Roshan-Bakhsh, A.; Pourjam, E.; Pedram, M. 2016: Description of *Longidorus perangustus* sp. n. (Dorylaimida: Longidoridae), an amphimictic species from Iran. *European Journal of Plant Pathology 144*: 581–594.

Rüdel, M. 1985: Grapevine damage induced by particular virus-vector combinations. *Phytopathologia Mediterranea 24*: 183–185.

Sakai, H.; Takeda, A.; Mizukubo, T. 2011: First report of *Xiphinema brevicolle* Lordello et Costa, 1961 (Nematoda, Longidoridae) in Japan. *ZooKeys 135*: 21–40.

Salomao, T. A. 1973: Soil transmission of artichoke yellow band virus. In *2nd Congress internazionale Studi Carciofo, Bari, Italy, 21–24 Nov*: 831–854.

Schmidt, H.; Fritzsche, F.; Lehmann, W. 1963: Transmission of Rye-grass mosaic virus by nematodes. *Naturwissenschaften 50*: 386.

Seinhorst, J. W. 1954: On *Trichodorus pachydermus* n. sp. (Nematoda: Enoplida). *Journal of Helminthology 28*: 111–114.

Seinhorst, J. W. 1959: A rapid method for the transfer of nematodes from fixative to anhydrous glycerine. *Nematologica 4*: 67–69.

Shah, F. A.; Bell, N. L.; Bulman, S. R. 2009: Morphological and molecular confirmation of *Xiphinema brevicollum,* a nematode from the virus-vectoring *X. americanum* group, from New Zealand. *Australasian Plant Pathology 38:* 500–504.

Siddiqi, M. R. 1960: Two new species of the genus *Trichodorus* (Nematoda: Dorylaimoidea) from India. *Proceedings of the Helminthological Society of Washington* 27: 22–27.

Siddiqi, M. R. 1961: On *Xiphinema opisthohysterum* n. sp. and *X. pratense* Loos, 1949, two dorylaimid nematodes attacking fruit trees in India. *Zeitschrift fiir Parasitenkunde 20*: 457–465.

Siddiqi, M. R. 1963: *Trichodorus* spp. (Nematoda: Trichodoridae) from Tunesia and Nicaragua. *Nematologica 9*: 69–75.

Siddiqi, M. R. 1974: Systematics of the genus *Trichodorus* Cobb, 1913 (Nematoda: Dorylaimida), with descriptions of three new species. *Nematologica 19*: 259–278.

Siddiqi, M. R. 1980: On the generic status of *Atlantadorus* Siddiqi, 1974 and *Nanidorus* Siddiqi, 1974 (Nematoda: Trichodoridae). *Systematic Parasitology 1*: 151–152.

Siddiqi, M. R. 2002: *Ecuadorus equatorius* gen. n., sp. n. and *Nanidorus mexicanus* sp. n. (Nematoda: Trichodoridae). *International Journal of Nematology 12*: 197–202.

Siddiqi, M. R.; Hooper, D. J.; Khan, E. 1963: A new nematode genus *Paralongidorus* (Nematoda: Dorylaimoidea) with descriptions of two new species and observations on *Paralongidorus citri* (Siddiqi 1959) n. comb. *Nematologica 9*: 7–14.

Siddiqi, M. R.; Sharma, S. B. 1995: *Trichodorus reduneus* sp. n. and *Tylenehorhynehus (Divittus) dispersus* sp. n. associated with groundnut in Vietnam. *Afro-Asian Journal of Nematology 5*: 48–52.

Širca, S.; Elshishka, M.; Urek, G.; Lazarova, S.; Mavrič Pleško, I.; Marn, M. V.; Peneva, V. 2010: Detection of Grapevine fanleaf virus (GFLV) in *Xiphinema italiae* Meyl, 1953 (Longidoridae) from Bulgaria. Pp: 19–23. In *Proceedings of the 30th ESN Symposium, Vienna.*

Širca, S.; Stare, B. G.; Mavrič Pleško, I.; Marn, M. V.; Urek, G.; Javornik, B. 2007: *Xiphinema rivesi* from Slovenia transmit Tobacco ringspot virus and Tomato ringspot virus to cucumber bait plants. *Plant Disease 91*: 770.

Sol, H. H.; Seinhorst, J. W. 1961: The transmission of rattle virus by *Trichodorus pachydermus*. *Tijdschrift over Plantenziekten 67*: 307–309.

Stringer, I.; Hitchmough, R. 2012: Assessing the conservation status of New Zealand's native terrestrial invertebrates. *New Zealand Entomologist 35*: 77–84.

Sturhan, D.; Barooti, S. 1983: *Longidorus iranicus* n. sp. (Nematoda: Dorylaimida). *Systematic Parasitology 5*: 21–24.

Sturhan, D.; Wouts, W.; Grandison, G.; Barber, C. 1997: Nematode vectors of plant viruses in New Zealand. *New Zealand Journal of Zoology 24*: 309–322.

Sturhan, D.; Wouts, W. 2008: Notes on *Xiphinema waimungui* Yeates, Boag & Brown, 1997 from New Zealand, a member of the *X. americanum* group. *Journal of Nematode Morphology and Systematics 11*: 105–108.

Tarjan, A. C. 1964: Plant-parasitic nematodes in the United Arab Republic. *FAO Plant Protection Bulletin 12*: 49–56.

Taylor, C. E. 1962: Transmission of raspberry ringspot virus by *Longidorus elongatus* (de Man) (Nematoda: Dorylaimidae). *Virology 17*: 493–494.

Taylor, C. E.; Brown, D. J. F. 1997: *Nematode vectors of plant viruses*: CAB International, Wallingford, UK, 286 pp.

Taylor, C. E.; Murant, A. F. 1969: Transmission of strains of raspberry ringspot and tomato black ring viruses by *Longidorus elongatus* (de Man). *Annals of Applied Biology* 64: 43–48.

Taylor, C.; Robertson, W. 1969: The location of raspberry ringspot and tomato black ring viruses in the nematode vector, *Longidorus elongatus* (de Man). *Annals of Applied Biology 64*: 233–237.

Taylor, C.; Thomas, P. 1968: The association of *Xiphinema diversicaudatum* (Micoletsky) with strawberry latent ringspot and arabis mosaic viruses in a raspberry plantation. *Annals of Applied Biology 62*: 147–157.

Thomas, W.; Procter, C. H. 1972: Arabis mosaic virus in *Cyphomandra betaceae* Sendt. *New Zealand Journal of Agricultural Research 15*: 395–404.

Thompson, J. D.; Gibson, T. J.; Plewniak, F.; Jeanmougin, F.; Higgins, D. G. 1997: The Clustal X Windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research 25*: 4876–4882.

Thorne, G. 1935a: Nemic parasites and associates of the mountain pine beetle (*Dendroctonus monticolae*) in Utah. *Journal of Agricultural Research 51*: 131–144.

Thorne, G. 1935b: Notes on free-living and plant-parasitic nematodes II. *Proceedings of the Helminthological Society of Washington 2*: 96–98.

Thorne, G. 1939: A monograph of the nematodes of the superfamily Dorylaimoidea. *Capita Zoologica 8*: 1–261.

Thorne, G.; Swanger, H. H. 1936: A monograph of the nematode genera *Dorylaimus* Dujardin, *Aporcelaimus* n. g., *Dorylaimoides* n. g. and *Pungentus* n. g. *Capita Zoological 6*: 1–223.

Thorne, G.; Allen, M. 1950: *Paratylenchus hamatus* n. sp. and *Xiphinema index* n. sp., two nematodes associated with fig roots with a note on *Paratylenchus* anceps Cobb. *Proceedings Helminthological Society of Washington 17*: 27–35.

Townsend, A.; De Lange, P.; Duffy, C.; Miskelly, C.; Molloy, J.; Norton, D. 2008: New Zealand threat classification system manual. *Wellington, Department of Conservation,* 30 pp.

Trisciuzzi, N.; Archidona-Yuste, A.; Troccoli, A.; Fanelli, E.; De Luca, F.; Vovlas, N.; Castillo, P. 2015: Description of a new needle nematode, *Longidorus asiaticus* n. sp. (Nematoda: Longidoridae), from the rhizosphere of crepe myrtle (*Lagerstroemia indica*) bonsai trees imported into Italy from China. *European Journal of Plant Pathology 143*: 567–580.

Trudgill, D. L.; Brown, D. J. F.; McNamara, D. G. 1983: Methods and criteria for assessing the transmission of plant viruses by longidorid nematodes. *Revue de Nématologie 6*: 133–141.

Valdez, R. B. 1972: Transmission of raspberry ringspot virus by *Longidorus caespiticola*, *L. leptocephalus* and *Xiphinema diversicaudatum* and of arabis mosaic virus by *L. caespiticola* and *X. diversicaudatum*. *Annals of Applied Biology 71*: 229–234.

Valdez, R. B.; McNamara, D. G.; Ormerod, P. J.; Pitcher, R. S.; Thresh, J. M. 1974: Transmission of the hop strain of arabis mosaic virus by *Xiphinema diversicaudatum*. *Annals of Applied Biology 76*: 113–122.

van den Berg, E.; Marais, M.; Swart, A. 2017: Nematode morphology and classification. *In*: Fourie, H.; Spaull, V.; Jones, R.; Daneel, M.; De Waele, D. (Eds) *Nematology in South Africa: A View from the 21st Century*. Springer, Cham.

van der Meer, F. A. 1965: Investigations of current viruses in the Netherlands. Further observations on spoon leaf virus, a soil borne virus transmitted by the nematode *Longidorus elongatus*. *Netherlands Journal of Plant Pathology 71*: 33–46.

Van Hoof, H. A. 1962: *Trichodorus pachydermus* and *T. teres*, vectors of the early browning virus of peas. *Tijdschrift Plantenziekten 68*: 391–396.

Van Hoof, H. A. 1964: *Trichodorus teres,* a vector of rattle virus. *Netherlands Journal of Plant Pathology 70*: 187–187.

Van Hoof, H. A. 1971: Viruses transmitted by *Xiphinema* species in the Netherlands. *Netherlands Journal of Plant Pathology 77*: 30–31.

Varela-Benavides, I.; Peraza-Padilla, W.; Cantalapiedra-Navarrete, C.; Palomares-Rius, J. E.; Castillo, P.; Archidona-Yuste, A. 2018: A new dagger nematode, *Xiphinema poasense* n. sp. (Nematoda: Longidoridae), from Costa Rica. *Nematology 20:* 235–252.

Vazifeh, N.; Niknam, G.; Jabbari, H.; Naghavi, A. 2019: Description of a new dagger nematode, *Xiphinema barooghii* n. sp. (Nematoda: Longidoridae) and additional data on the three known species of the genus from northwest of Iran. *Journal of Nematology 51*: 1–17.

von Linstow, O. F. B. 1879: Helminthologische studien. *Archiv für Naturgeschichte* (*45. Jahrgang*) *1:* 165–188.

Walkinshaw, C.; Larson, R.; Griffin, G. 1961: *Trichodorous christiei* as a vector of potato corky ringspot (tobacco rattle) virus. *Phytopathology 51*: 806.

Watson, R.; Bell, N., 2001: Dynamics of sympatric *Paratylenchus nanus* and *Paratrichodorus minor* populations in soil under pasture. *Nematology 3*: 267–275.

White, T. J.; Bruns, T.; Lee, S.; Taylor, J. 1990: Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *In* Innes, M. A.; Gelfard, D. H., Sninsky, J. J., White, T. J. (eds.), *PCR protocols. A guide to methods and applications*. San Diego, Academic Press.

Whitehead, A. G.; Hemming, J. R. 1965: A comparison of some quantitative methods for extracting small vermiform nematodes from soil. *Annals of Applied Biology 55*: 25–38.

Whitehead, A.; Hooper, D. 1970: Needle nematodes (*Longidorus* spp.) and stubby-root nematodes (*Trichodorus* spp.) harmful to sugar beet and other field crops in England. *Annals of Applied Biology 65*: 339–350.

Williams, B. D.; Schrank, B.; Huynh, C.; Shownkeen, R.; Waterston, R. H. 1992: A genetic mapping system in *Caenorhabditis elegans* based on polymorphic sequence-tagged sites. *Genetics 131*: 609–624.

Xie, H.; Feng, Z.; Zhao, L. 2000: Description of *Trichodorus guangzhouensis* n. sp. (Nematoda: Trichodoridae). *Acta Phytopathologica Sinica 30*: 349–352.

Xu, J. H.; Cheng, H. R. 1991: [A new species of *Longidorus* (Nematoda: Longidoridae)]. *Journal of Nanjing Agricultural University 14*: 38–42 (in Chinese).

Xu, Y.; Guo, K.; Ye, W.; Wang, J.; Zheng, J.; Zhao, Z. 2017: Morphological and molecular characterisation of *Longidorus juglans* sp. nov. and a sister species *L. fangi* Xu & Cheng, 1991 (Nematoda: Longidoridae) from China. *Nematology 19*: 951–970.

Xu, Y.; Ye, W.; Wang, J.; Zhao, Z. 2018: Morphological and molecular characterisation of *Longidorus pinus* sp. n. (Nematoda: Longidoridae) from China and a key to known species of *Longidorus* in China. *Nematology 20*: 617–639.

Yagita, H.; Komuro, Y. 1972: Transmission of mulberry ringspot virus by *Longidorus martini* Merny. *Japanese Journal of Phytopathology 38*: 275–283.

Ye, W. 2018: Nematodes of agricultural importance in North and South Carolina. Pp 247–276 In: *Plant Parasitic Nematodes in Sustainable Agriculture of North America*: Vol. 2-Northeastern, Midwestern and Southern USA, Springer, Cham.

Yeates, G. 1967: Studies on nematodes from dune sands. 4. Diphtherophoroidea. *New Zealand Journal of Science 10*: 322–329.

Yeates, G. 1969: The status of *Trichodorus clarki* Yeates, 1967, *Ereptonema inflatum* Yeates, 1967 and *Mononchoides potohikus* Yeates, 1969. *Nematologica 15*: 430–430.

Yeates, G. 1973: Morphometrics and growth in eight New Zealand soil nematode populations. *New Zealand Journal of Science 16*: 711–725.

Yeates, G. 2010: Phylum Nematoda: roundworms, eelworms. *New Zealand Inventory of Biodiversity 2*: 480–493.

Yeates, G. W.; Prestidge, R. A. 1986: Nematode populations and their effects on herbage production in a volcanic plateau pasture. *New Zealand Journal of Agricultural Research 29*: 517–523.

Yeates, G.; Van Etteger, M. 1991: Morphometrics of developmental stages of four Dorylaimida (Nematoda). *New Zealand DSIR Land Resources Technical Record 38*: 1–11.

Yeates, G. W.; Van Etteger, M.; Hooper, D. J. 1992: *Longidorus orongorongensis* n. sp. (Nematoda: Dorylaimida) from subsoil of conifer/broadleaved forest. *New Zealand Journal of Zoology 19*: 25–31.

Yeates, G. W.; Boag, B.; Brown, D. J. F. 1997: Two new species of Longidoridae (Nematoda) from New Zealand forests. *Systematic Parasitology 38:* 33–43.

Yeates, G. W.; Mercer, C. F.; Newton, P. C. D. 2008: Populations of *Longidorus elongatus* (Nematoda: Longidoridae) in two New Zealand soils under grazed pasture. *New Zealand Journal of Zoology 35*: 287–296.

Yeates, G. W.; Zhao, Z. Q.; Hitchmough, R. A.; Stringer, I. A. N. 2012: The conservation status of New Zealand Nematoda. *New Zealand Entomologist 35*: 128–130.

Zahedi, E.; Niknam, G.; Decraemer, W.; Karegar, A. 2009: *Trichodorus arasbaranensis* n. sp. (Nematoda: Trichodoridae) from a natural forest in Arasbaran, north-west Iran. *Nematology 11*: 243–252.

Zasada, I. A.; Peetz, A.; Howe, D. K.; Wilhelm, L. J.; Cheam, D.; Denver, D. R.; Smythe, A. B. 2014: Using mitogenomic and nuclear ribosomal sequence data to investigate the phylogeny of the *Xiphinema americanum* species complex. *PLoS One 9*: e90035.

Zhao, L.; Xie, H.; Gu, J.; Xu, C. 2013: Description of *Trichodorus japonicus* n. sp. (Triplonchida: Trichodoridae) from Japan. *Nematology 15*: 783–793.

Zhao, L.; Ye, W.; Maria, M.; Pedram, M.; Gu, J. 2017: *Xiphinema japonicum* n. sp. (Nematoda: Longidorinae) from the rhizosphere of Japanese *Podocarpus macrophyllus* (Thunb.), a cryptic species related to *Xiphinema bakeri* Williams, 1961. *Journal of Nematology 49*: 404–417.

Zhao, Z. Q.; Buckley, T. R. 2009: Phylogenetic analysis of nematode nuclear 18S rDNA sequences indicates the genus *Tripylina* Brzeski, 1963 (Nematoda: Tripylidae de Man, 1876) should be placed in Enoplida. *Zootaxa 2238*: 25–32.

Zheng, J. W.; Subbotin, S. A.; He, S. S.; Gu, J. F.; Moens, M. 2002: Molecular characterisation of some Asian isolates of *Bursaphelenchus xylophilus* and *B. mucronatus* using PCR-RFLPs and sequences of ribosomal DNA. *Russian Journal of Nematology 11*: 17–22.

Zullini, A. 2006: Order Triplonchida. Pp. 293–325 In Eyualem, A.; Andrássy, I.; Traunspurger, W. (Eds) *Freshwater nematodes: Ecology and taxonomy*. Wallingford, UK: CAB International.

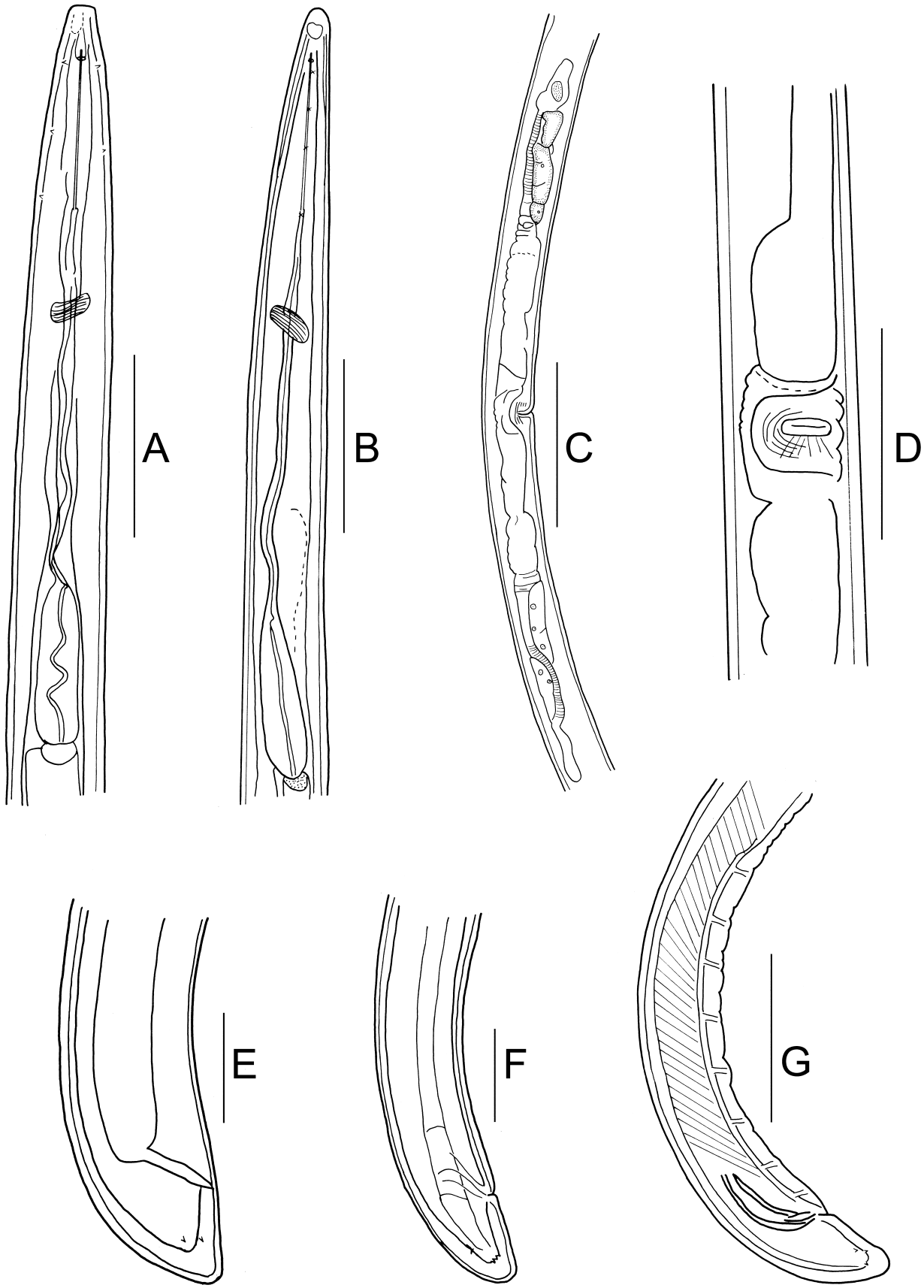


Fig. 1. Line drawings of *Longidorus elongatus* females and males. A: Female anterior region; B: Male anterior region; C: Female reproductive systems; D: Vulval region, ventral view; E, F: Female tail shape; G: Male tail, showing spicules and supplements. Scale bars: A, B, D, G=100 µm; C=200 µm; E, F=50 µm.

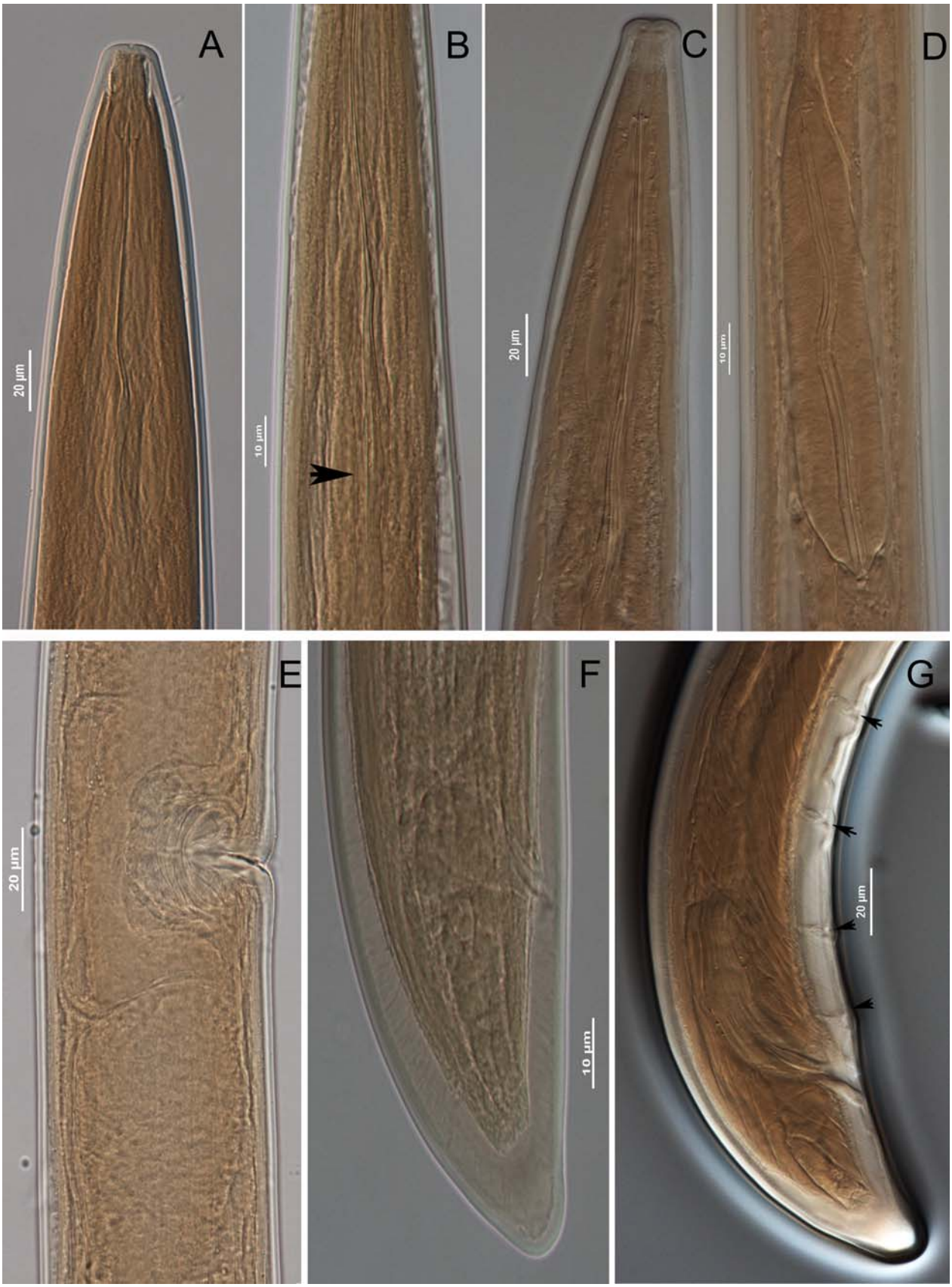


Fig. 2. Micrographs of *Longidorus elongatus* females and males. Female: A, B, E, F. A: Anterior region; B: Odontophore base (arrow); E: Vulval region, lateral view; F: Tail shape. Male: C, D, G. C: Anterior region; D: Pharyngeal bulb; G: Tail, showing spicules and supplements (arrows).

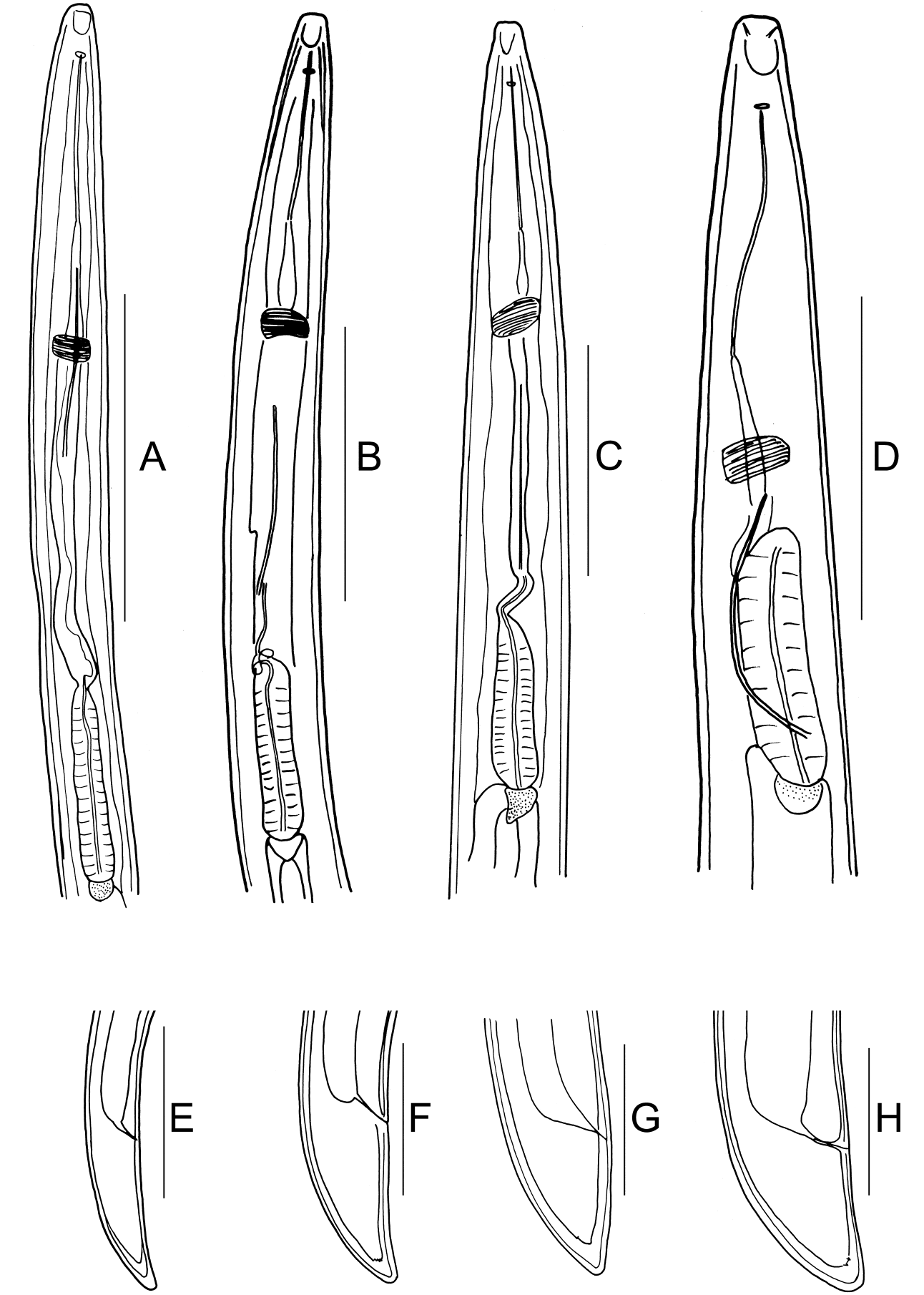


Fig. 3. Line drawings of *Longidorus elongatus* juveniles. A–D: J1–J4 anterior region, respectively; E–H: J1–J4 tail, respectively. Scale bars: A–D=100 µm; E–H=50 µm.

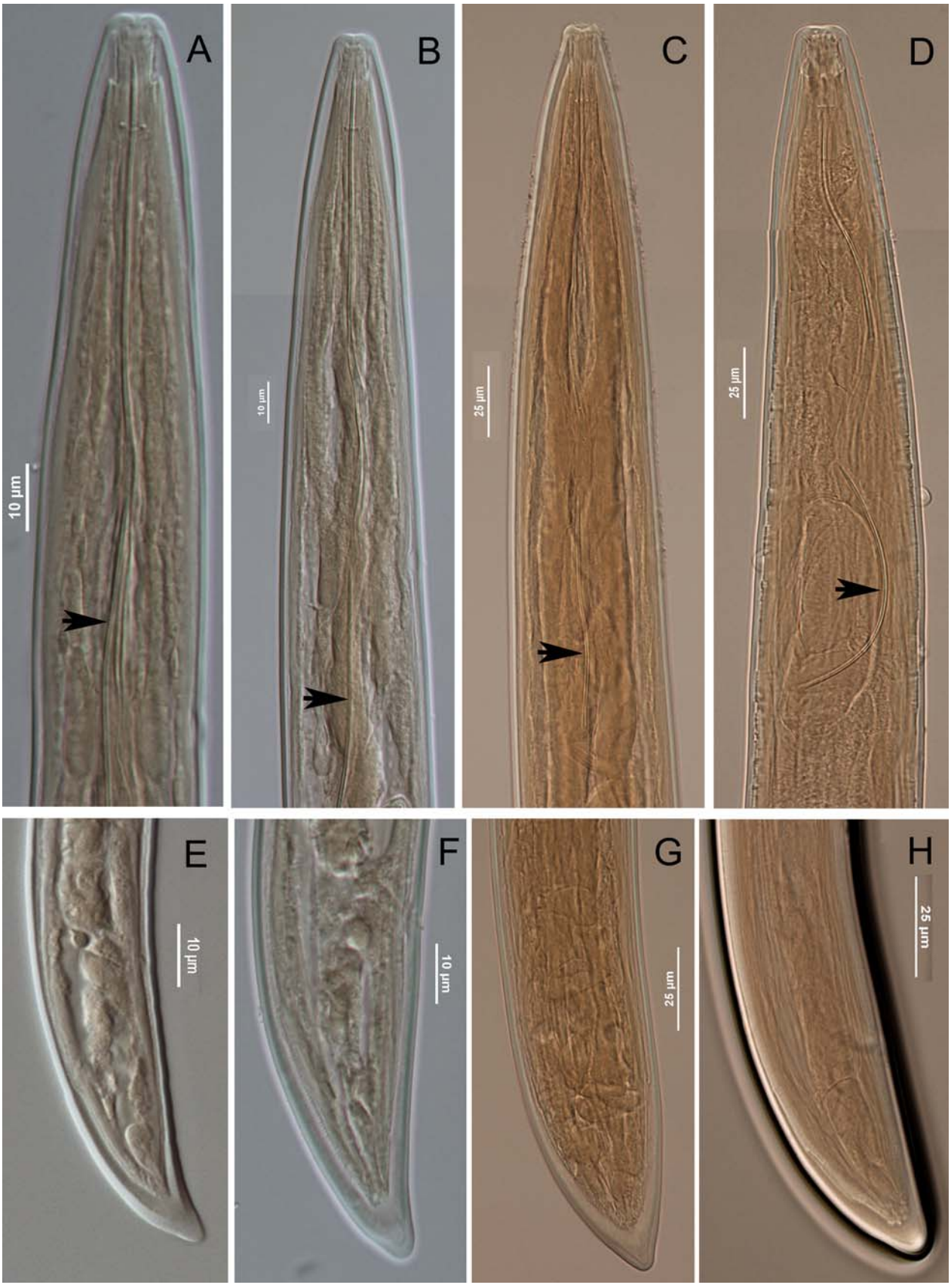


Fig. 4. Micrographs of *Longidorus elongatus* juveniles. A–D: J1–J4 anterior region, replacement odontostyle (arrows), respectively; E–H: J1–J4 tail, respectively.

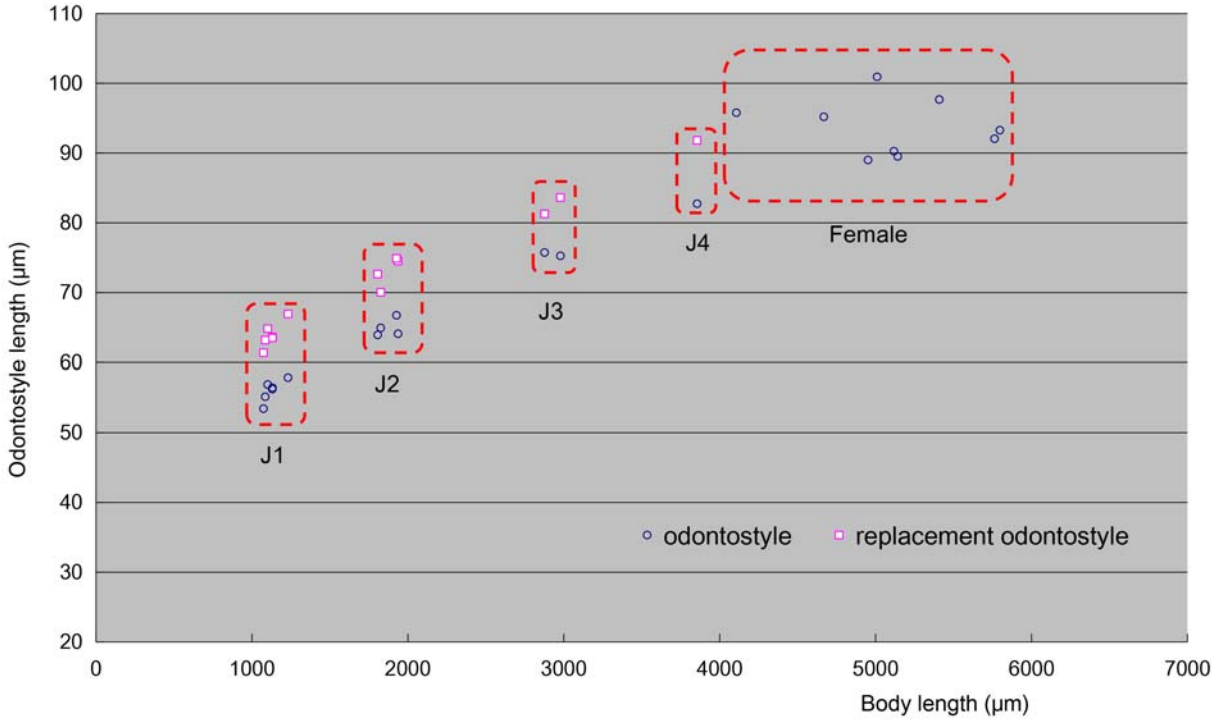


Fig. 5. Scatter plot of odontostyle length and replacement odontostyle length against body length of *Longidorus elongatus* juveniles and females.

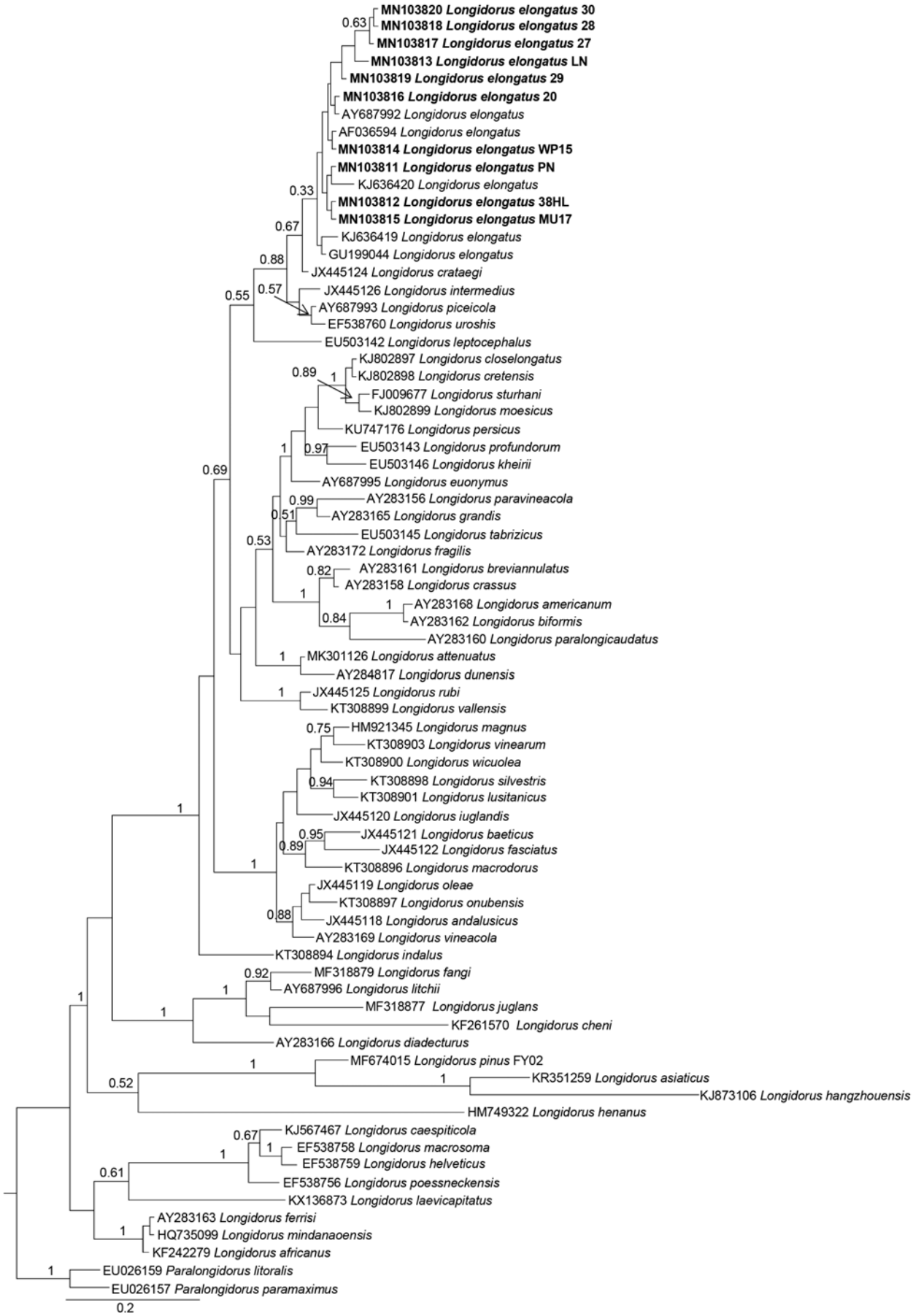


Fig. 6. Bayesian consensus tree of *Longidorus elongatus* inferred from SSU sequences under TIM2ef + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

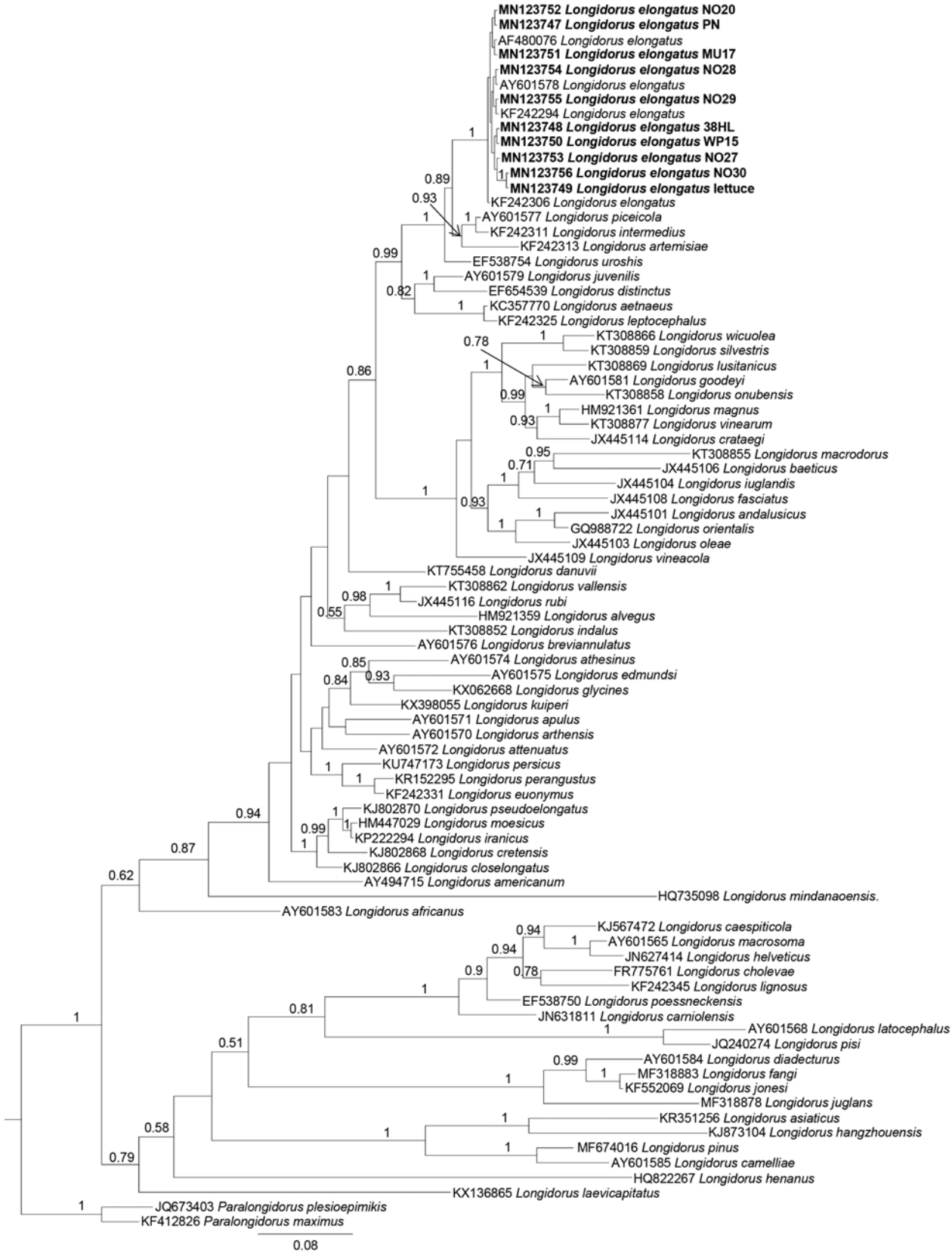


Fig. 7. Bayesian consensus tree of *Longidorus elongatus* inferred from D2-D3 of LSU sequences under GTR + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

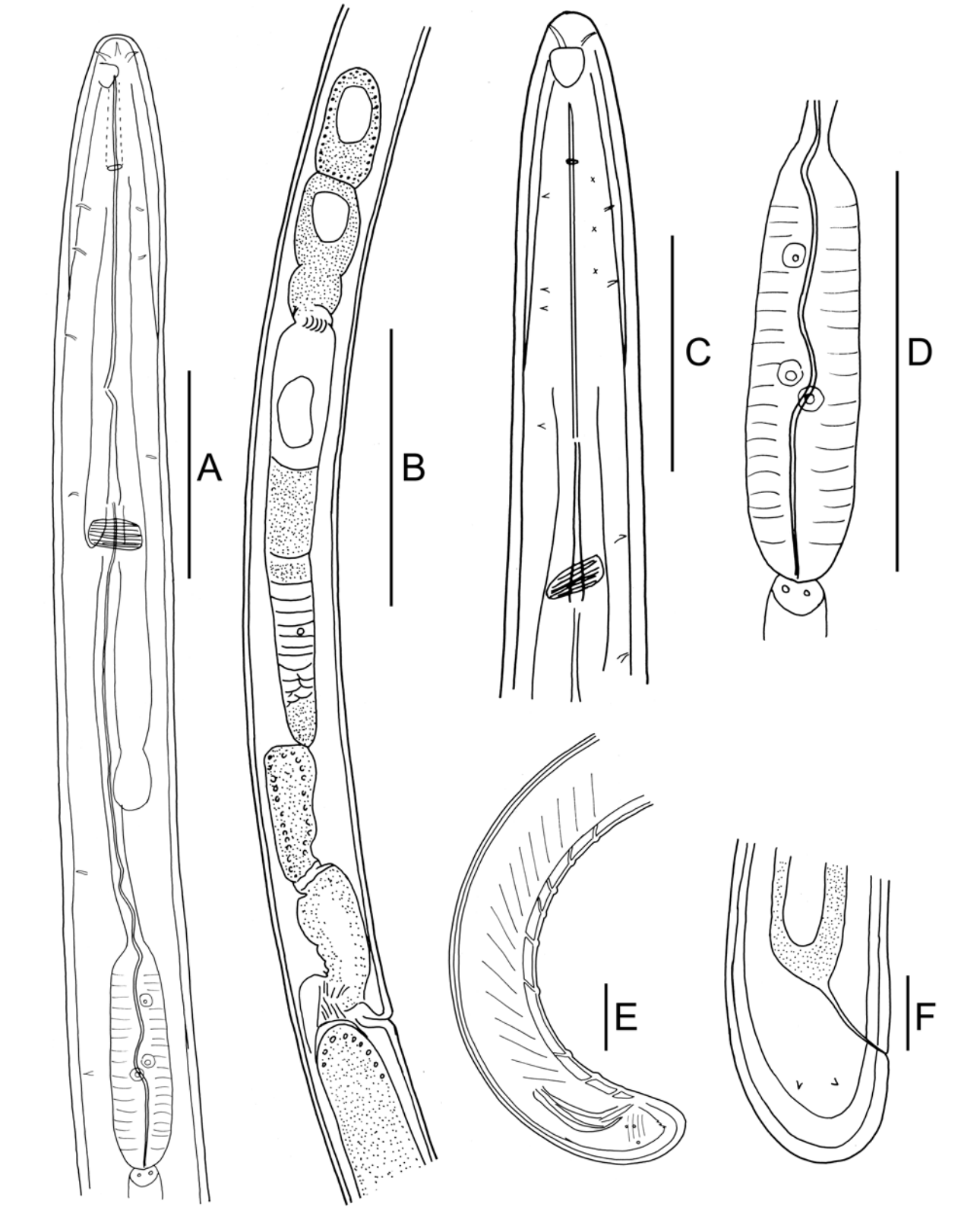


Fig. 8. Line drawings of *Longidorus orongorongensis* females and males. A: Female anterior region; B: Female reproductive system; C: Male anterior region; D: Female pharyngeal bulb; E: Male tail; F: Female tail. Scale bars: A, C, D=100 µm; B=200 µm; E=50 µm; F=25 µm.

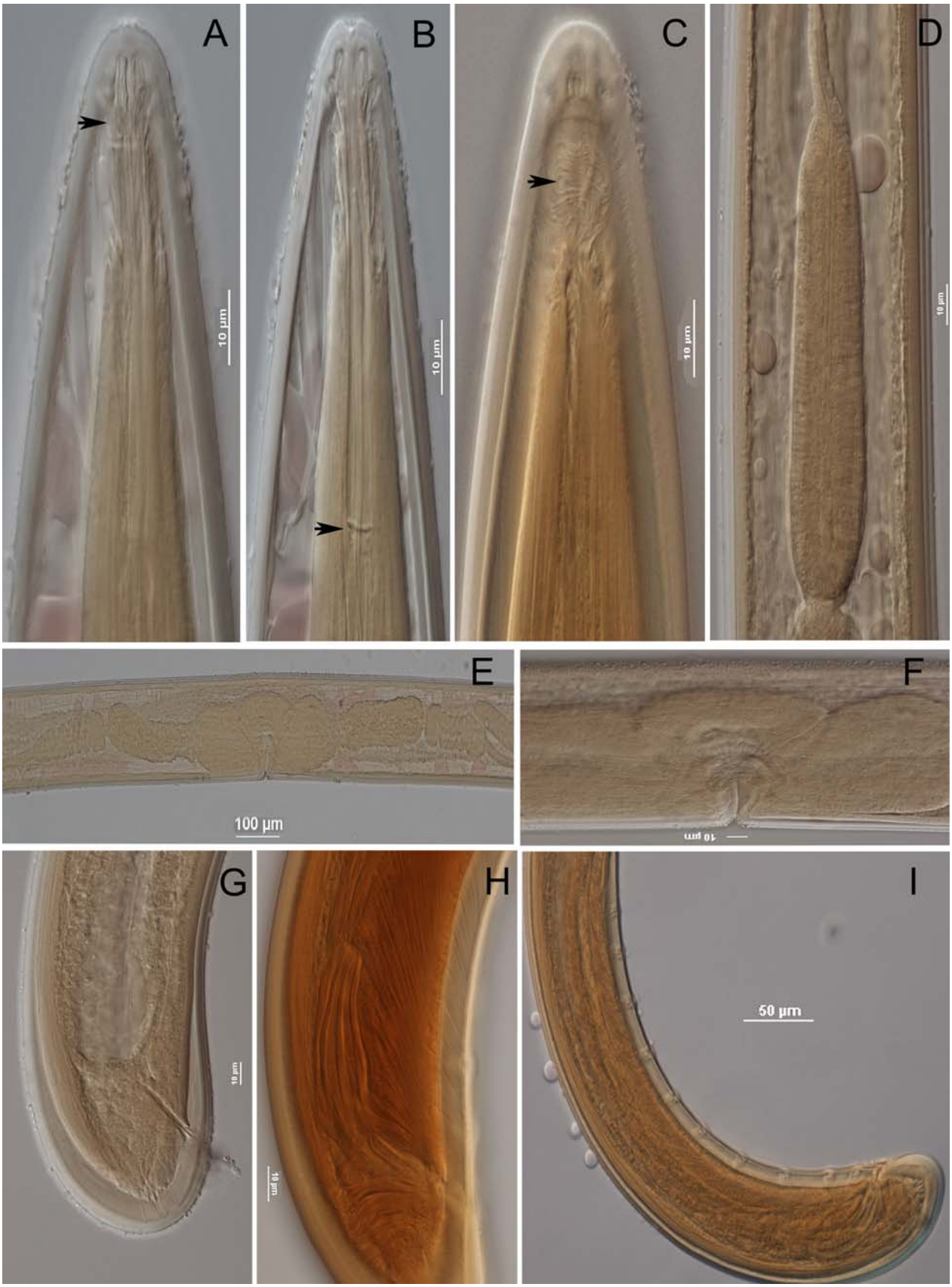


Fig. 9. Micrographs of *Longidorus orongorongensis*. A: Female amphid (arrow); B: Female guide ring (arrow); C: Male amphid (arrow); D: Female pharyngeal bulb; E: Female reproductive system; F: Vulva; G: Female tail; H: Male spicule; I: Male tail.

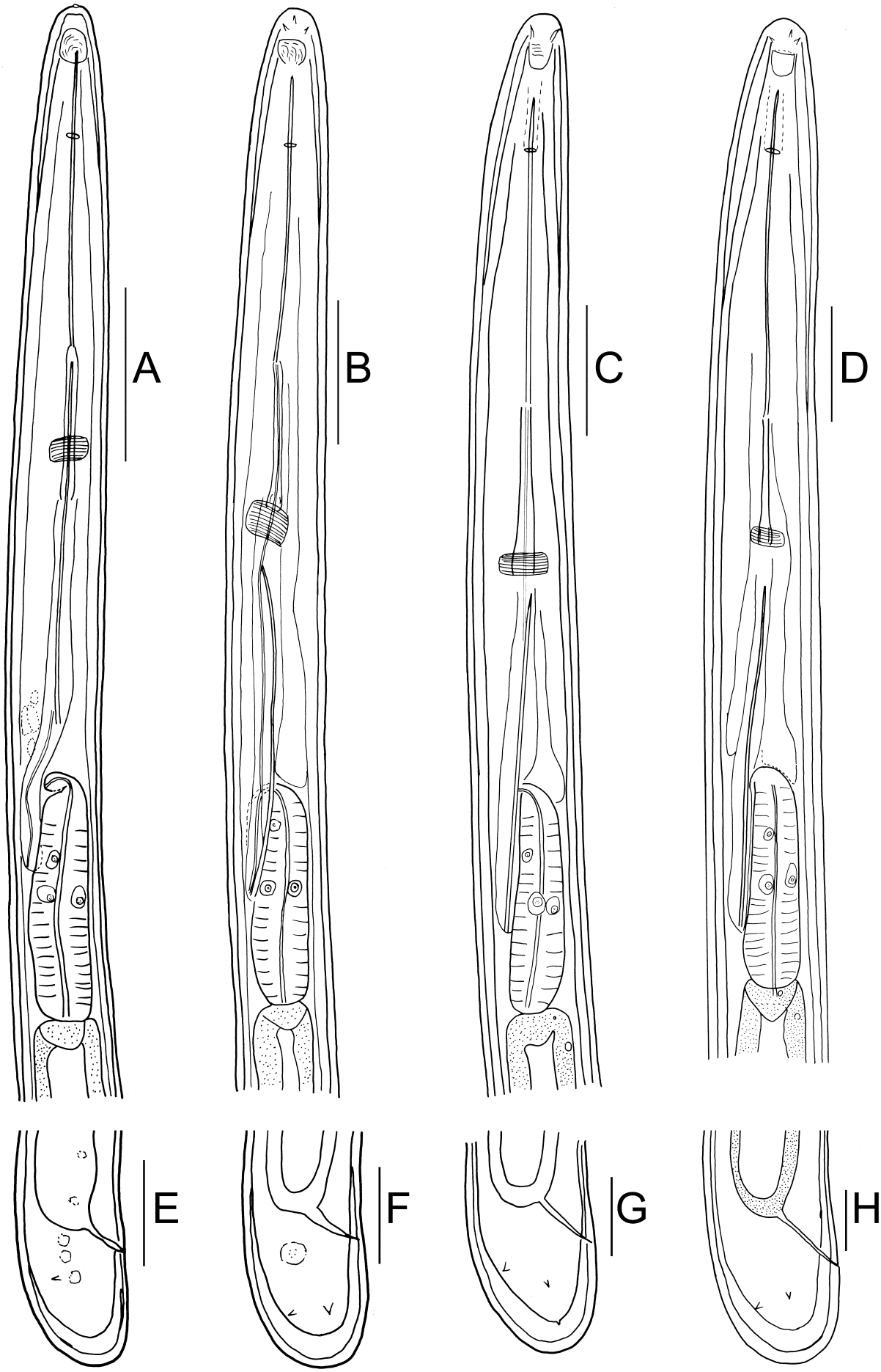


Fig. 10. Line drawings of *Longidorus orongorongensis* juveniles. A–D: J1–J4 anterior region, respectively; E–H: J1–J4 tail, respectively. Scale bars: A–D=50 µm; E–H=25 µm.

Fig. 11. Micrographs of *Longidorus orongorongensis* juveniles. A–D: J1–J4 anterior region, respectively; E–H: J1–J4 tail, respectively.

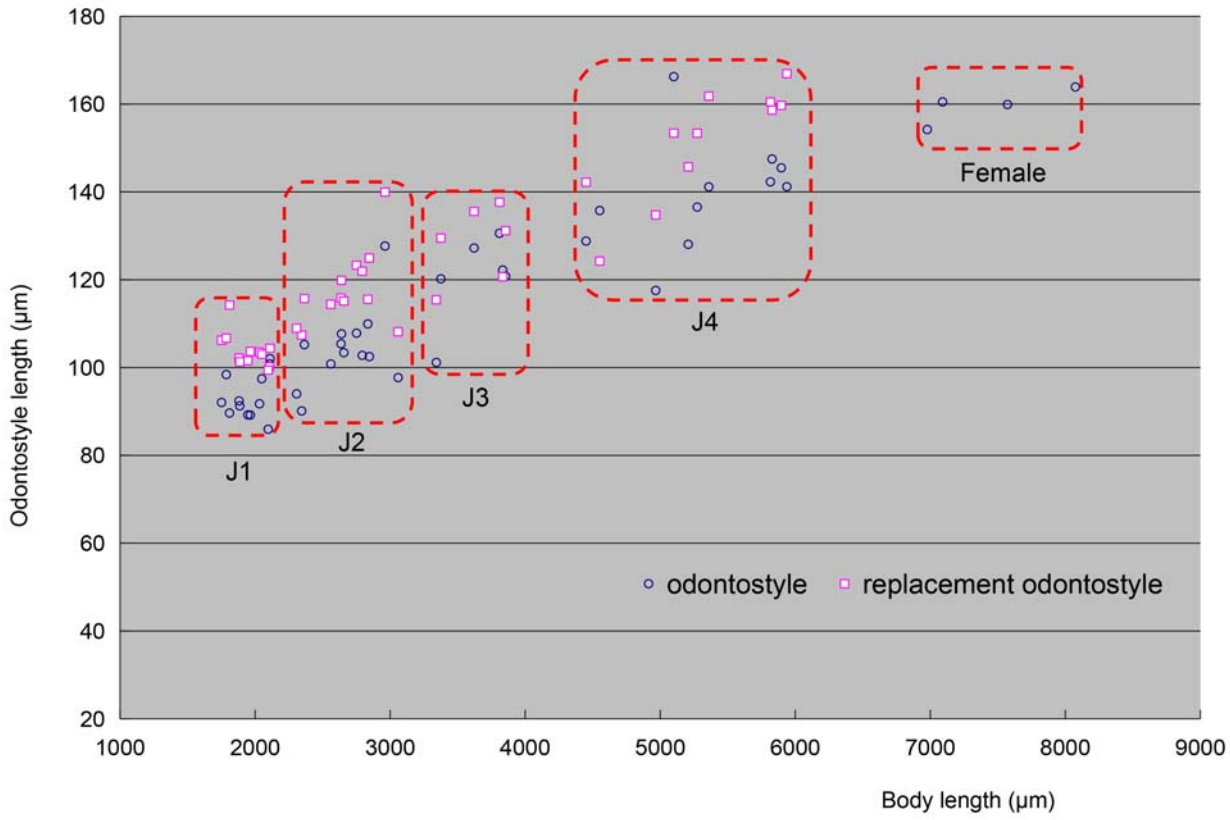


Fig. 12. Scatter plot of odontostyle length and replacement odontostyle length against body length of *Longidorus orongorongensis* juveniles and females.

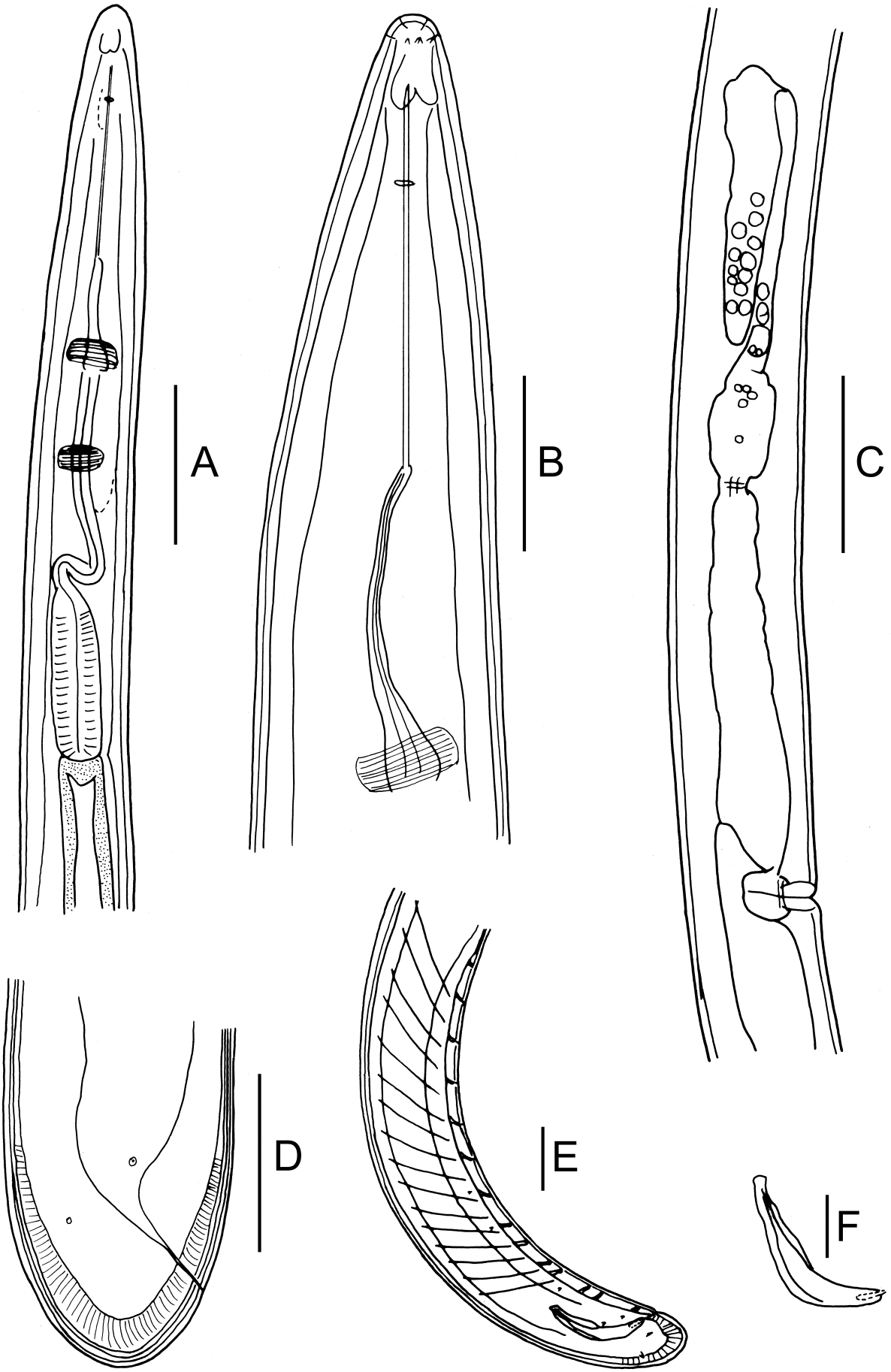


Fig. 13. Line drawings of *Longidorus taniwha* females and males. A: Female anterior region; B: Female amphid; C: Female anterior gonad; D: Female tail; E: Male tail (After Clark 1963a); F: Spicules (After Clark 1963a). Scale bars: A, C=100 µm; B, D, E=50 µm; F=25 µm.

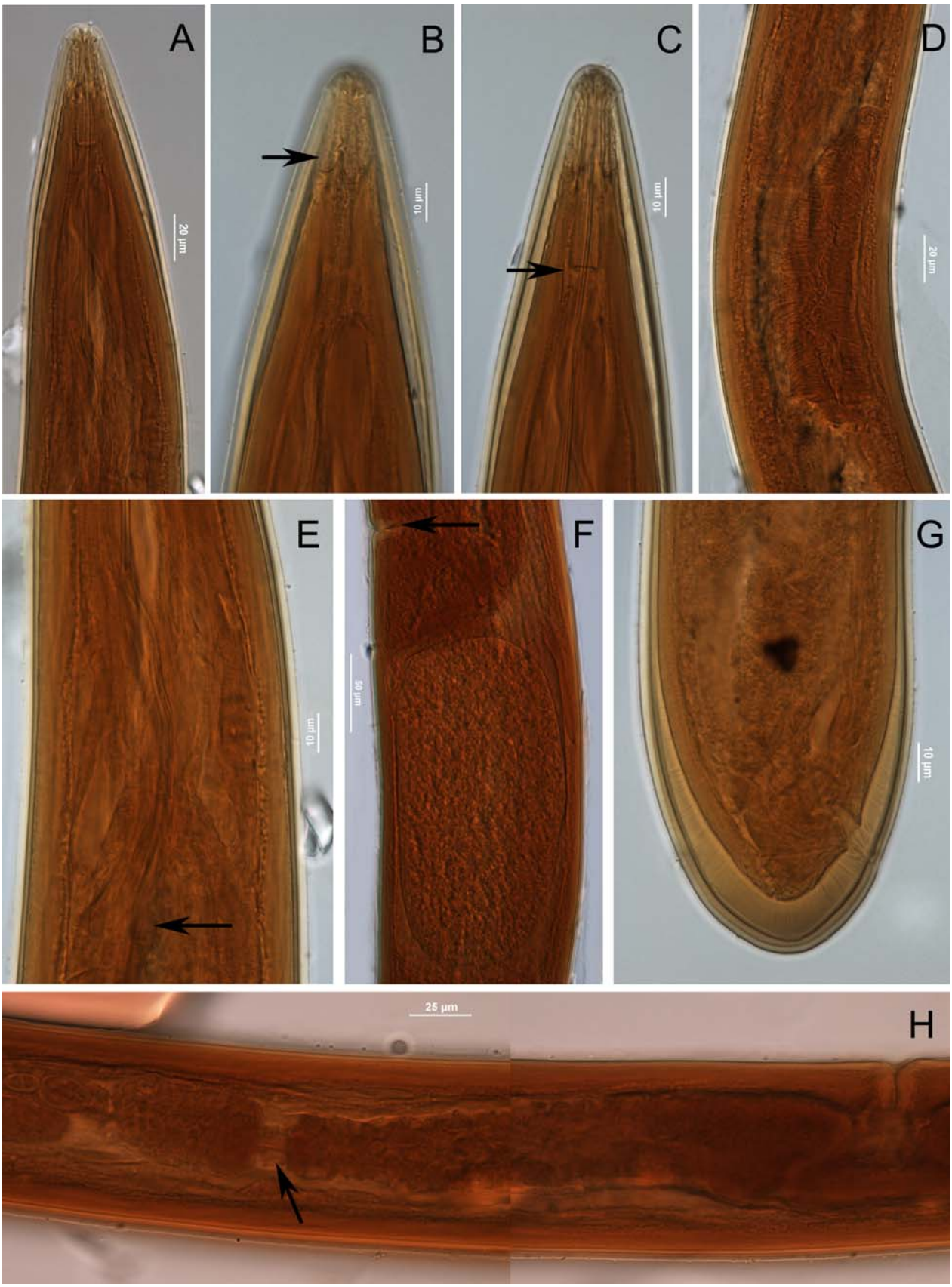


Fig. 14. Micrographs of *Longidorus taniwha* females. A: Anterior region; B: Amphid (arrow); C: Guide ring (arrow) and odontostyle; D: Pharyngeal bulb; E: Odontophore base (arrow); F: Vulva (arrow) and egg; G: Tail; H: Female anterior reproductive system, spermatozoa (arrow).

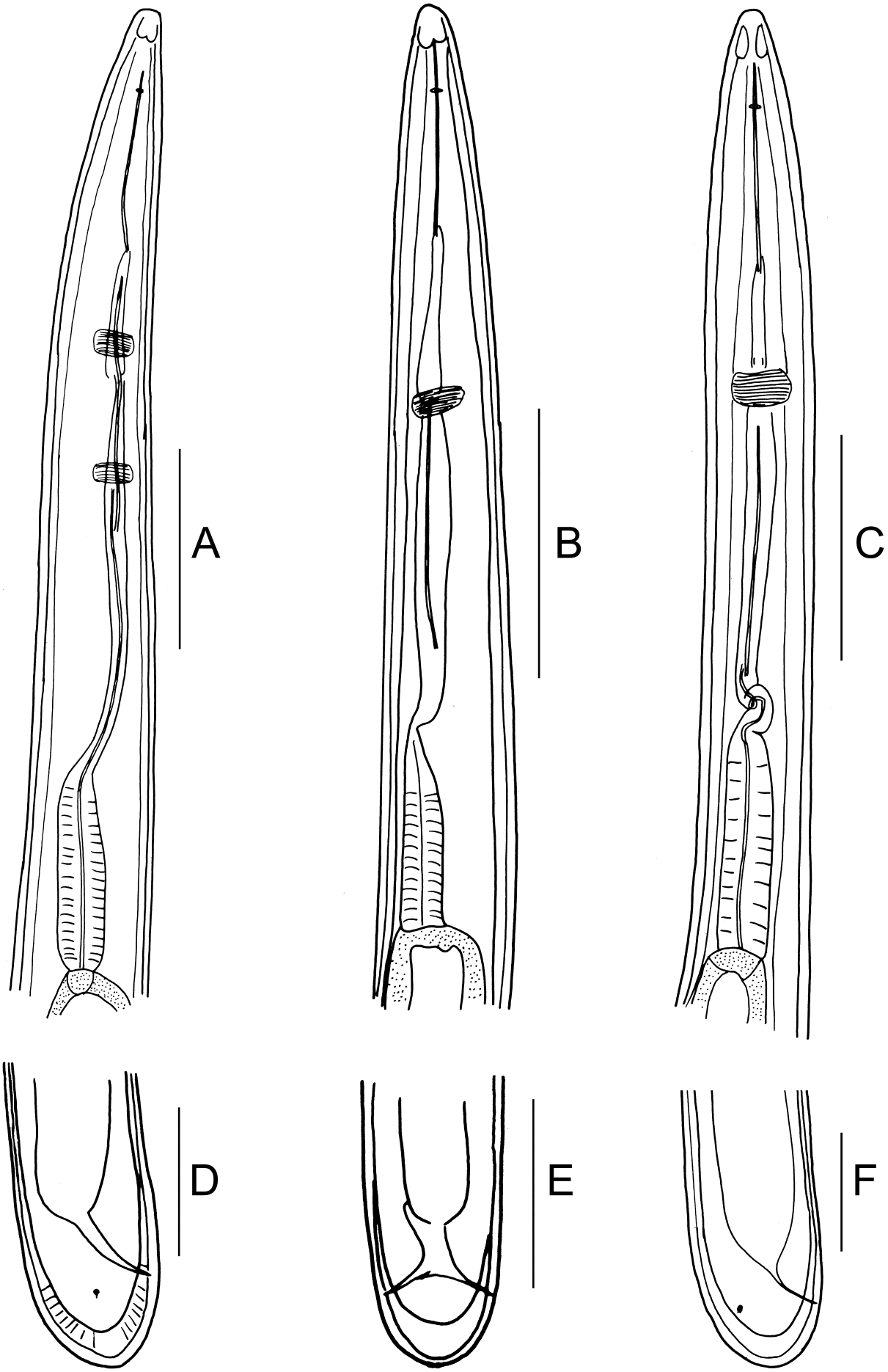


Fig. 15. Line drawings of *Longidorus taniwha* juveniles. A–C: J1–J3 Anterior region, respectively; D–F: J1–J3 tail shape, respectively. Scale bars: A–C=100 µm; D–F=50 µm.

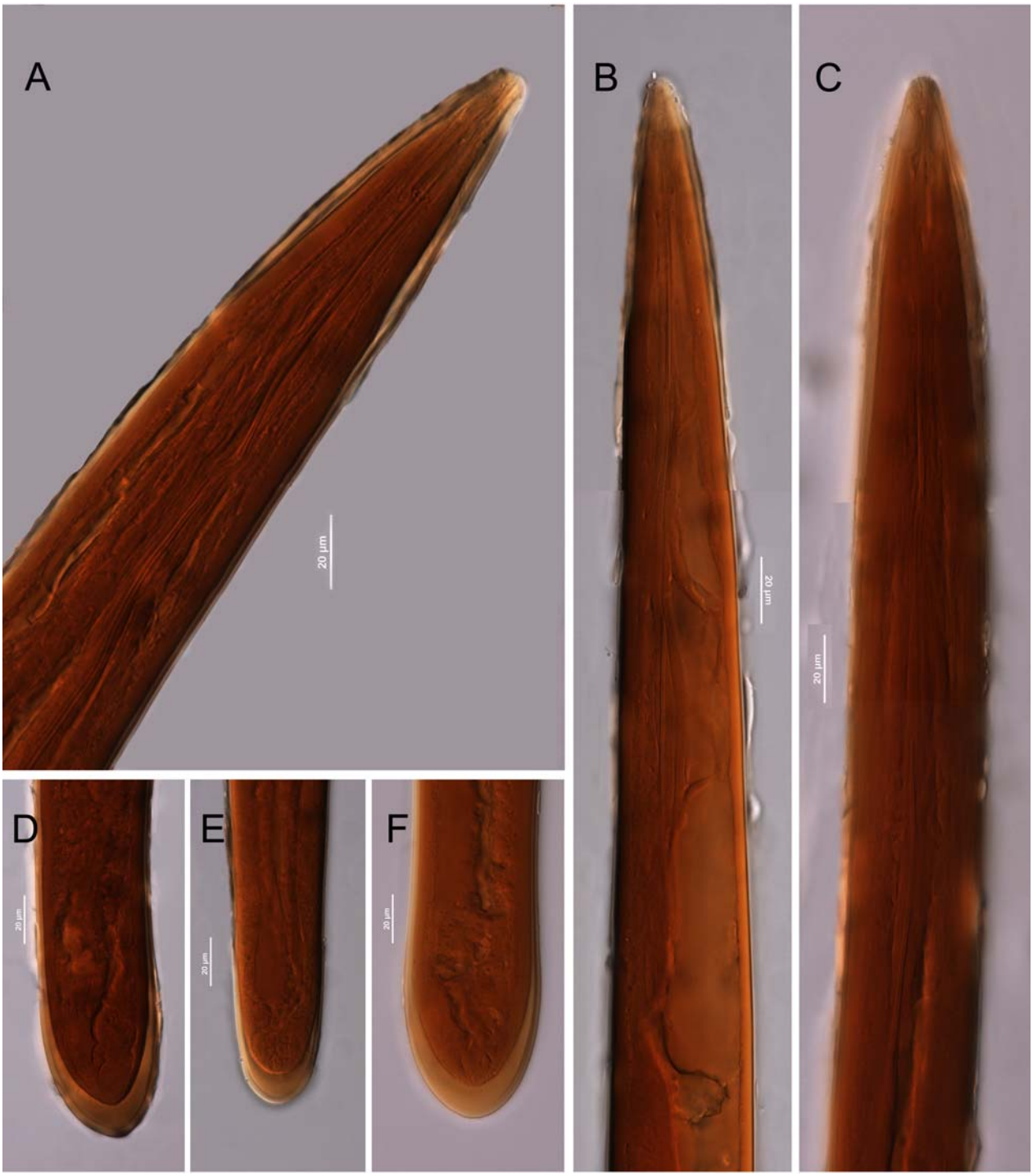


Fig. 16. Micrographs of *Longidorus taniwha* juveniles. A–C: J1–J3 Anterior region; D–F: J1–J3 tail shape.

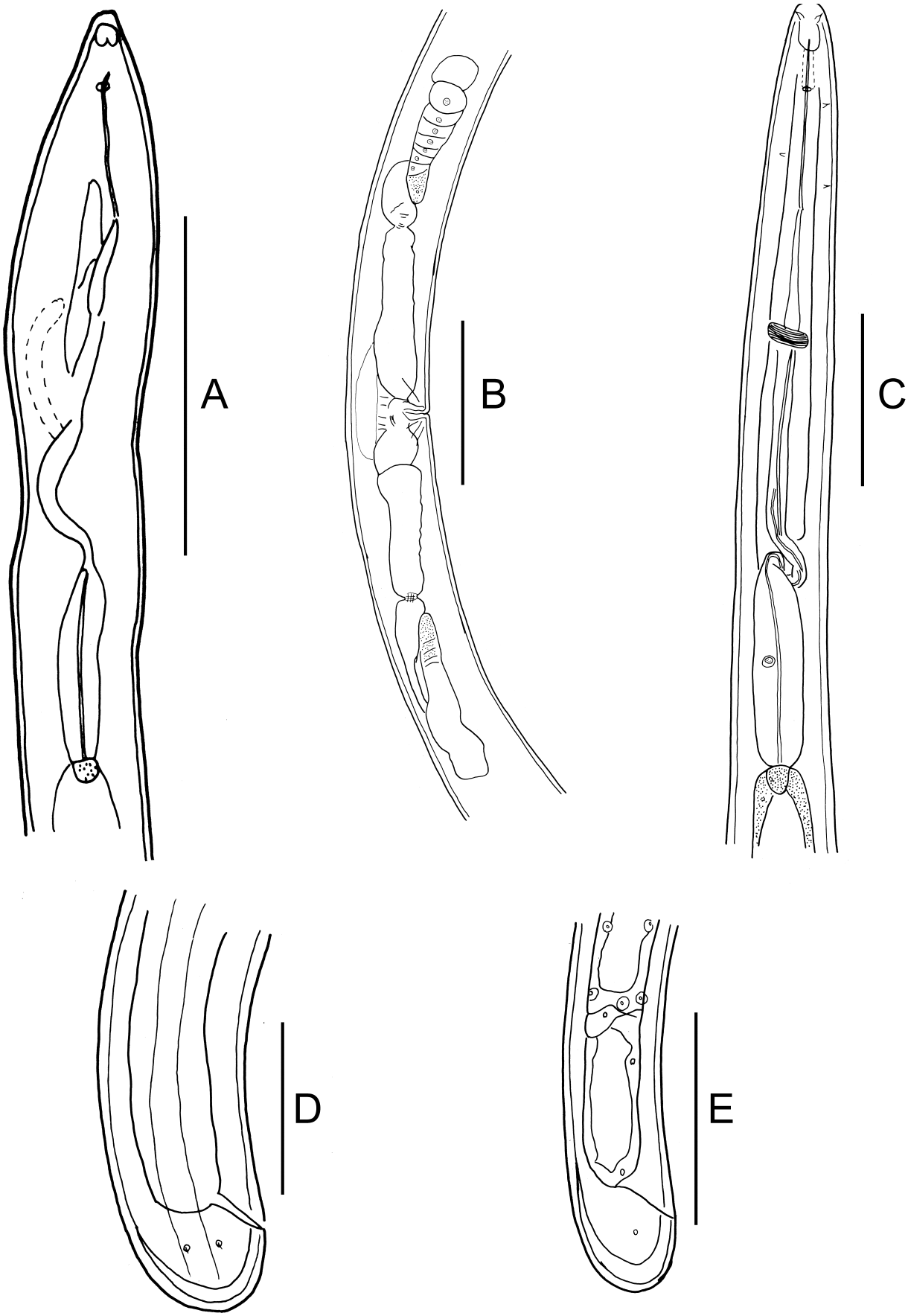


Fig. 17. Line drawings of *Longidorus waikouaitii* females and juveniles. A: Female anterior region; B: Female reproductive systems; C: J3/J4 anterior region; D: Female tail; E: J3/J4 tail. Scale bars: A=250 μm; B=200 μm; C–E=100 μm.

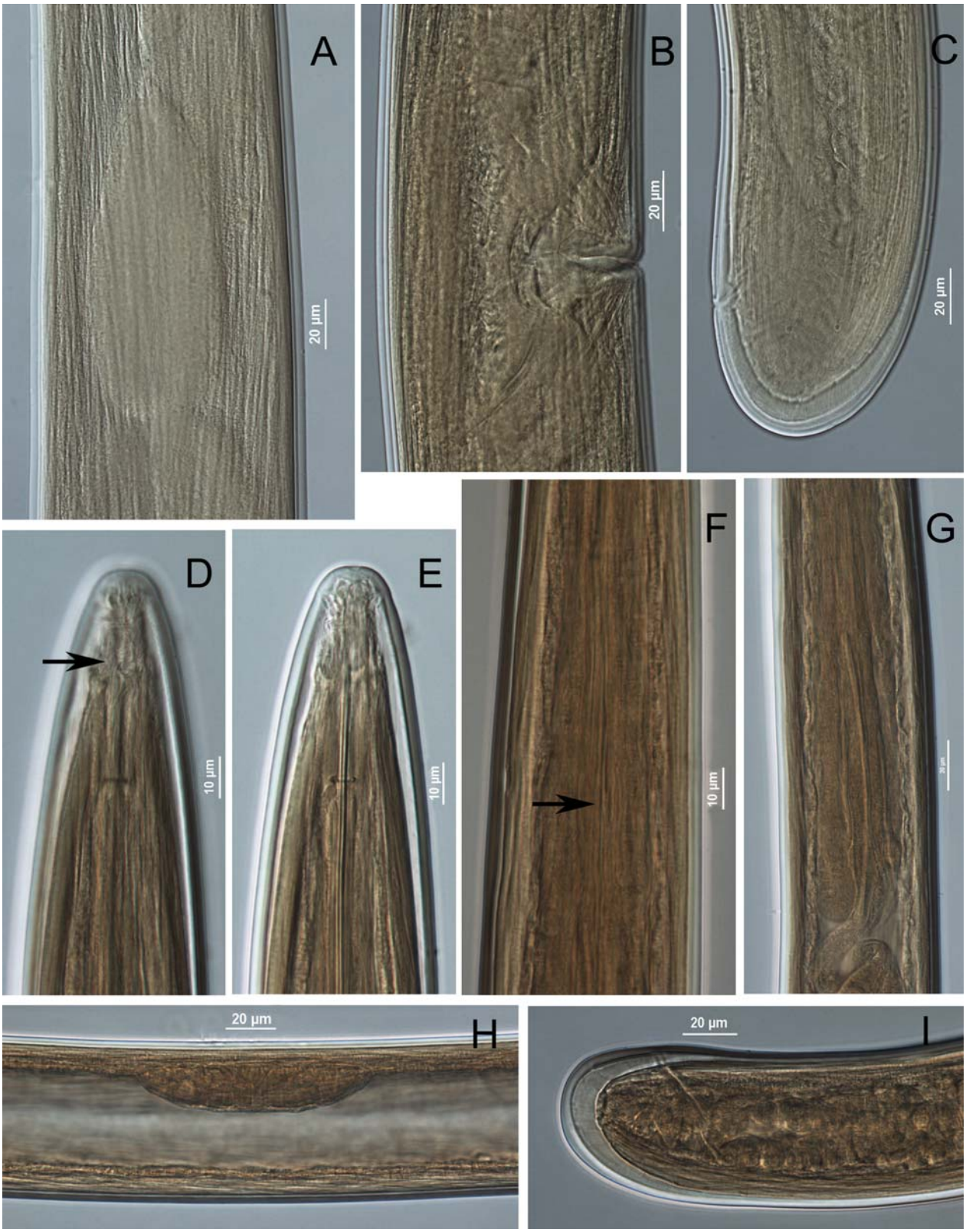


Fig. 18. Micrographs of *Longidorus waikouaitii* females and juveniles. Female: A–C. A: Pharyngeal bulb; B: Vulva; C: Tail; Juveniles: D–H. D: Amphid (arrow); E: Guide ring and odontostyle; F: Odontophore base (arrow); G: Replacement odontostyle; H: J3/J4 genital primordial; H: Tail.

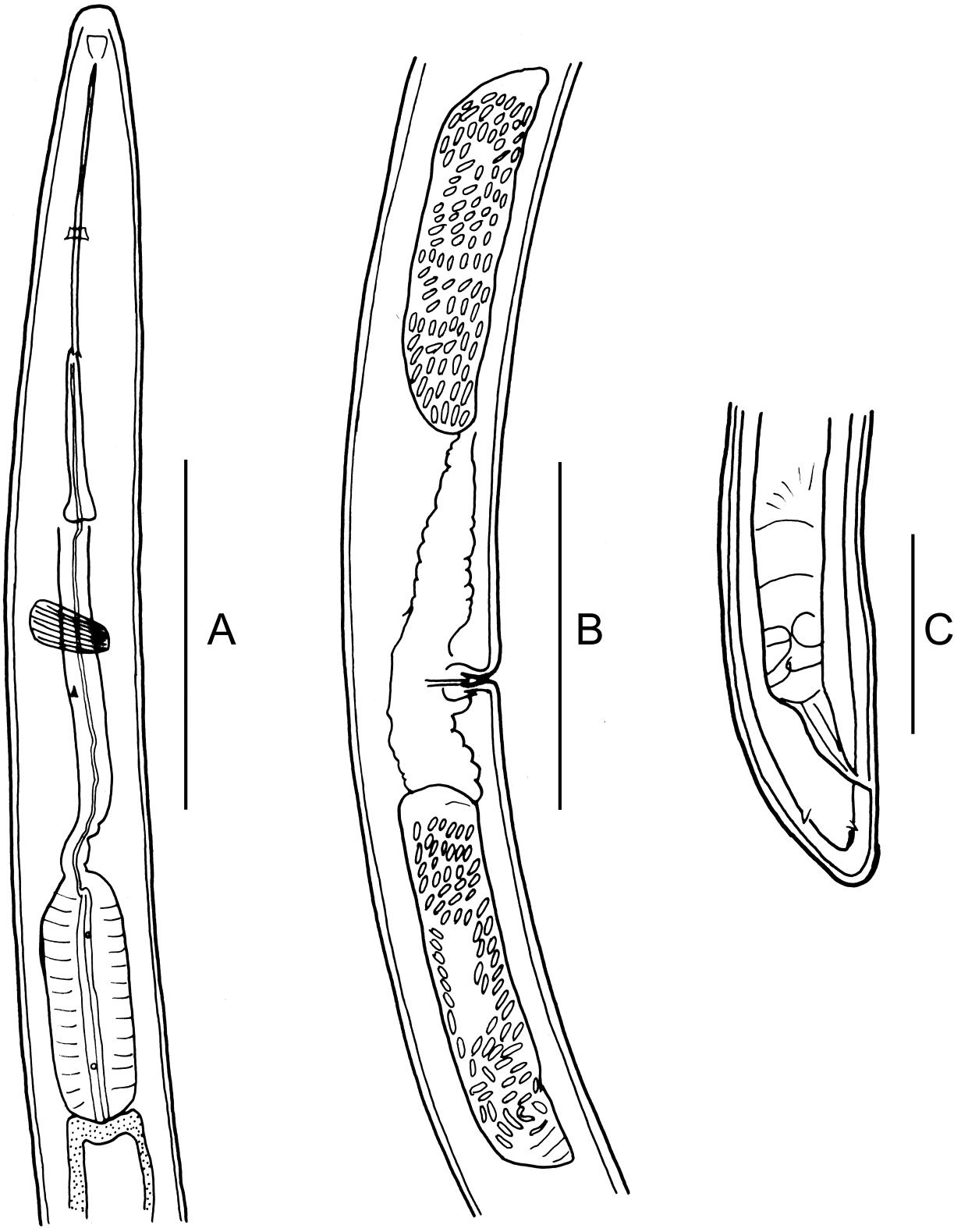


Fig. 19. Line drawings of *Xiphinema brevicolle* females. A: Anterior region; B: Reproductive systems; C: Tail. Scale bars: A, B=100 μm; C=50 μm.

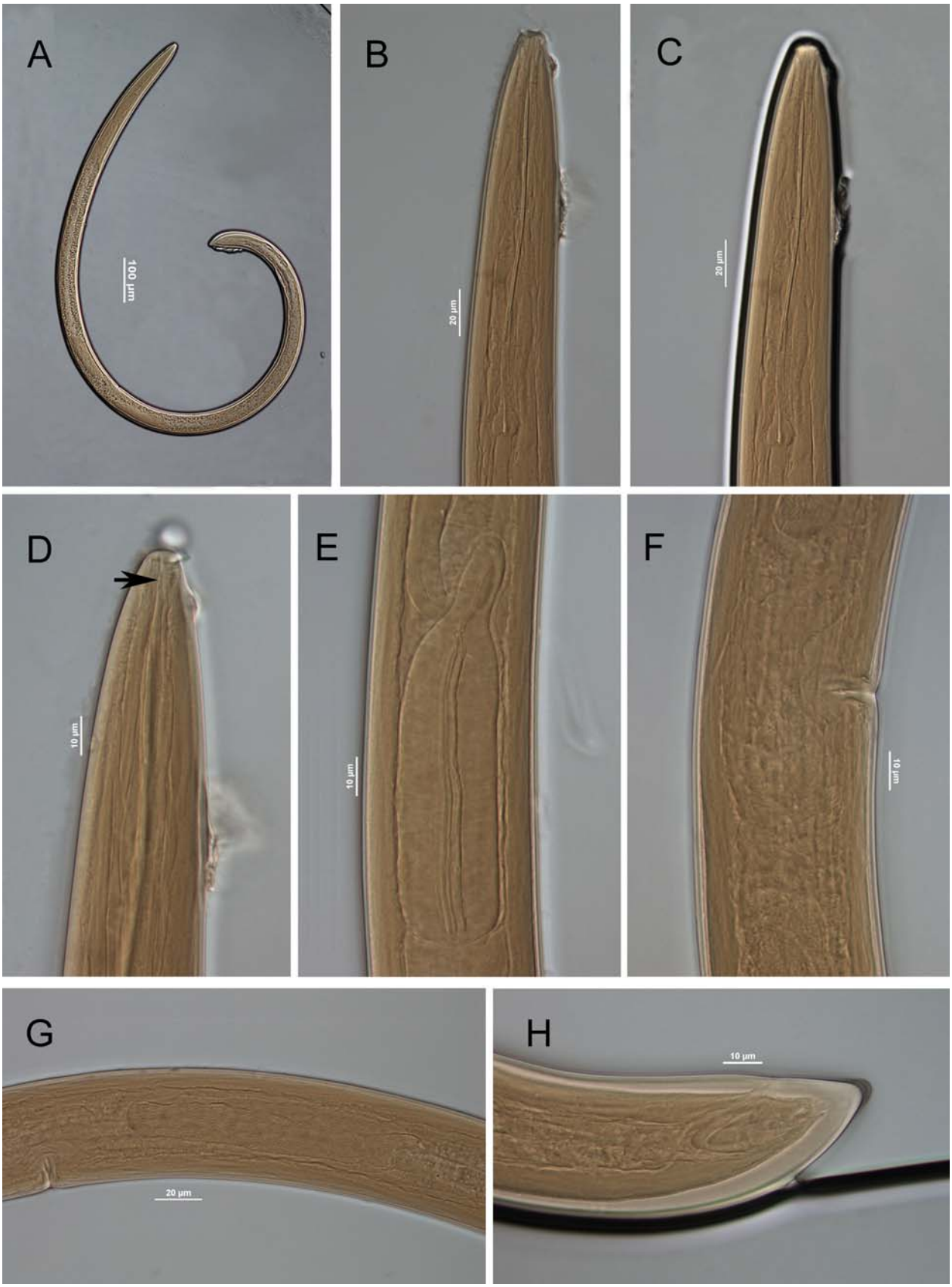


Fig. 20. Micrographs of *Xiphinema brevicolle* females. A: Whole body; B, C: Anterior region, showing odontophore, guide ring and flange; D: Amphid (arrow); E: Pharyngeal bulb; F: Vulval region; G: Anterior gonad; H: Tail.

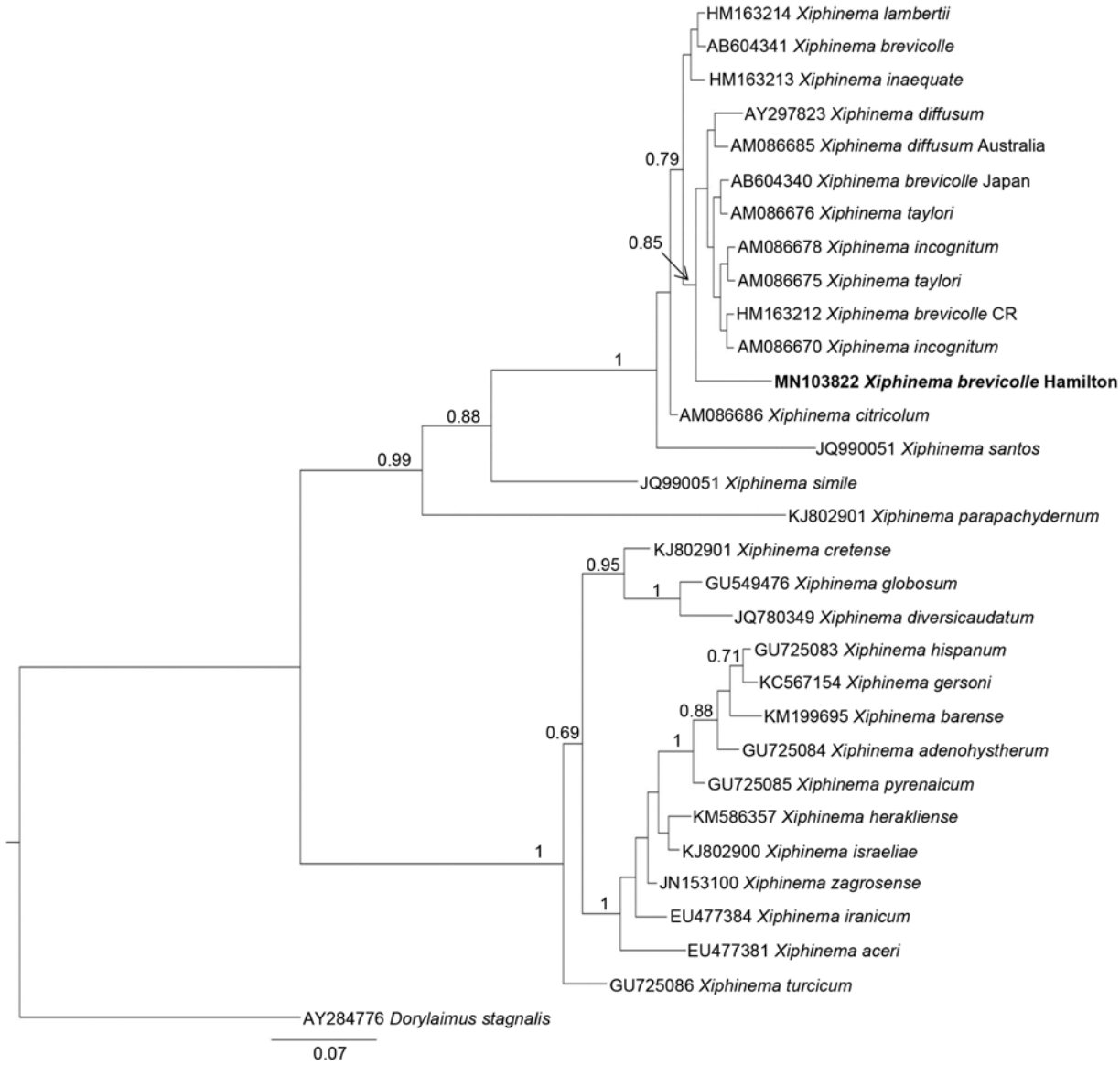


Fig. 21. Bayesian consensus tree of *Xiphinema brevicolle* inferred from SSU sequences under TrN + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

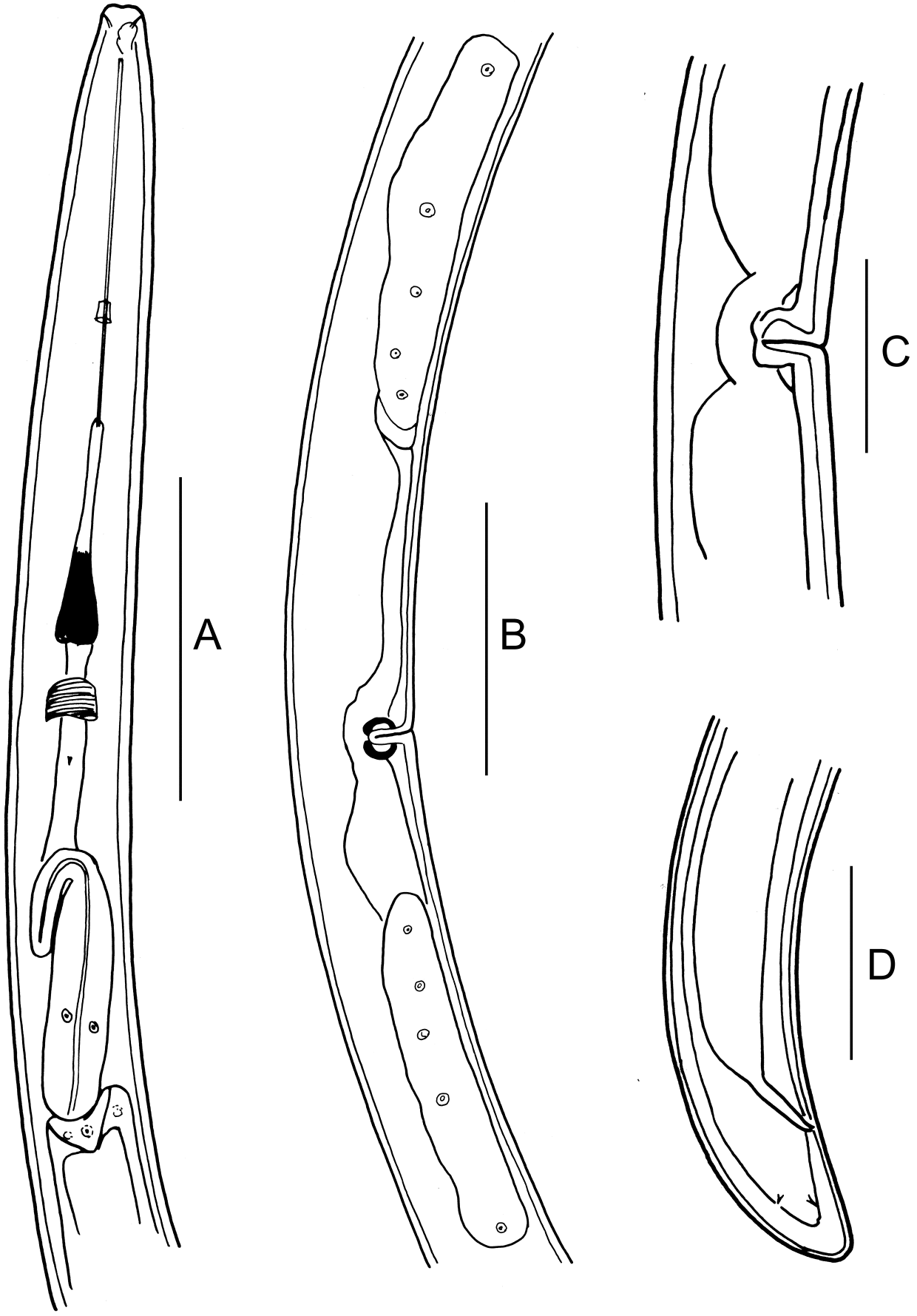


Fig. 22. Line drawings of *Xiphinema waimungui* females. A: Anterior region; B: Reproductive systems; C: Vulval region; D: Tail. Scale bars: A, B=100 µm; C, D=50 µm.

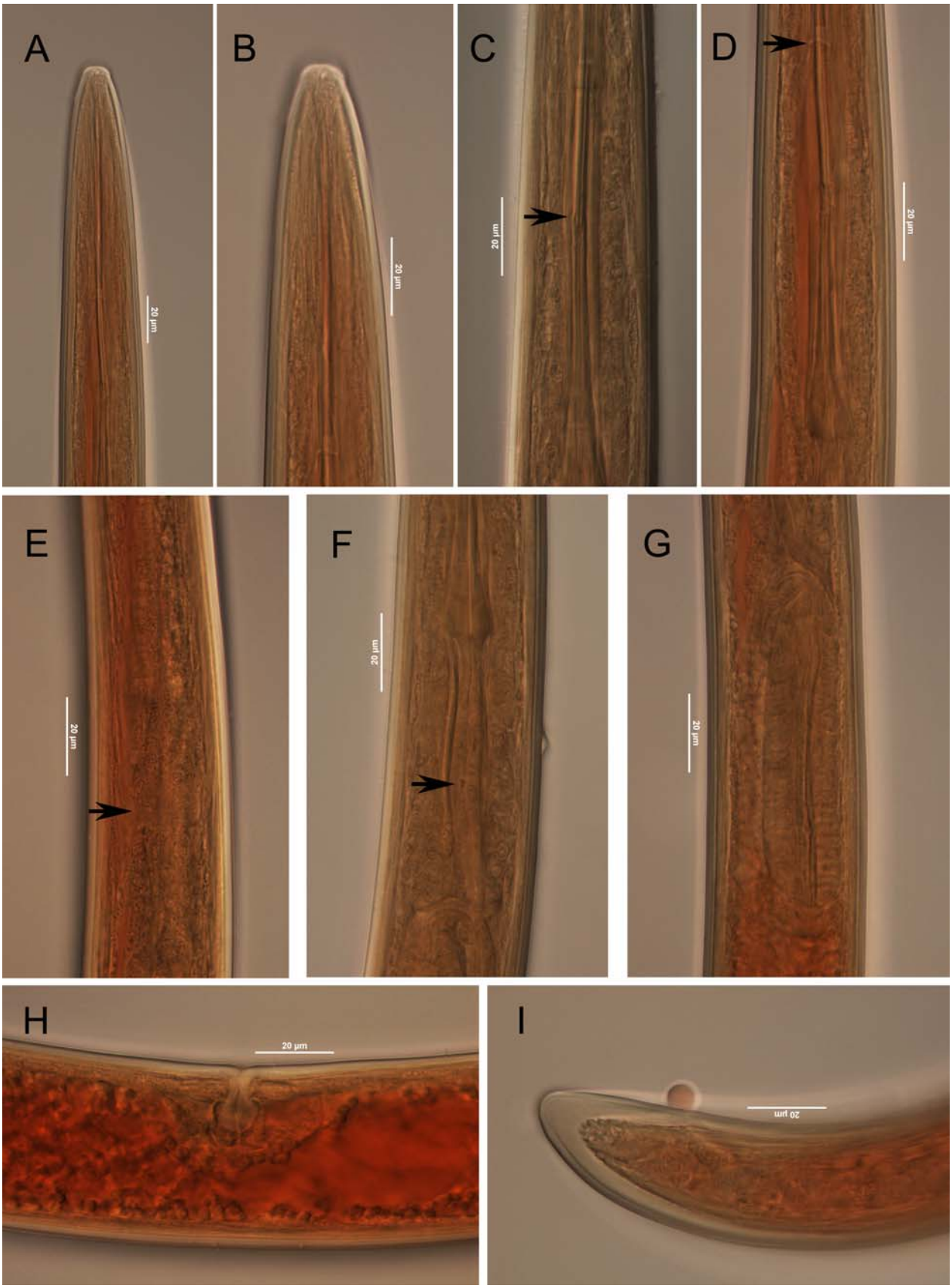


Fig. 23. Micrographs of *Xiphinema waimungui* females. A, B: Anterior region and amphid; C: Forked odontostyle base (arrow); D: Guide ring (arrow) and flange; E: Nerve ring (arrow); F: Mucro (arrow); G: Pharyngeal bulb; H: Vulva; I: Tail.

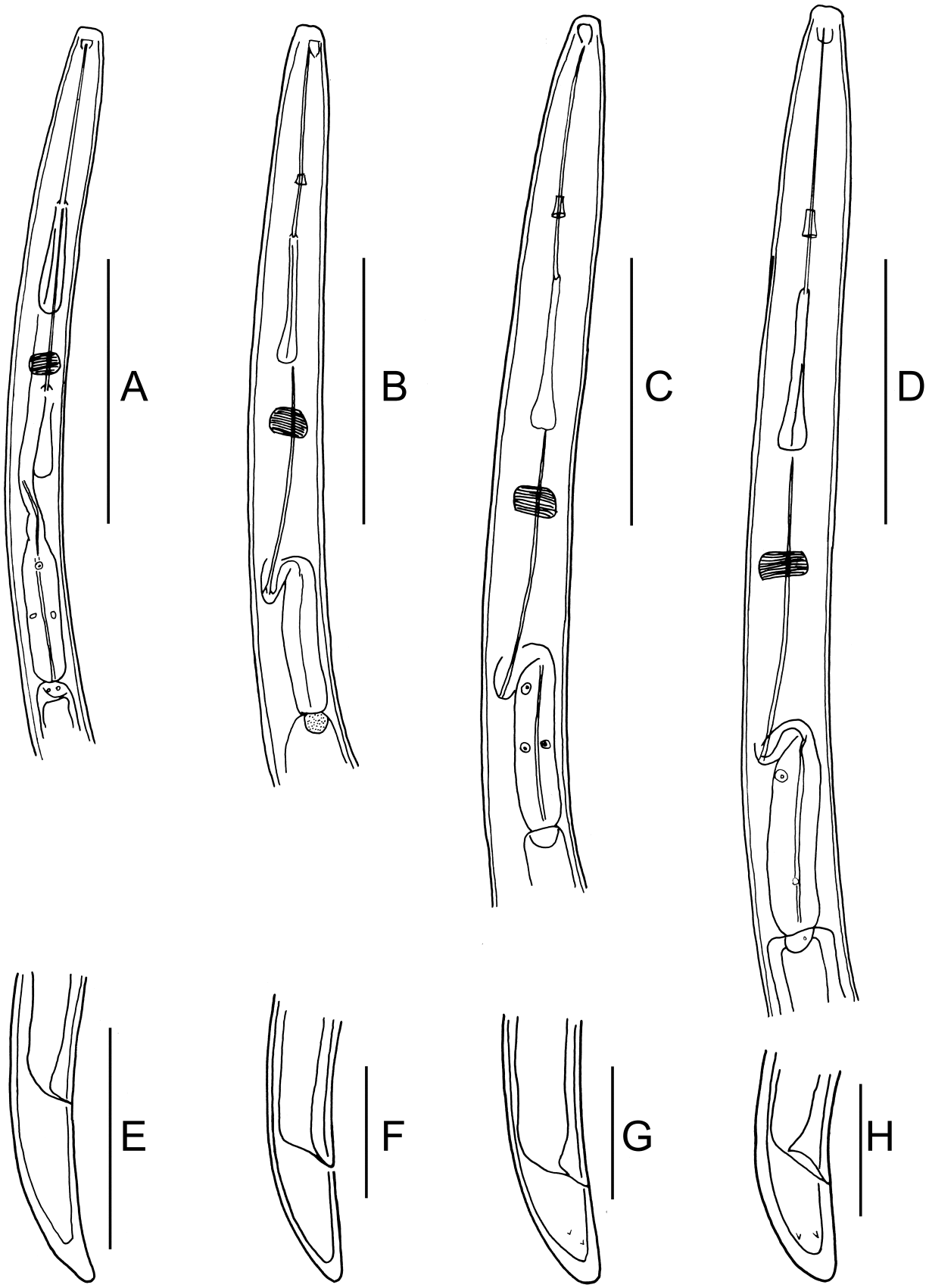


Fig. 24. Line drawings of *Xiphinema waimungui* juveniles. A–D: J1–J4 anterior region, respectively; E–H: J1–J4 tail, respectively. Scale bars: A–D=100 µm; E–H=50 µm.

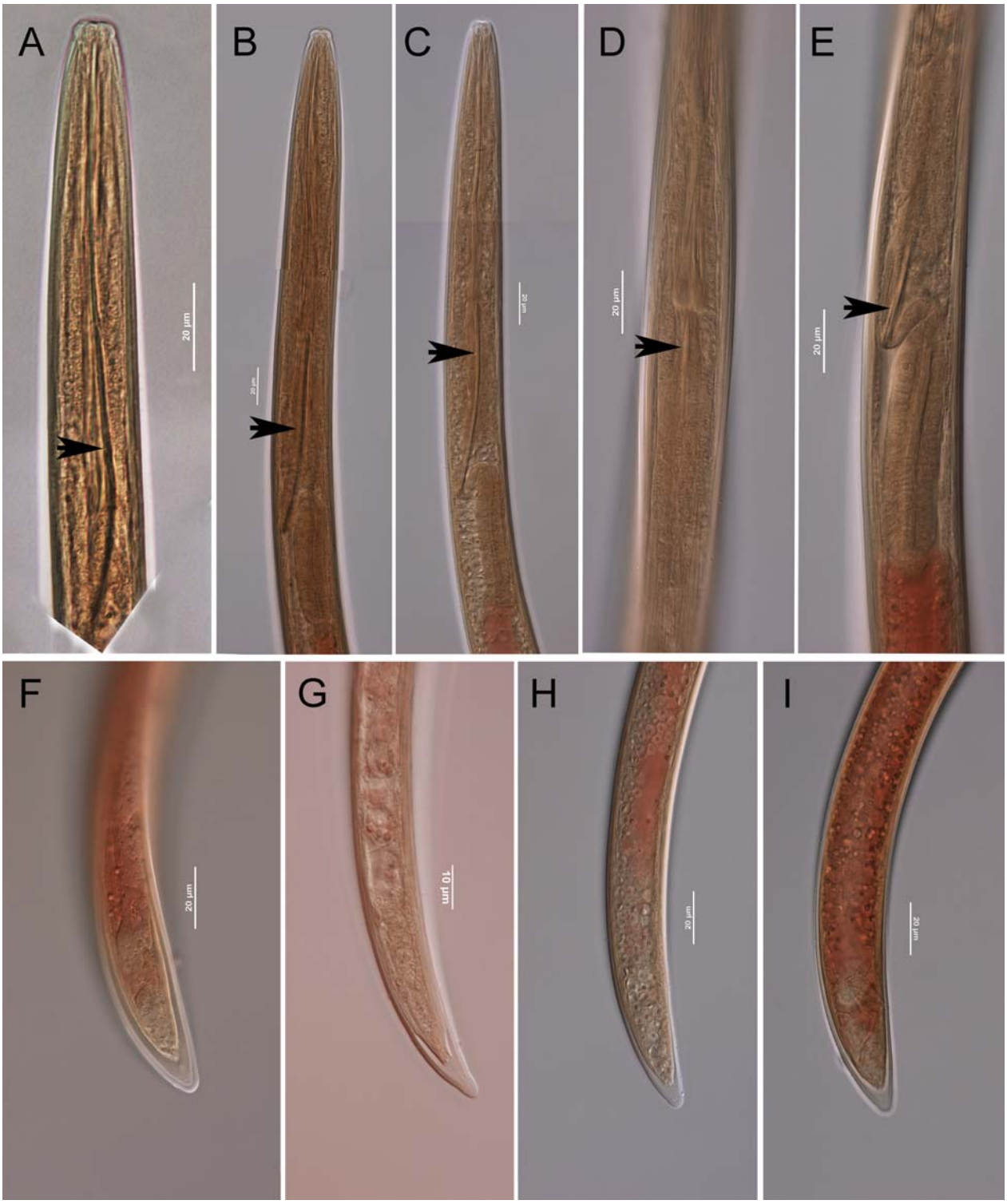


Fig. 25. Micrographs of *Xiphinema waimungui* juveniles. A–C: J1–J3 anterior region, replacement odontostyle (arrow); D, E: J4 anterior region, replacement odontostyle (arrow); F–I: J1–J4 tail..

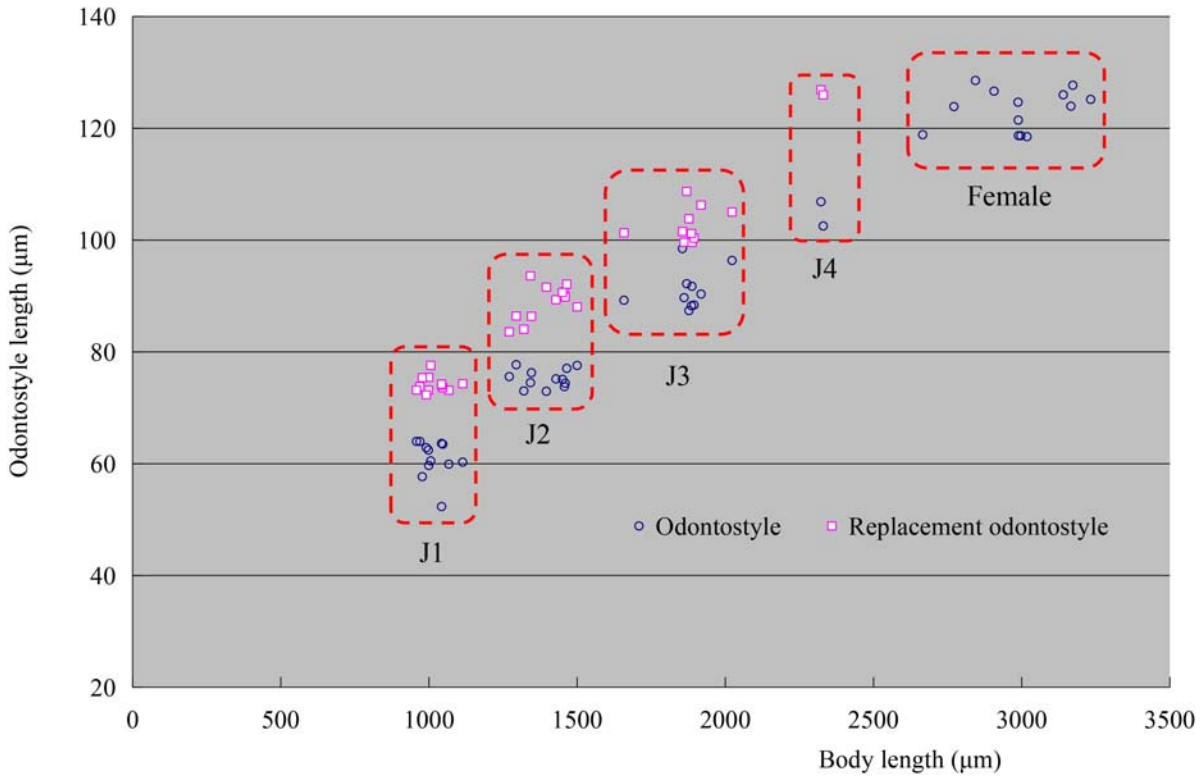


Fig. 26. Scatter plot of odontostyle length and replacement odontostyle length against body length of *Xiphinema waimungui* juveniles and females.

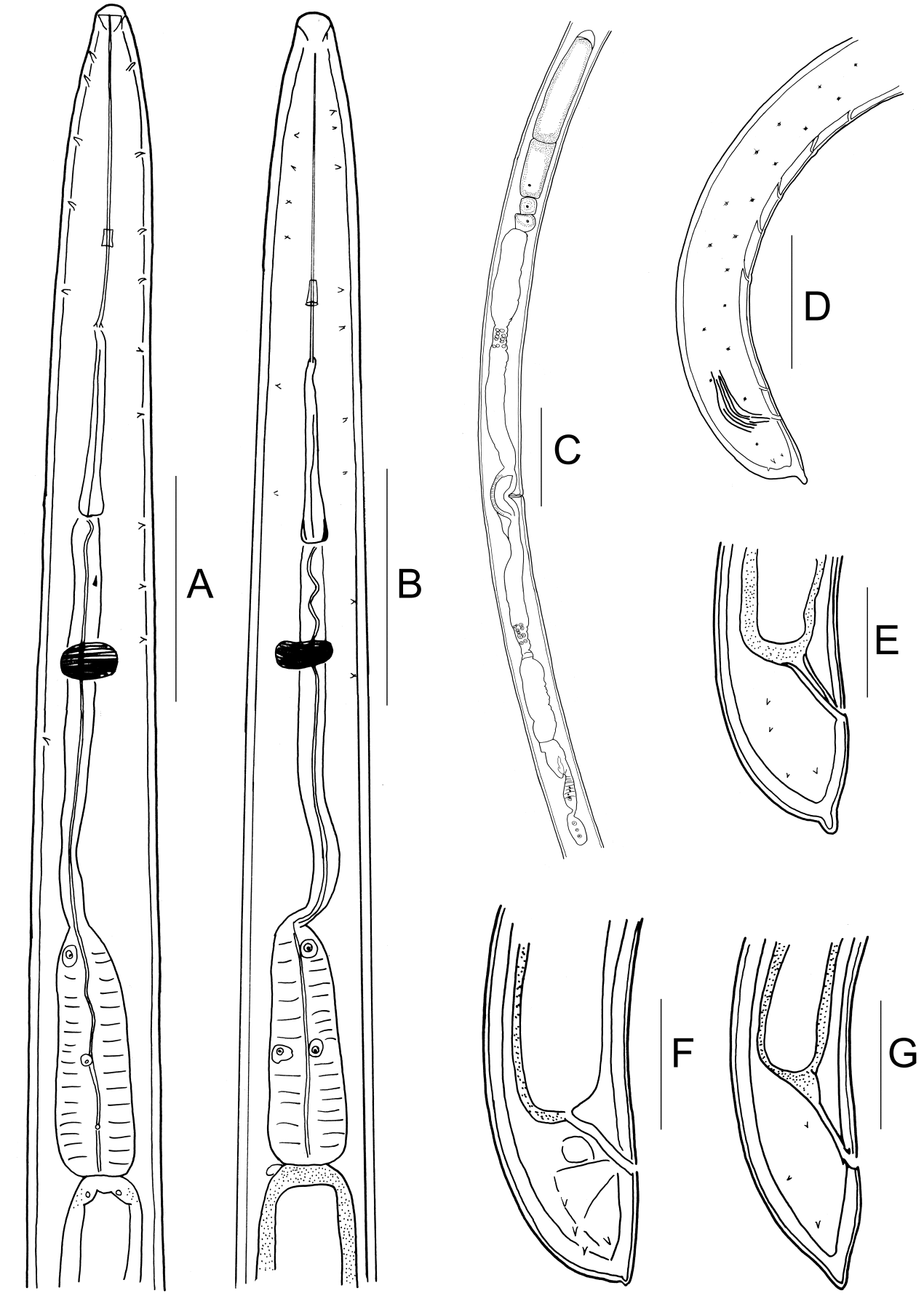


Fig. 27. Line drawings of *Xiphinema diversicaudatum*. A: Female anterior region; B: Male anterior region; C: Female reproductive systems; D: Male tail; E–G: Female tail shape. Scale bars: A, B, D=100 μm; C=200 μm; E, F, G=50 μm.

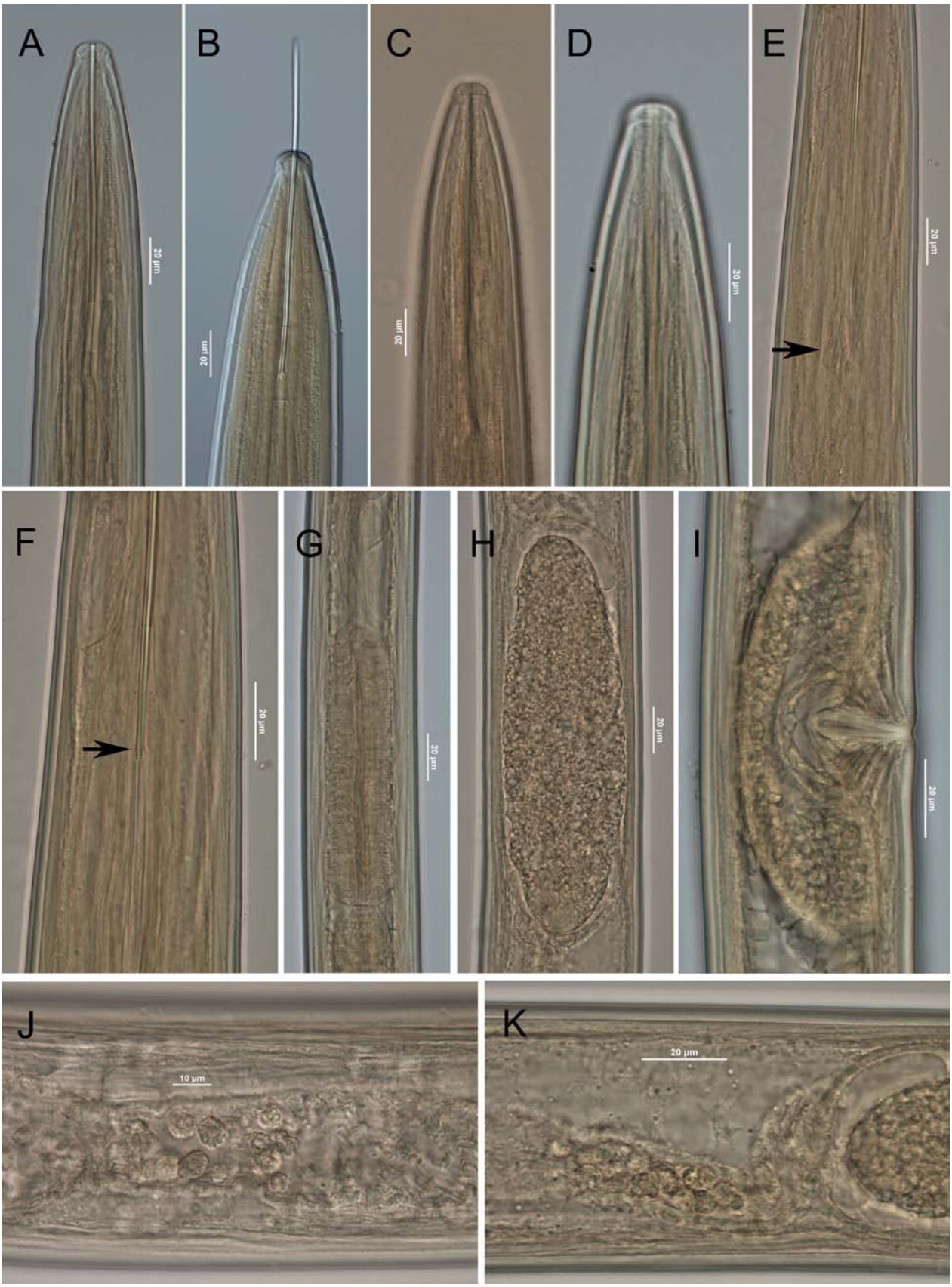


Fig. 28. Micrographs of *Xiphinema diversicaudatum* females. A, B: Anterior region; C, D: Lip region; E: Flange (arrow); F: Forked odontostyle base (arrow); G: Pharyngeal bulb; H: Egg; I: Vulva; J, K: Pseudo-Z organ.

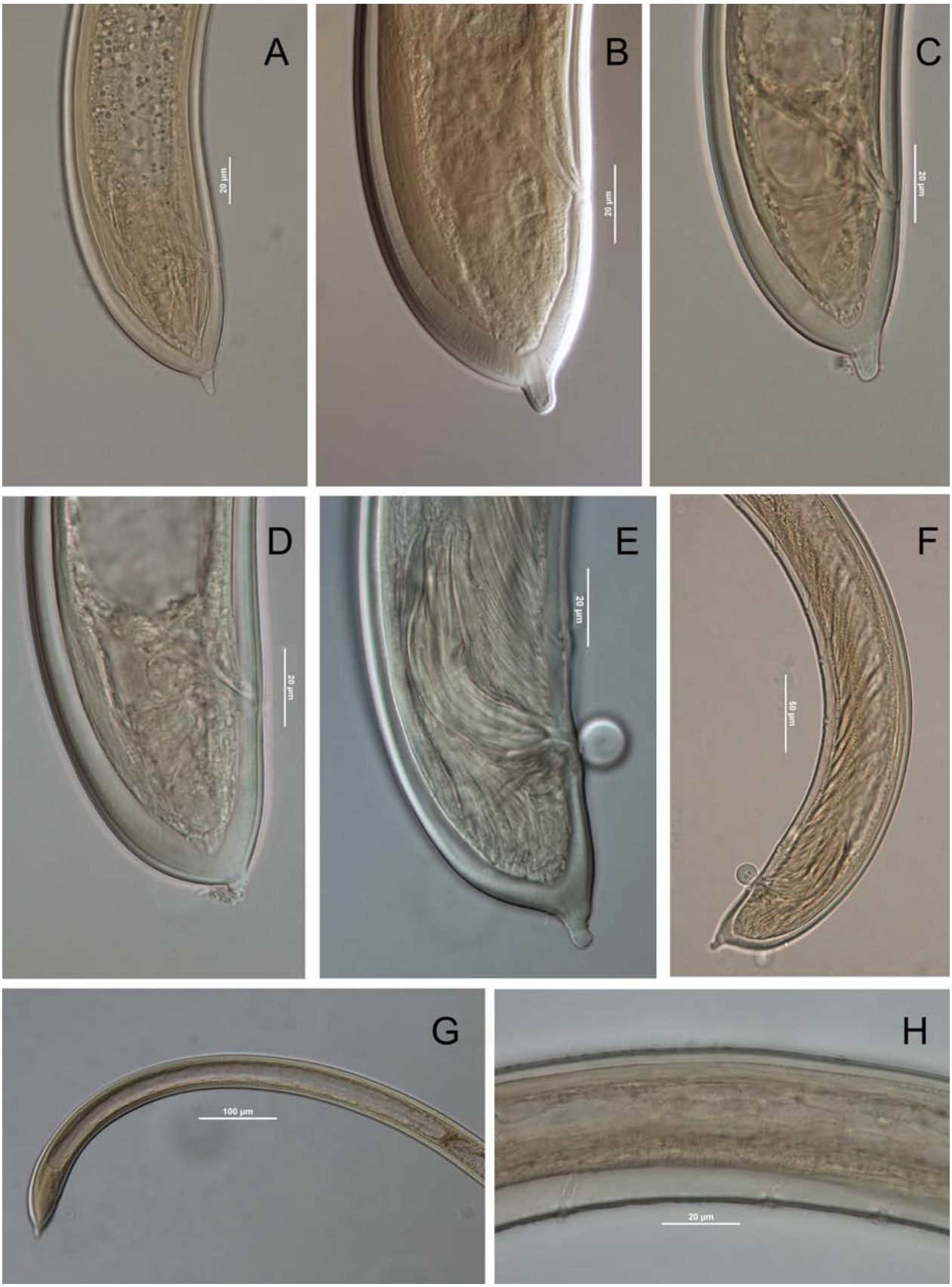


Fig. 29. Micrographs of *Xiphinema diversicaudatum* females and males. A–D: Female tail shape; E–F: Male tail; G: Female prerectum; H: Male supplementary papillae.

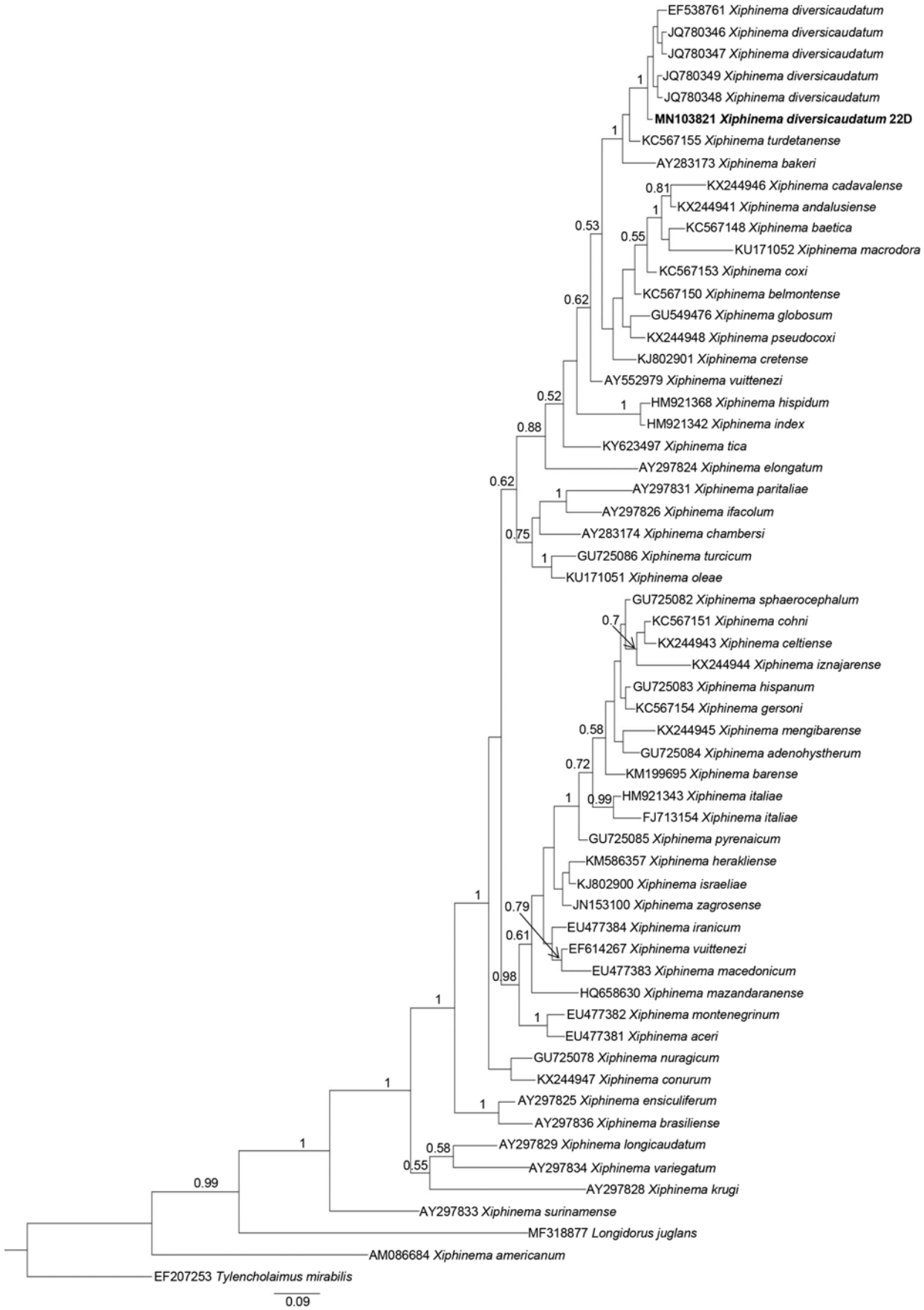


Fig. 30. Bayesian consensus tree of *Xiphinema diversicaudatum* inferred from SSU sequences under TrN + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

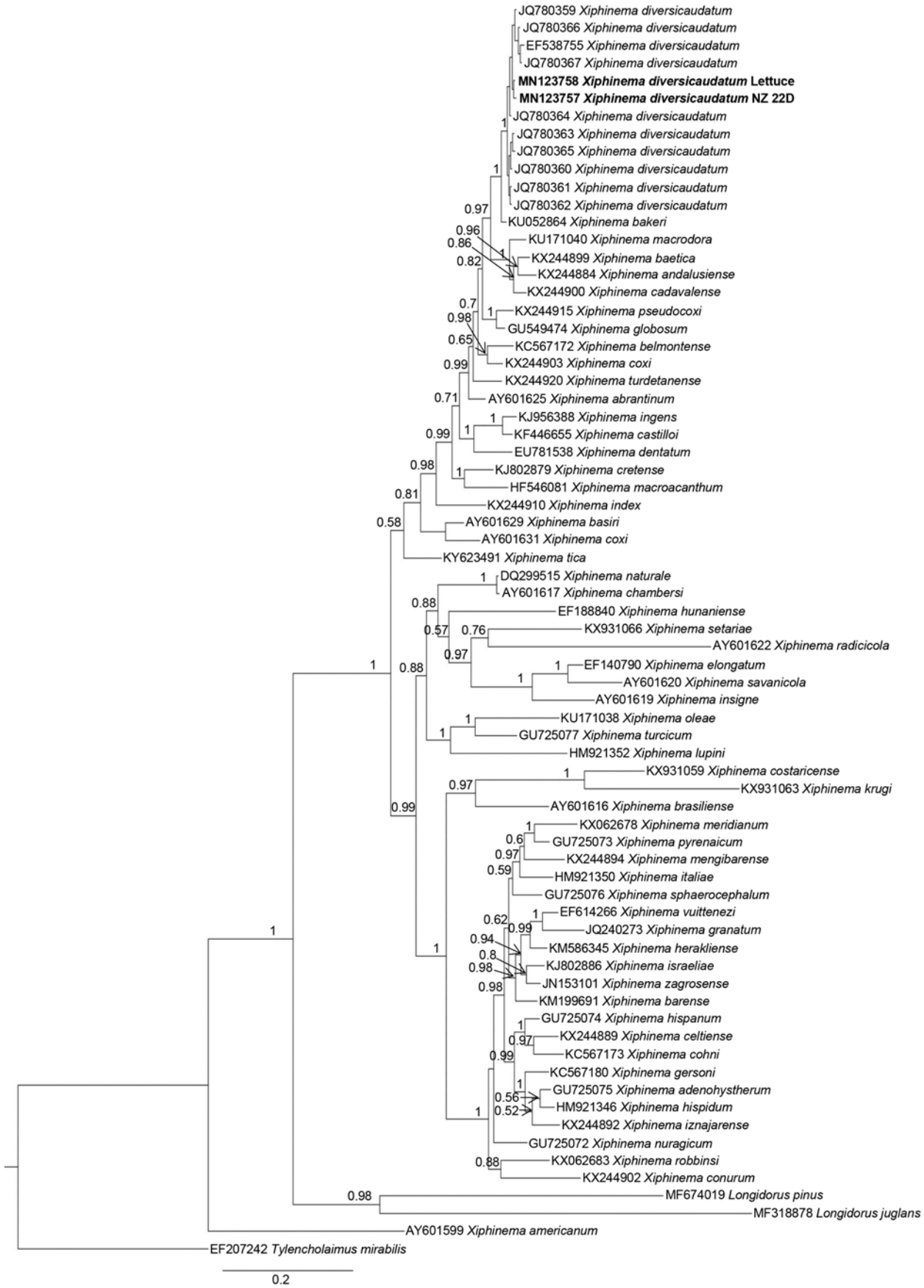


Fig. 31. Bayesian consensus tree of *Xiphinema diversicaudatum* inferred from D2-D3 of LSU sequences under TrN + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

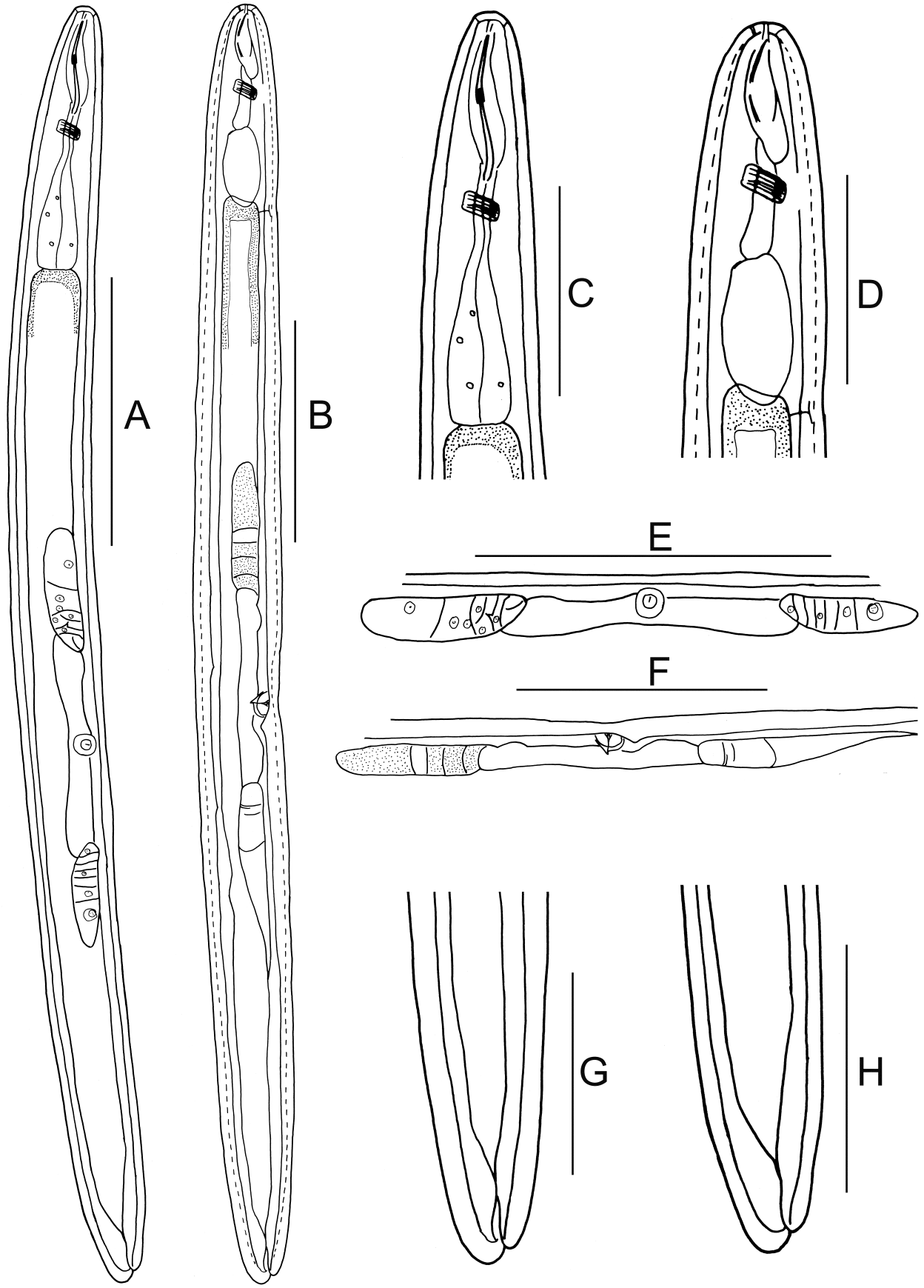


Fig. 32. Line drawings of *Nanidorus minor* female. A, B: Whole body; C: Anterior region; D: Anterior region, showing excretory pore; E, F: Reproductive system; G–H: Tail. Scale bars: A, B, E, F=100 µm; C, D, G, H=50 µm.

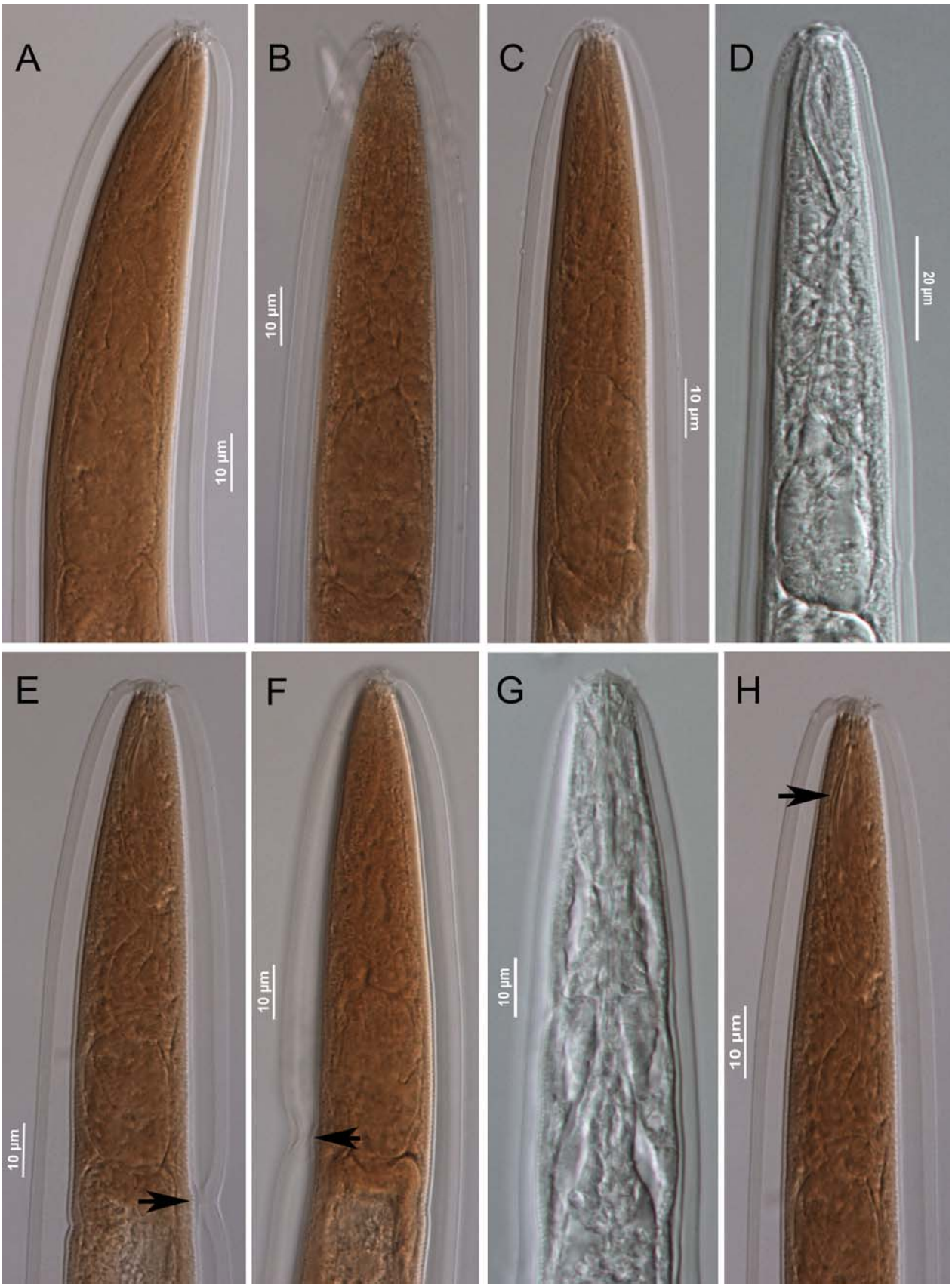


Fig. 33. Micrographs of *Nanidorus minor* females anterior region. A–D: Anterior region shape; E–F: Excretory pore (arrow); G: Amphid opening, ventral view; H: Onchiostyle (arrow).

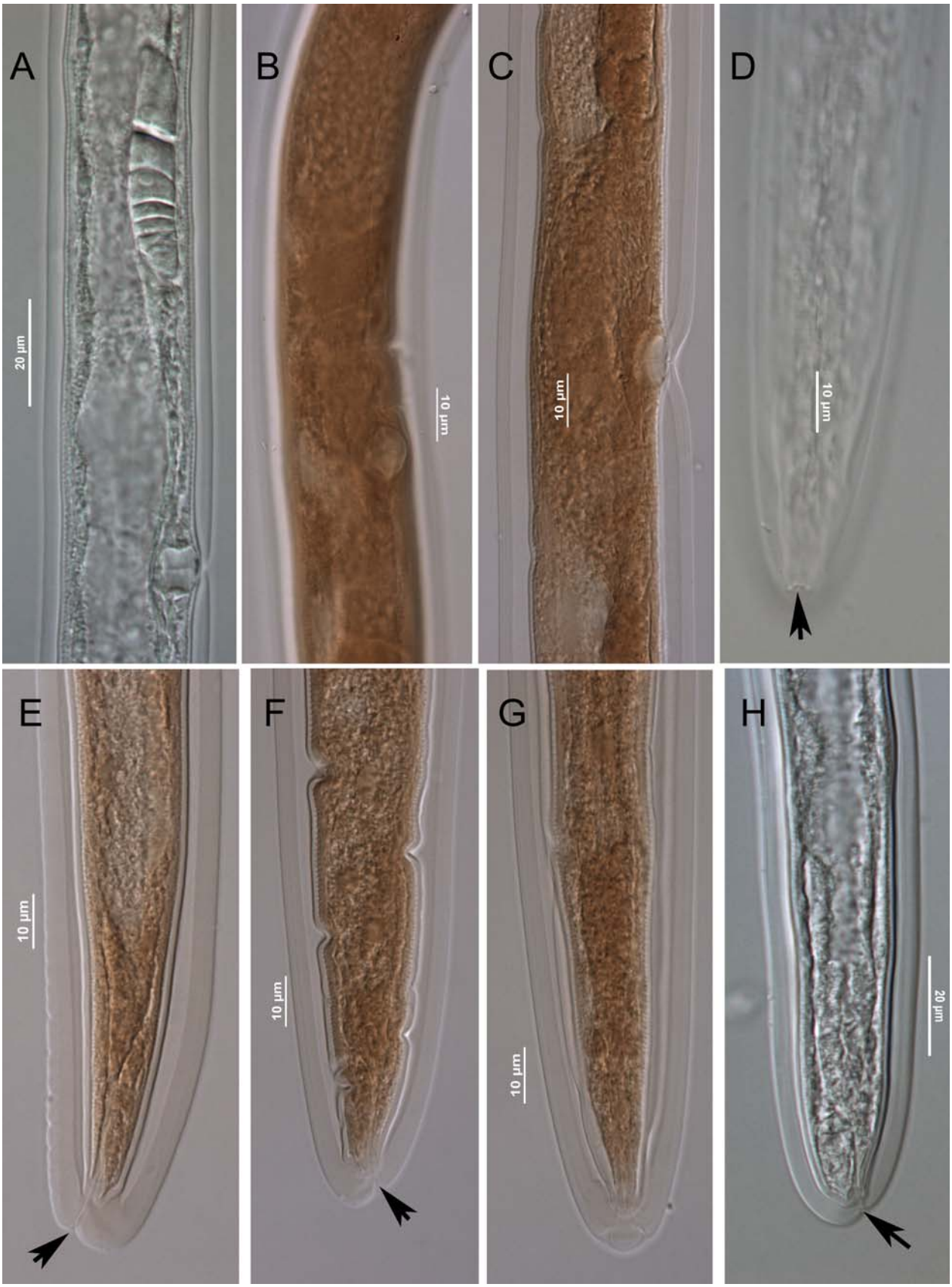


Fig. 34. Micrographs of *Nanidorus minor* female posterior region. A: Anterior gonad; B: Vulval region, ventral view; C: Vulval region, lateral view; D: Pinpoint at end of the tail (arrow); E–H: Various tail shape, anus (arrow).

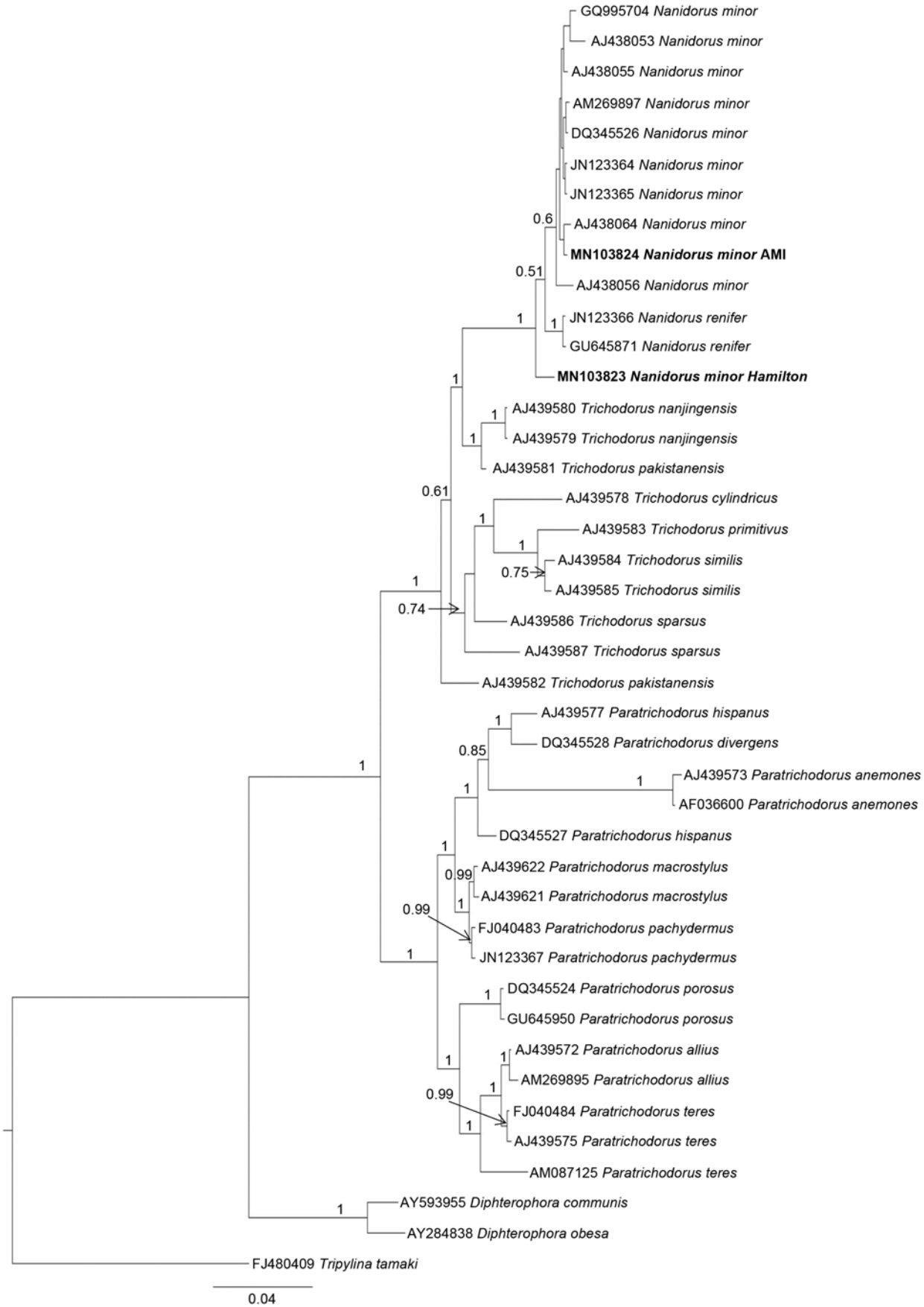


Fig. 35. Bayesian consensus tree of *Nanidorus minor* inferred from SSU sequences under TrN + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold. Sequences AJ438059 and AJ438060 seem to be more related to the genus *Nanidorus* (Kumari & Subbotin 2012; Ilieva-Makulec *et al.* 2017)

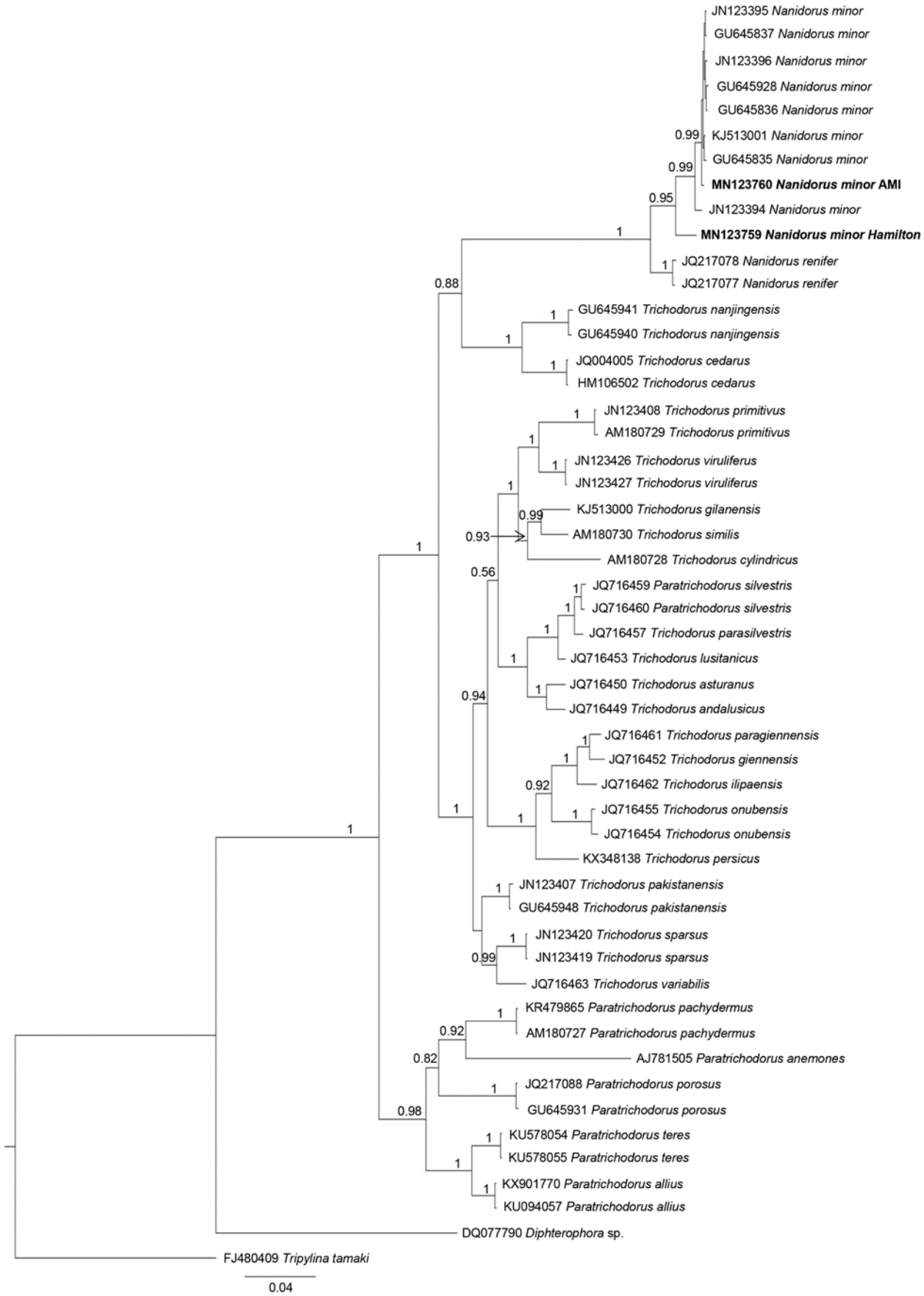


Fig. 36. Bayesian consensus tree of *Nanidorus minor* inferred from D2-D3 of LSU sequences under TrN + I + G model. Posterior probability values exceeding 50% are given on appropriate clades. Newly obtained sequences in this study are in bold.

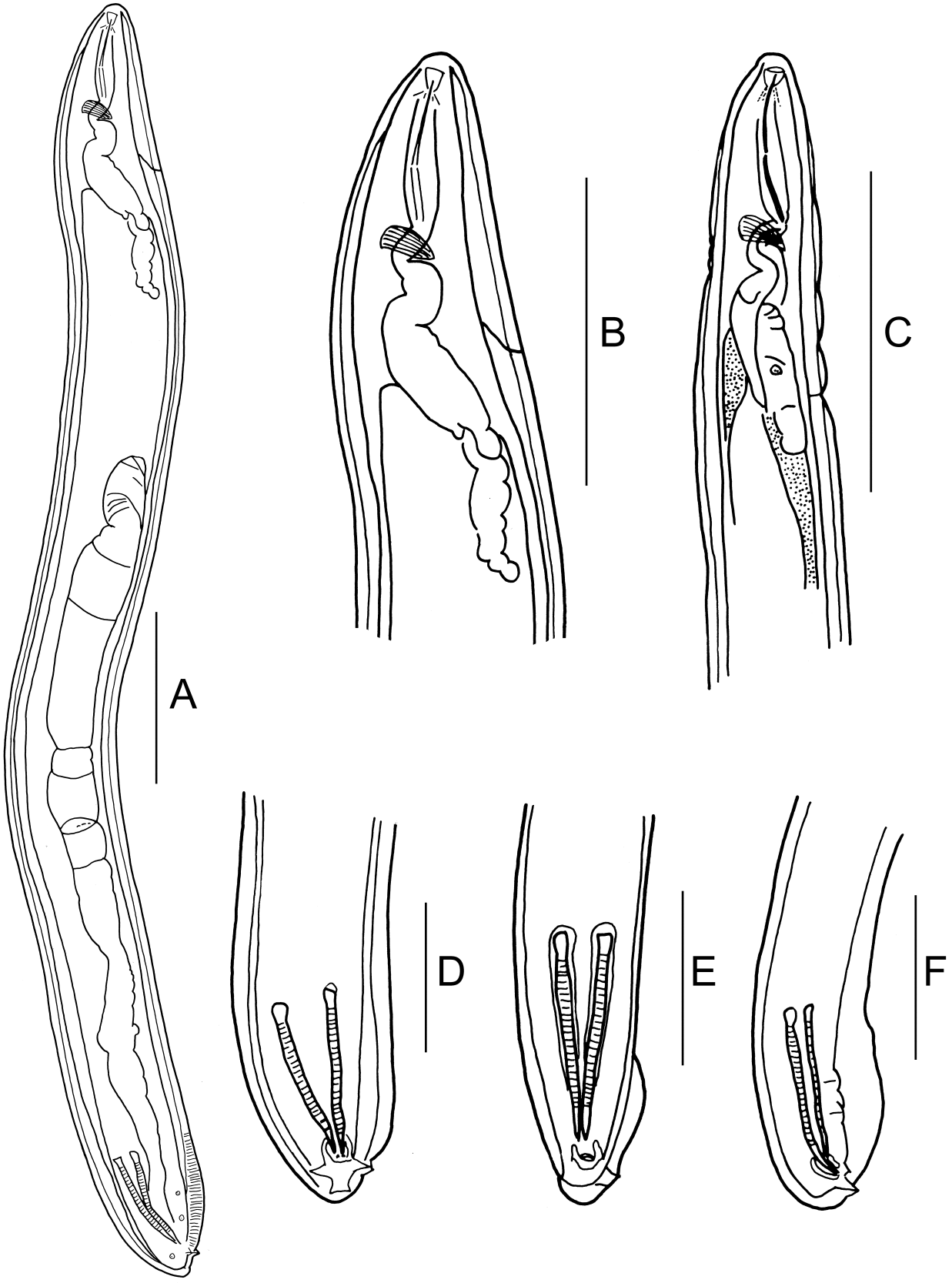


Fig. 37. Line drawings of *Paratrichodorus lobatus* males. A: Whole body; B, C: Anterior region; D–F: Tail shapes. Scale bars: A–C=100 μm; D–F=50 μm.

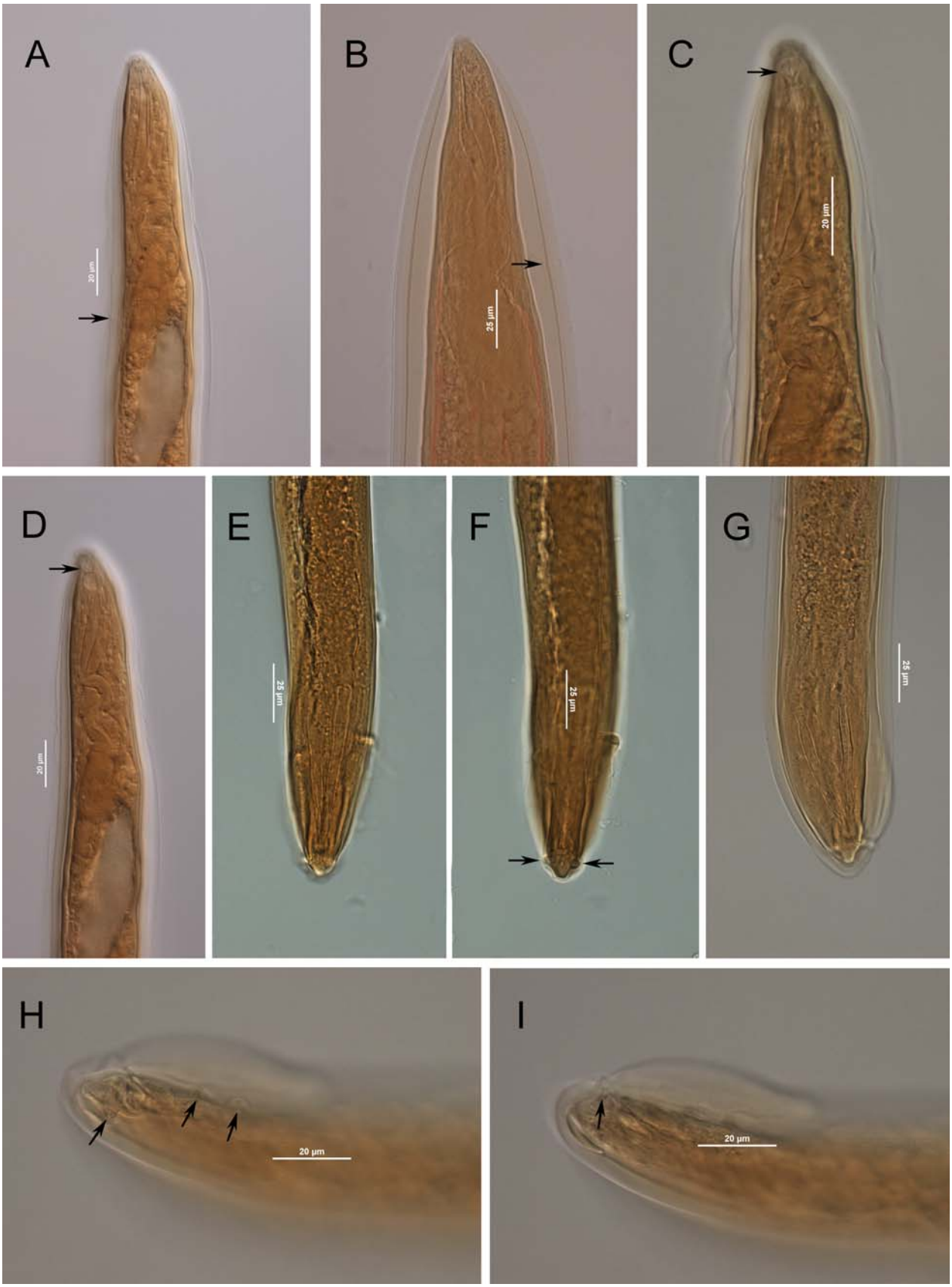


Fig. 38. Micrographs of *Paratrichodorus lobatus* males. A, B: Anterior region, excretory pore (arrow); C, D: Anterior region, amphid (arrow); E: Tail and spicules, ventral view; F: Spicules, ventral view, caudal papillae posterior to the cloaca (arrows); G: Spicules, ventrolateral view; H: Bursa, two precloacal supplementary papillae and one caudal papillae posterior to cloaca (arrows); I: Bursa and caudal papillae (arrow).

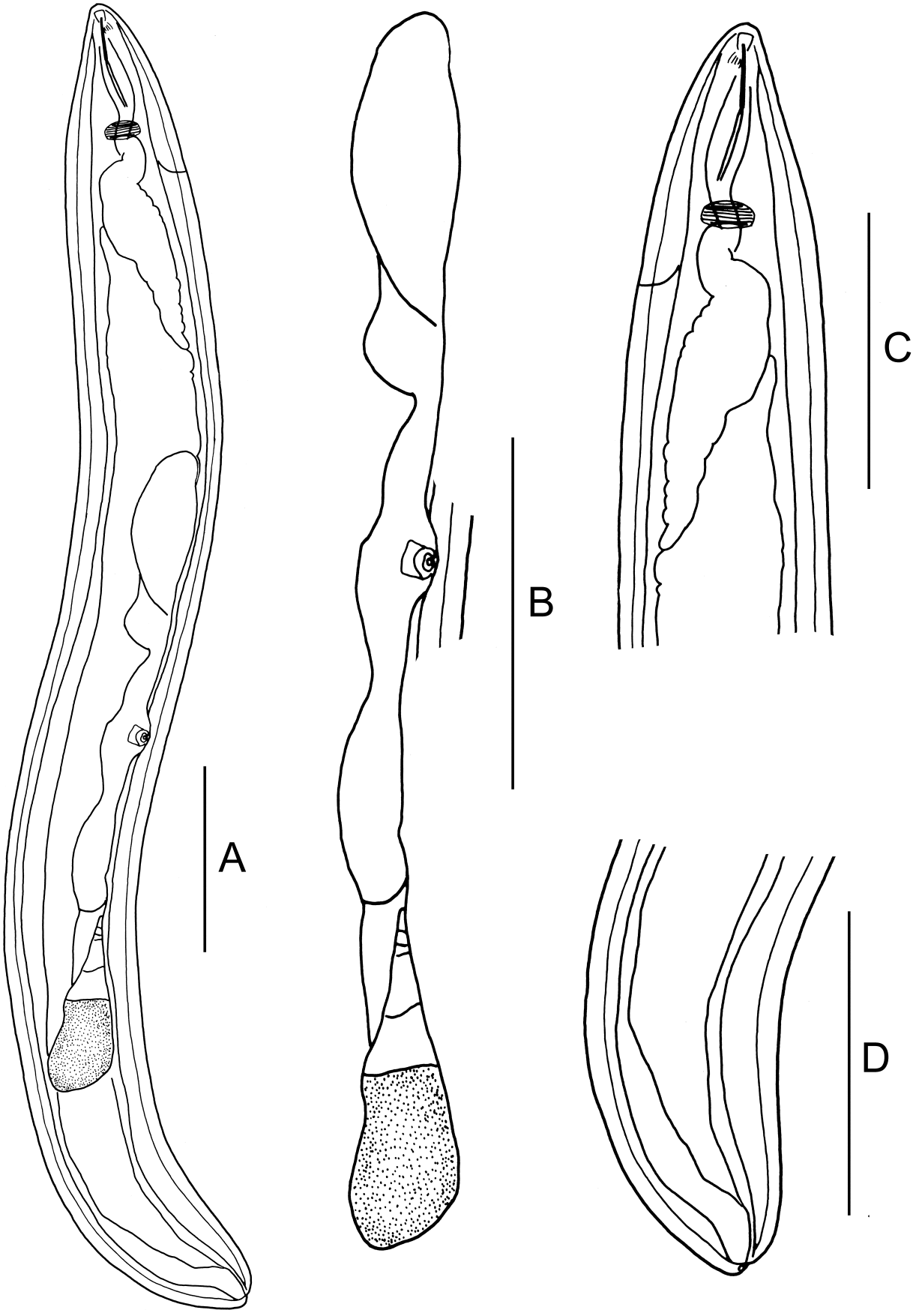


Fig. 39. Line drawings of *Paratrichodorus lobatus* females. A: Whole body; B: Reproductive systems; C: Anterior region; D: Tail. Scale bars: A–D=100 μm.

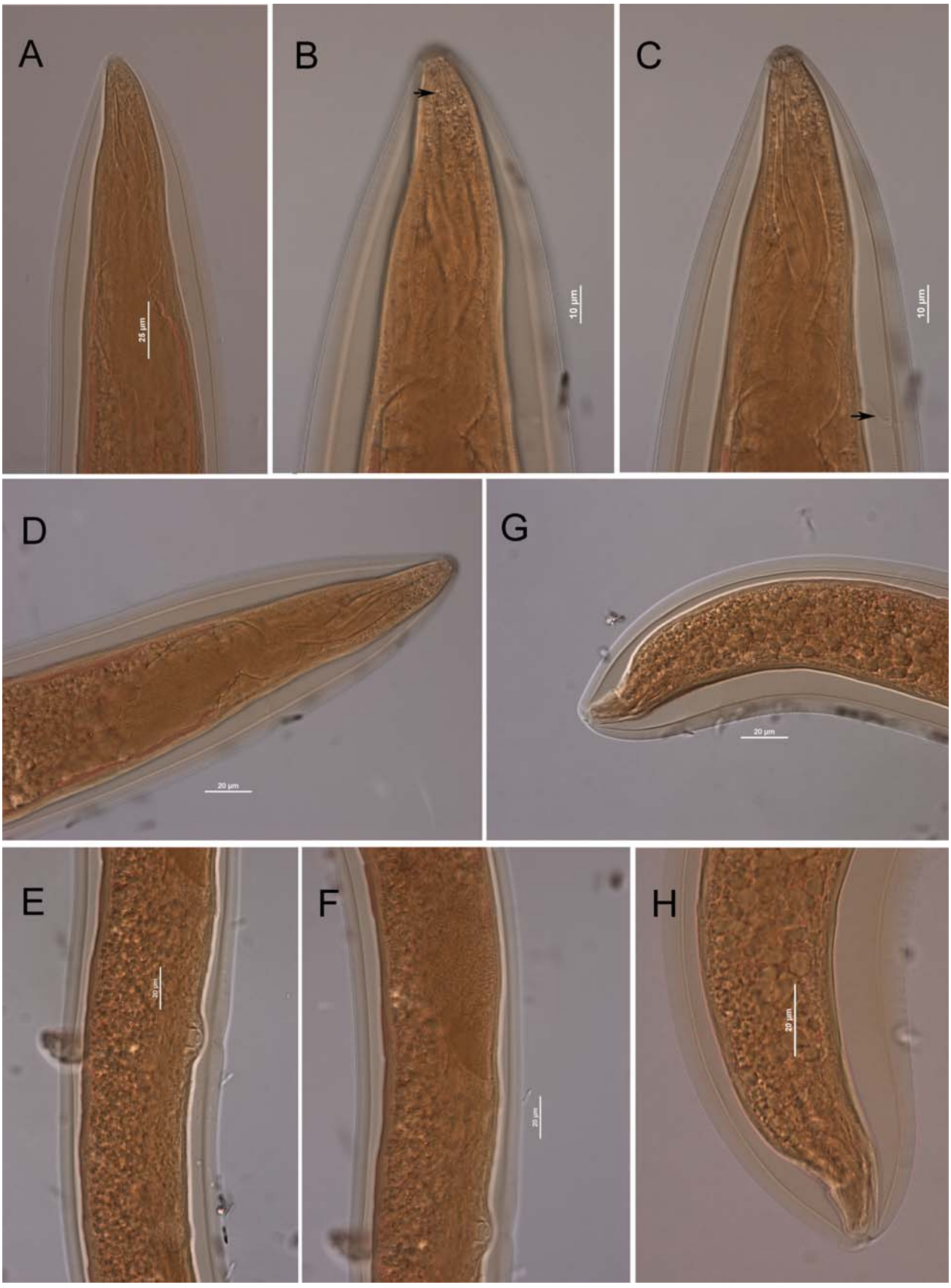


Fig. 40. Micrographs of *Paratrichodorus lobatus* females. A: Anterior region; B: Amphid (arrow); C: Onchiostyle and excretory pore (arrow); D: Pharynx overlapped intestine ventrally; E: Vulval region; F: Anterior gonad tract; G, H: Tail shape.

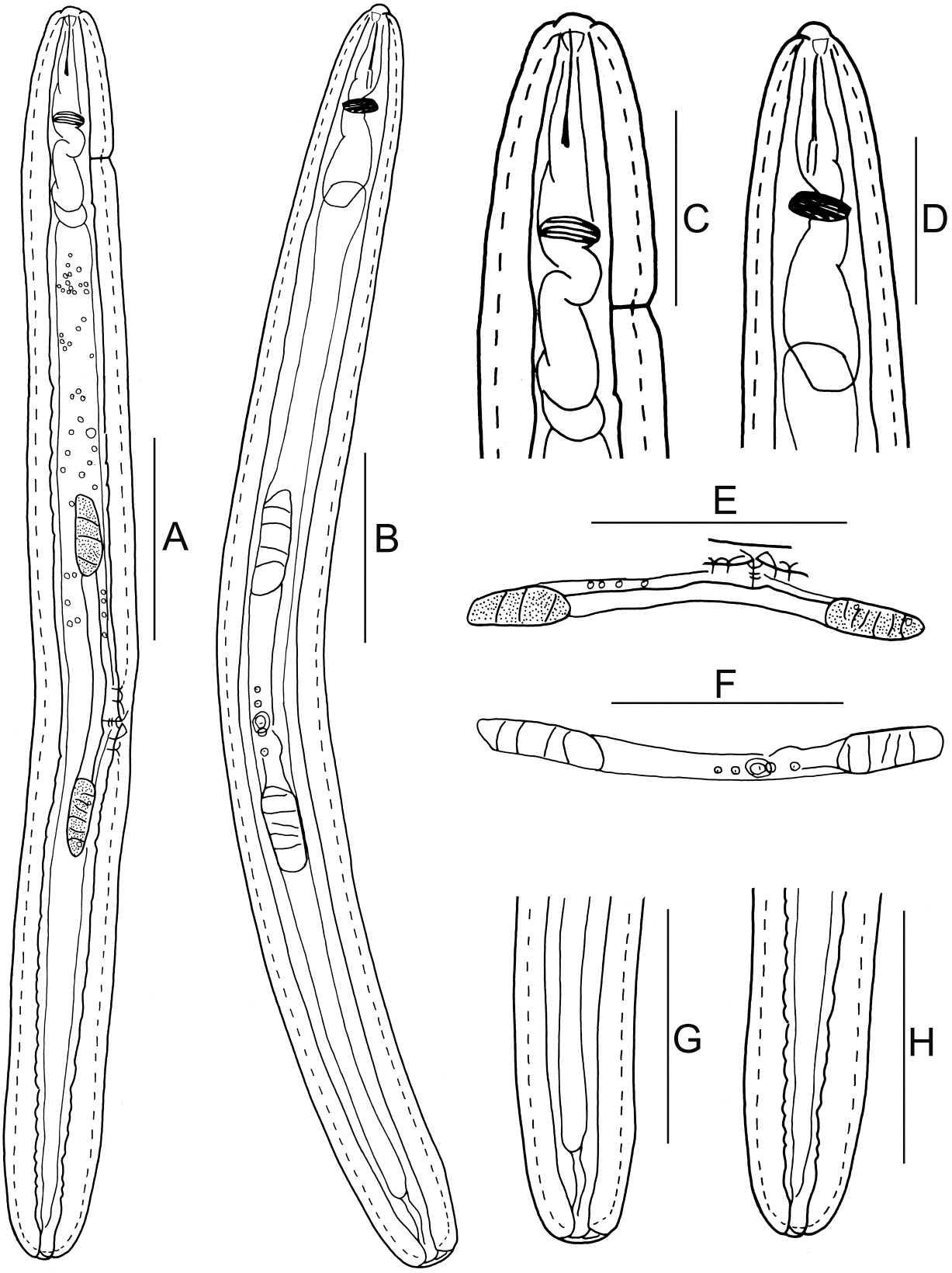


Fig. 41. Line drawings of *Paratrichodorus porosus* females. A: Whole body, lateral view; B: Whole body, ventral view; C, D: Anterior region, lateral view, showing amphid, excretory pore and onchiostyle; E: Reproductive system, lateral view, showing four advulval body pores; F: Reproductive system, ventral view, showing four advulval body pores; G–H: Tail shapes. Scale bars: A, B, E–H=100 μm; C, D=50 μm.

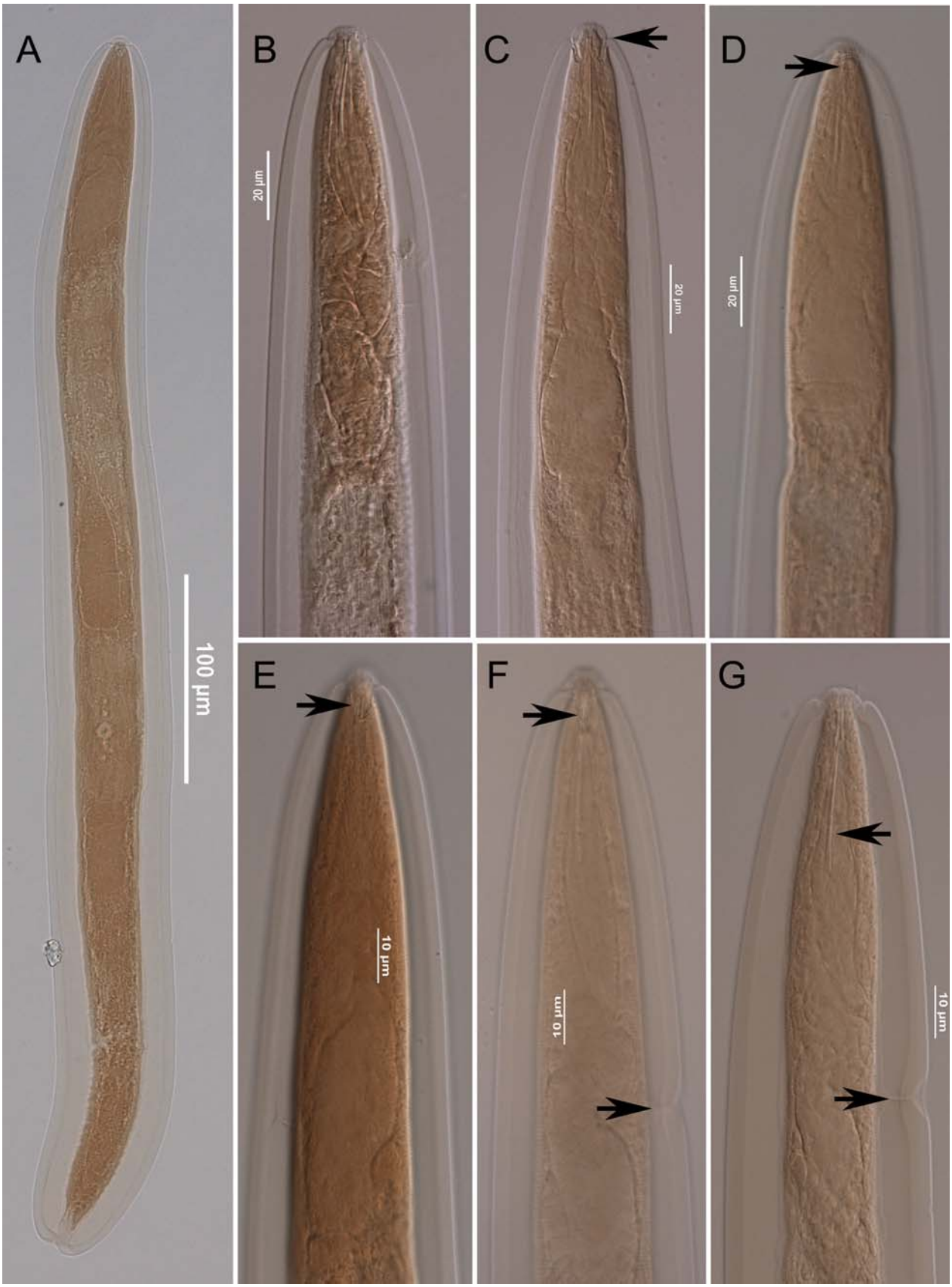


Fig. 42. Micrographs of *Paratrichodorus porosus* females. A: Whole body; B: Anterior region, lateral view; C: Anterior region, ventral view, showing amphid opening (arrow); D–E: Amphid (arrow), lateral view; F: Amphid (arrow) and excretory pore (arrow); G: Onchiostyle (arrow) and excretory pore (arrow).

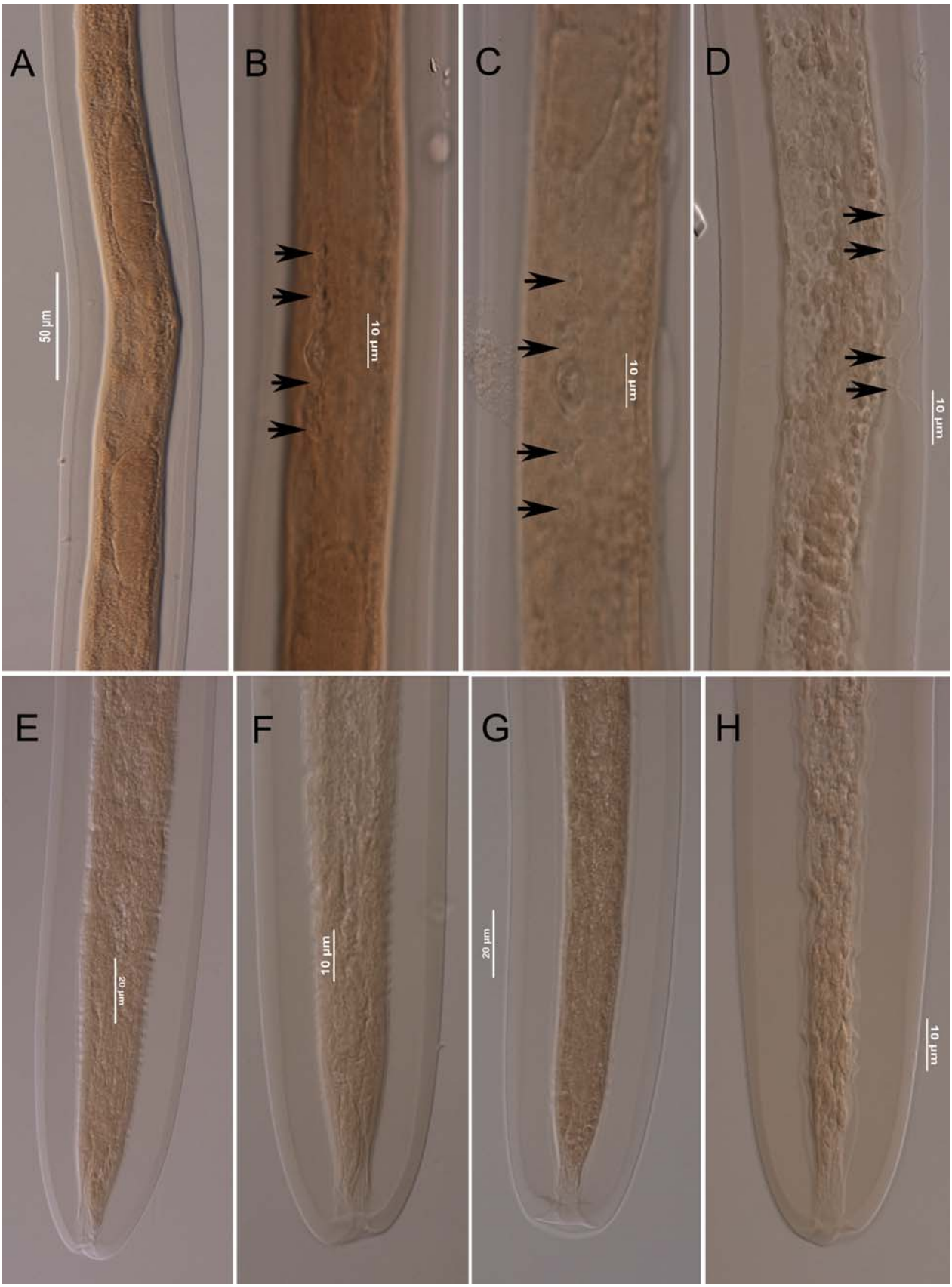


Fig. 43. Micrographs of *Paratrichodorus porosus* females. A: Female reproductive system; B–C: Vulva and ventromedian advulval body pores (arrows), ventral view; D: Vulva and ventromedian advulval body pores (arrows), lateral view; E–H: Tail shape.

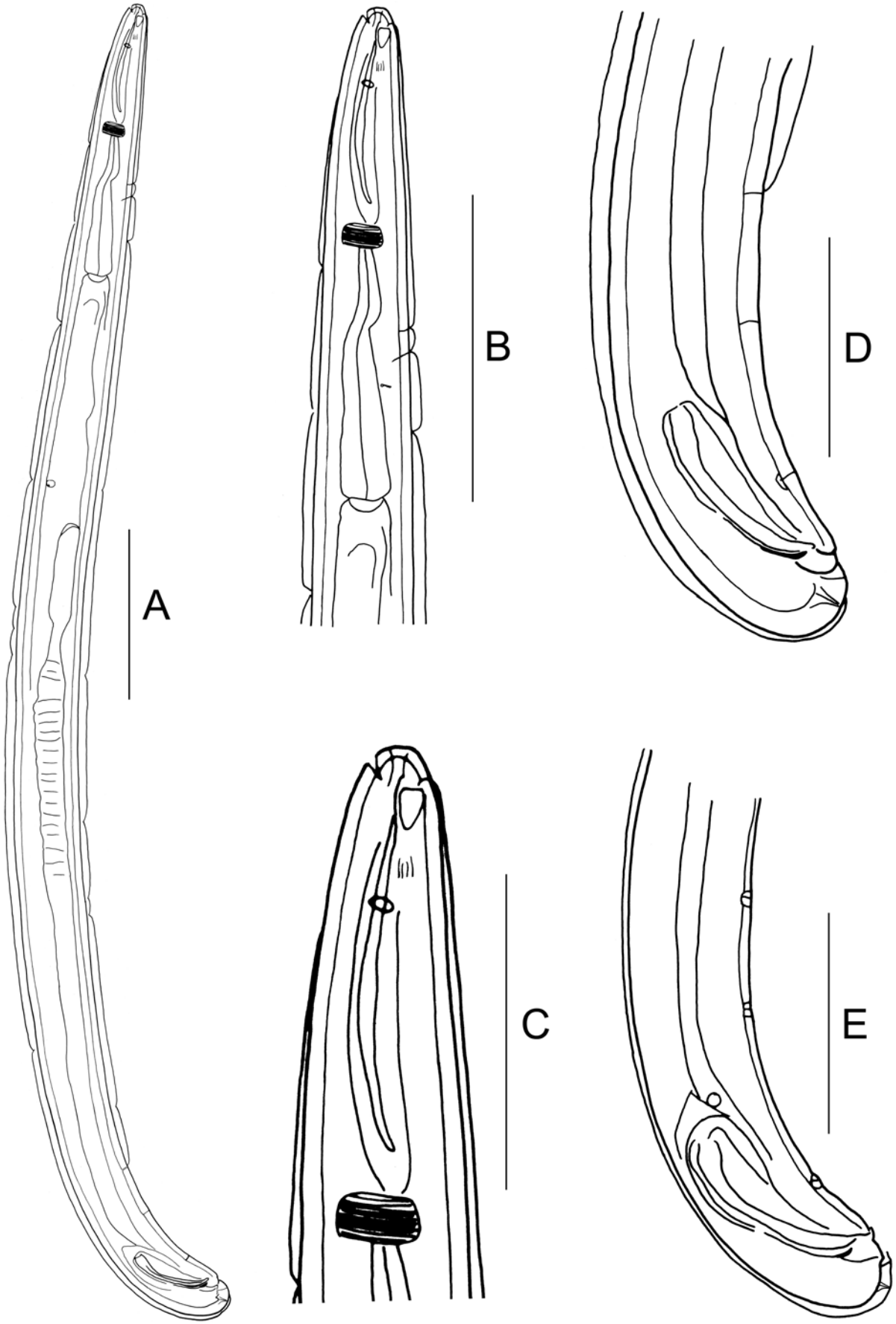


Fig. 44. Line drawings of *Trichodorus cottieri* males. A: Whole body; B: Anterior region; C: Amphid and onchiostyle; D, E: Tail shape. Scale bars: A, B=100 µm; C–E=50 µm.

Fig. 45. Micrographs of *Trichodorus cottieri* males. A: Whole body, lateral view; B: Anterior region and onchiostyle; C: Anterior region, amphid (arrow); D–F: Tail shape, lateral view, three ventromedian preanal copulatory supplements (arrows).

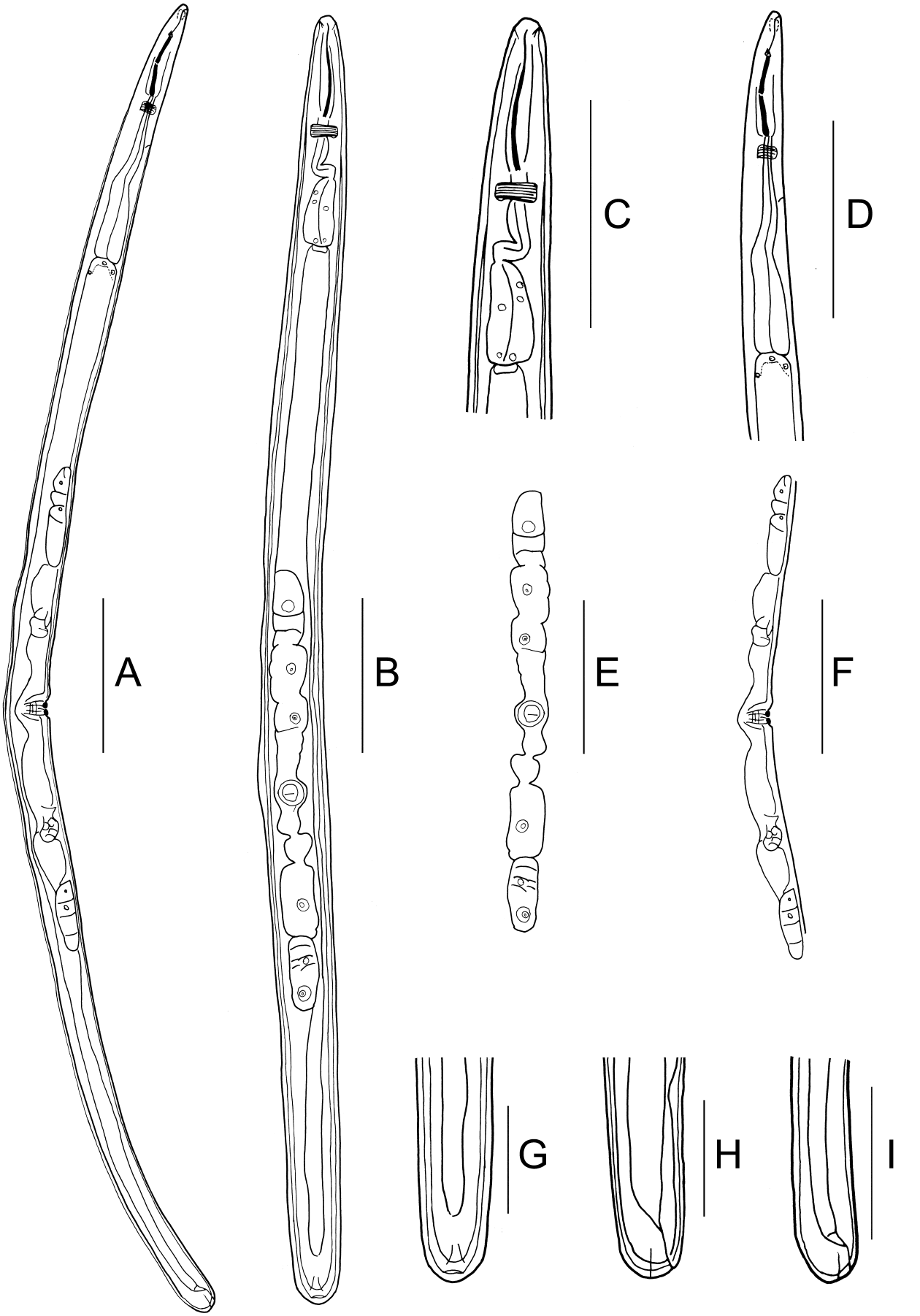


Fig. 46. Line drawings of *Trichodorus cottieri* females. A: Whole body, lateral view; B: Whole body, ventral view; C: Anterior region, ventral view; D: Anterior region, lateral view; E: Reproductive systems, ventral view; F: Reproductive system, lateral view; G: Tail, ventral view; H–I: Tail, lateral view. Scale bars: A–F=100 µm; G–I=50 µm.

Fig. 47. Micrographs of *Trichodorus cottieri* females. A: Anterior region; B: Anterior region and onchiostyle; C: Anterior region, amphid (arrow); D, E: Anterior region, excretory pore (arrow); F, G: Tail, lateral view; H: Tail, ventral view; I: Vulval region, lateral view; J: Vulval region, ventral view.

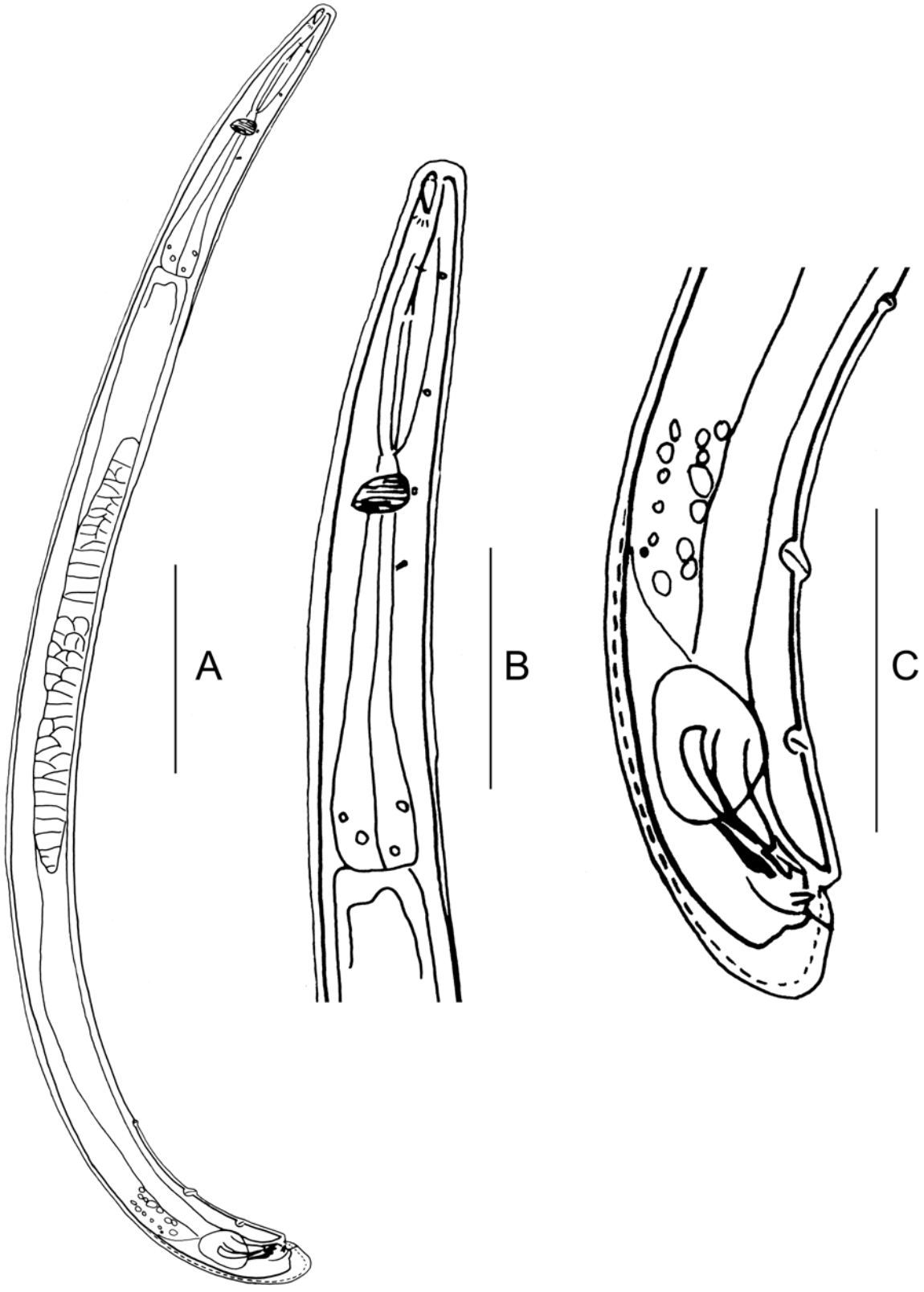


Fig. 48. Line drawings of *Trichodorus primitivus* males. A: Whole body; B: Anterior region; C: Tail shape. Scale bars: A=100 µm; B, C=50 µm.

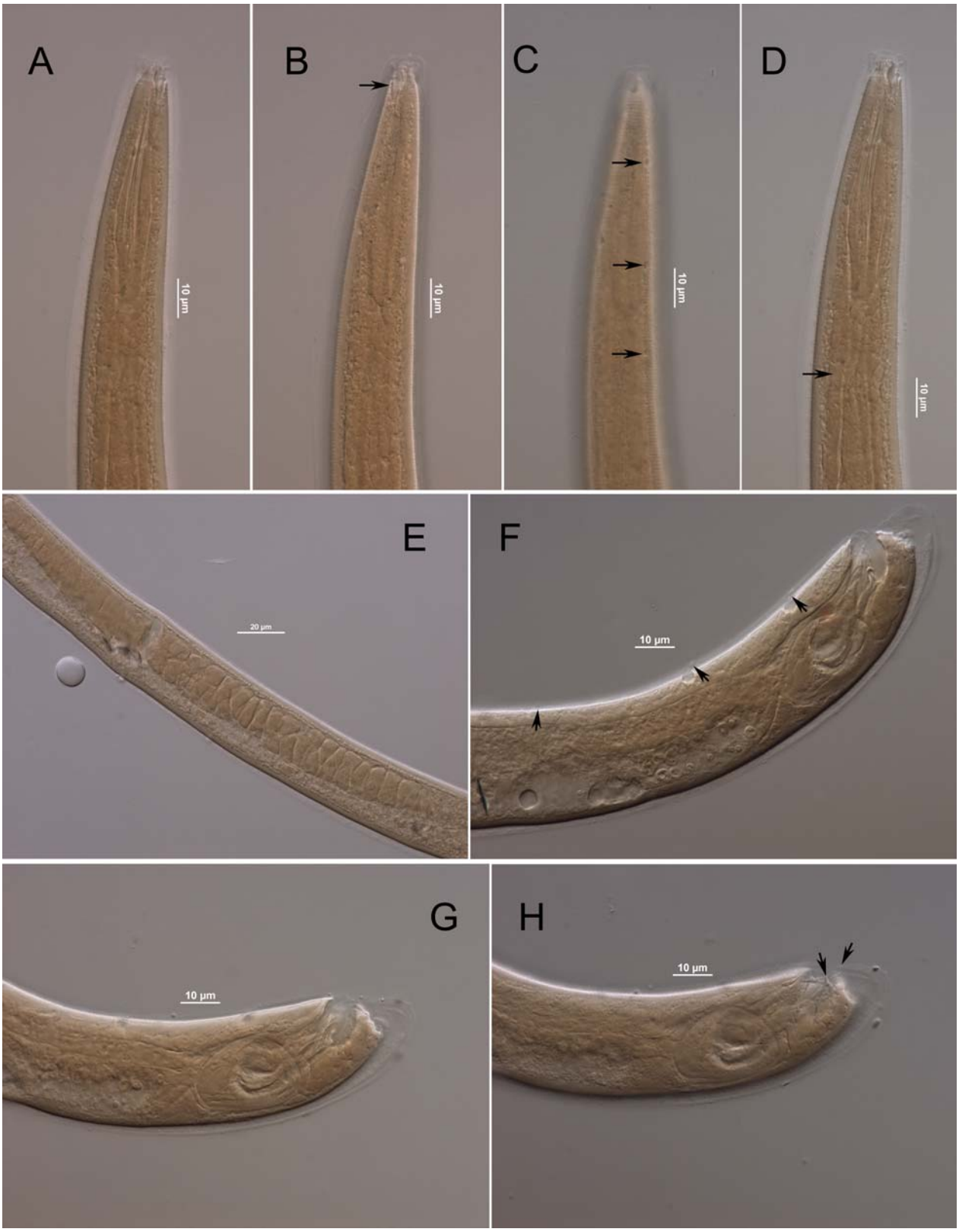


Fig. 49. Micrographs of *Trichodorus primitivus* males. A: Anterior region and onchiostyle; B: Anterior region, amphid (arrow); C: Anterior region, three cervical ventromedian papillae (arrows); D: Nerve ring (arrow); E: Testis; F: Tails shape, three ventromedian preanal supplements (arrows); G: Spicules; H: Postcloacal subventral papillae and subterminal caudal cuticular pores (arrows).

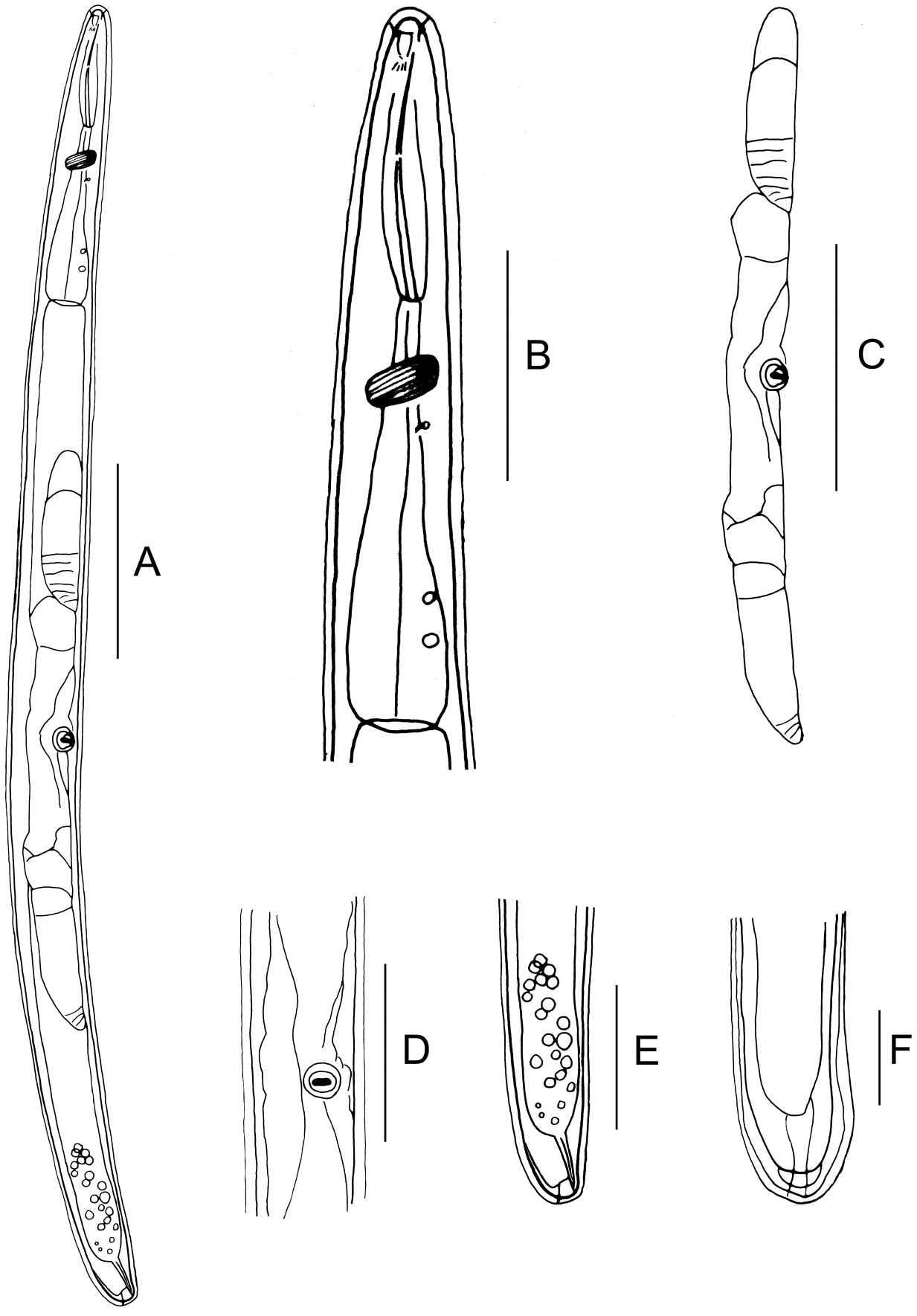


Fig. 50. Line drawings of *Trichodorus primitivus* females. A: Whole body; B: Anterior region; C: Reproductive systems, ventral view; D: Vulval region, ventral view; E, F: Tail shape. Scale bars: A, C=100 µm; B, D, E=50 µm; F=25 µm.

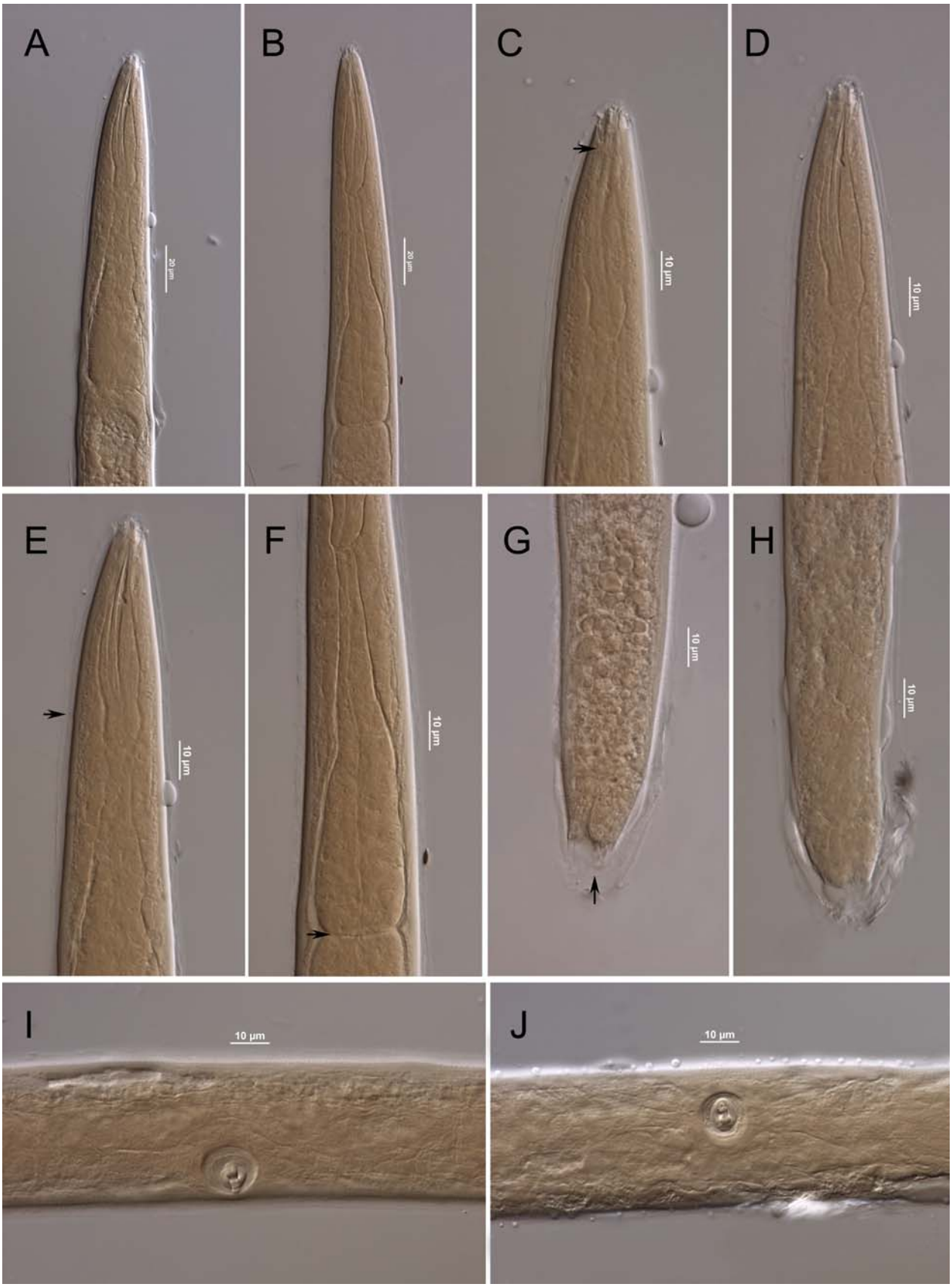
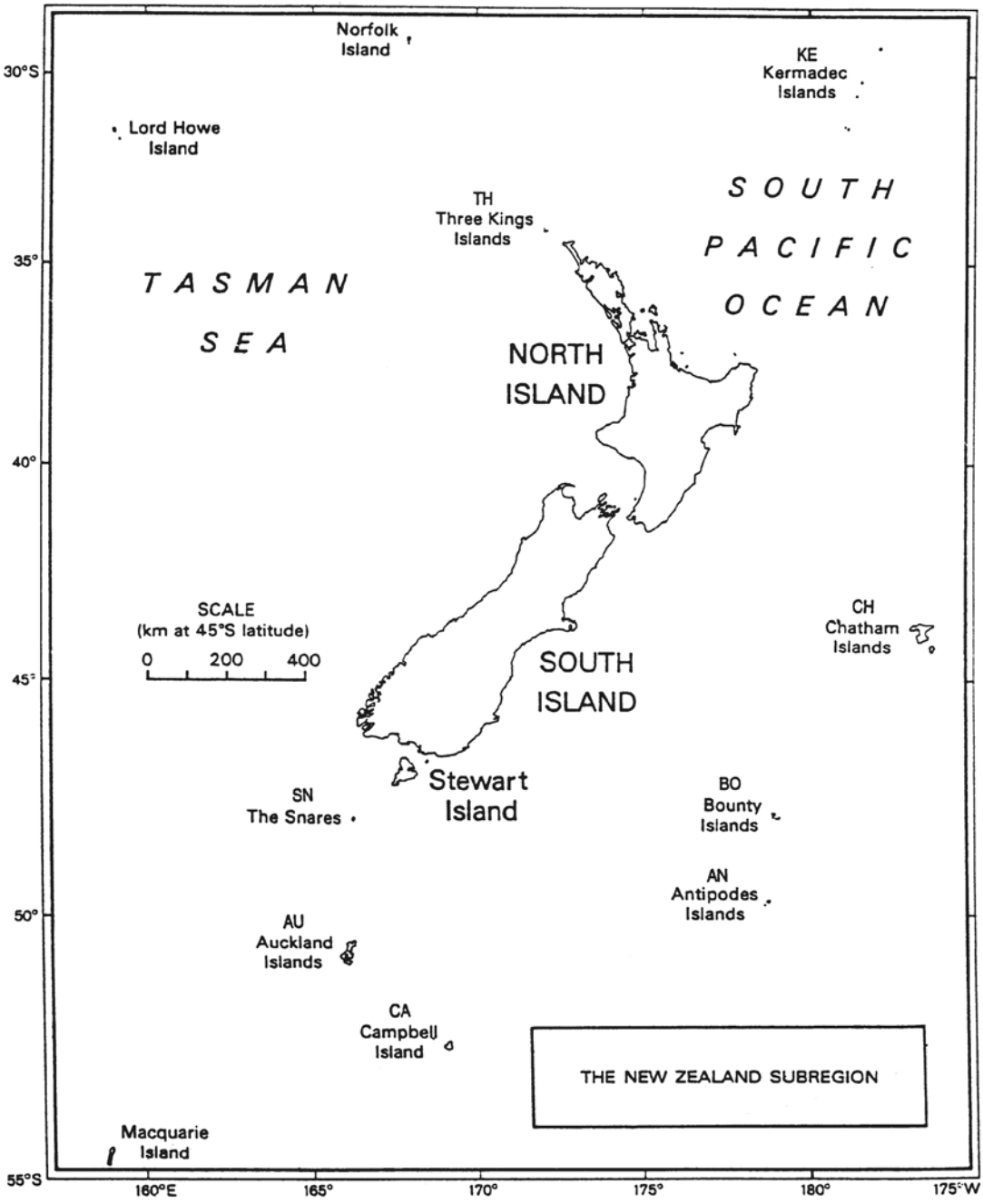
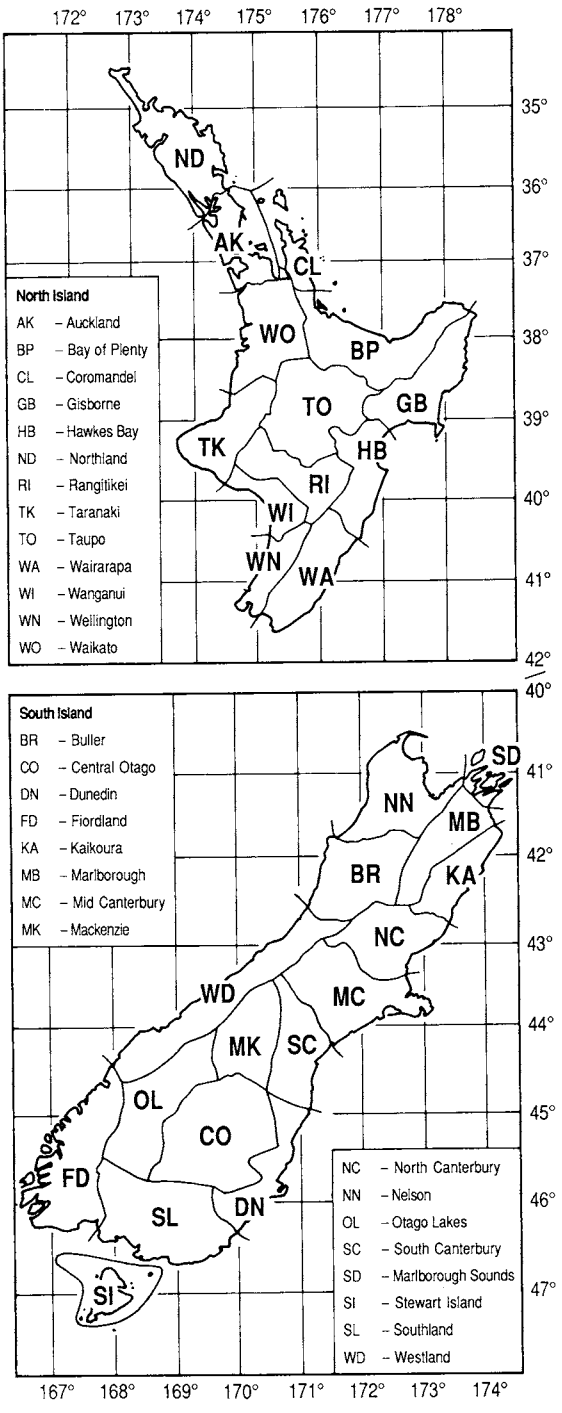
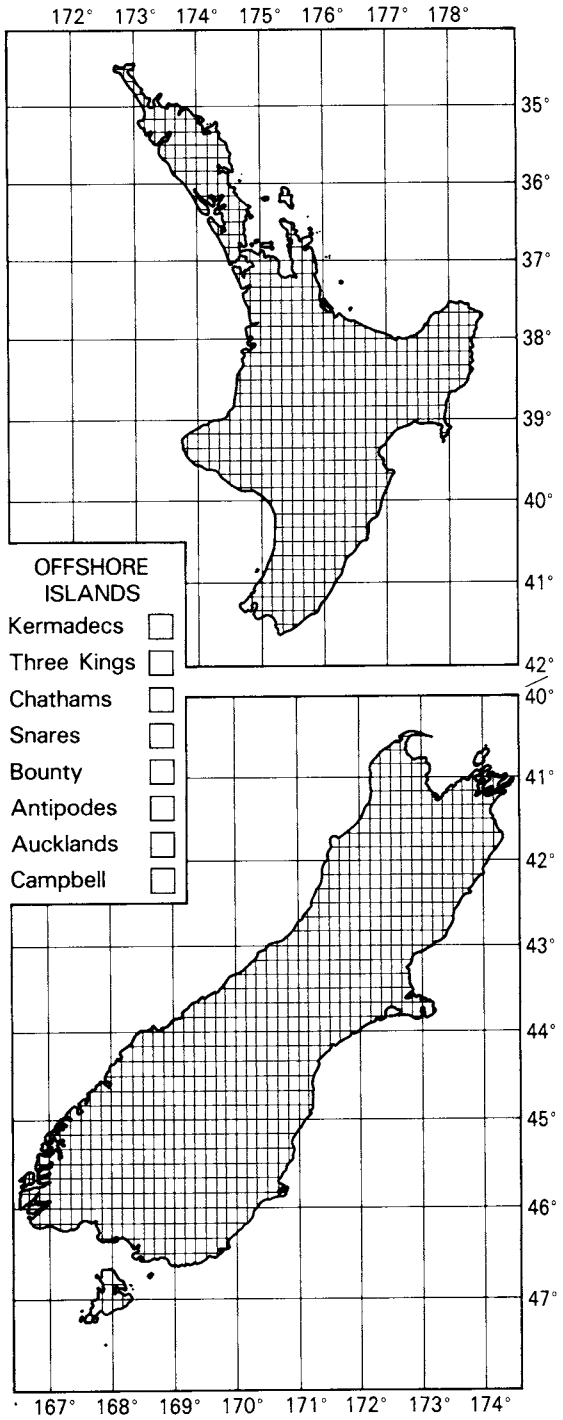


Fig. 51. Micrographs of *Trichodorus primitivus* females. A, B: Anterior region; C: Anterior region, amphid (arrow); D: Onchiostyle; E: Lateral body pore (arrow); F: Pharynx and intestine juncture (arrow); G, H: Tail shape, caudal pore (arrow); I, J: Vulval region, ventral view.

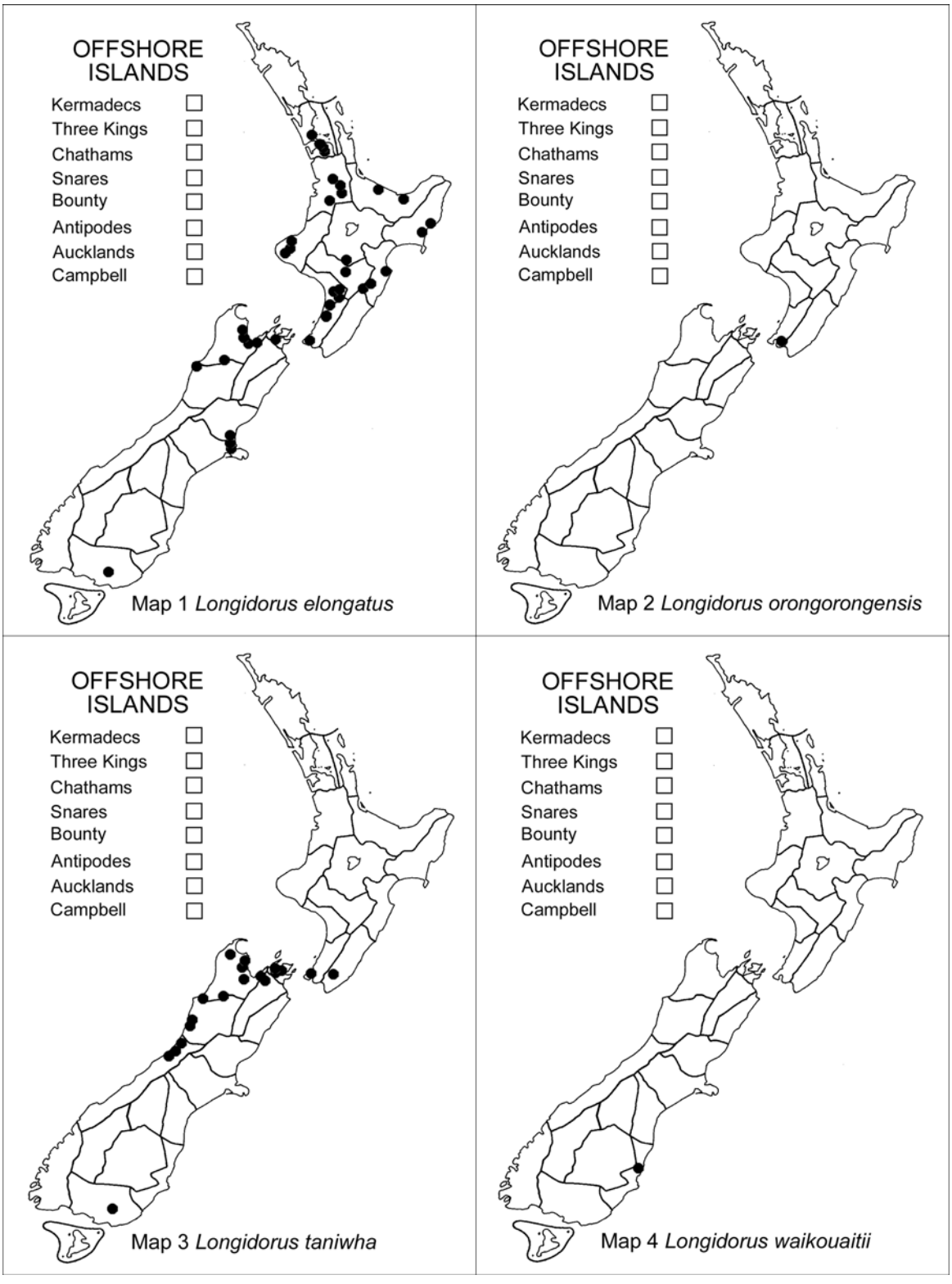

Norfolk Island
KE Kermadec Islands
Lord Howe Island
TH Three Kings Islands
SOUTH PACIFIC OCEAN
TASMAN SEA
NORTH ISLAND
SCALE (km at 45°S latitude)
0 200 400
SOUTH ISLAND
CH Chatham Islands
Stewart Island
SN The Snares
BO Bounty Islands
AN Antipodes Islands
AU Auckland Islands
CA Campbell Island
THE NEW ZEALAND SUBREGION
Macquarie Island
30°S
35°
40°
45°
50°
55°S
160°E
165°
170°
175°
180°
175°W

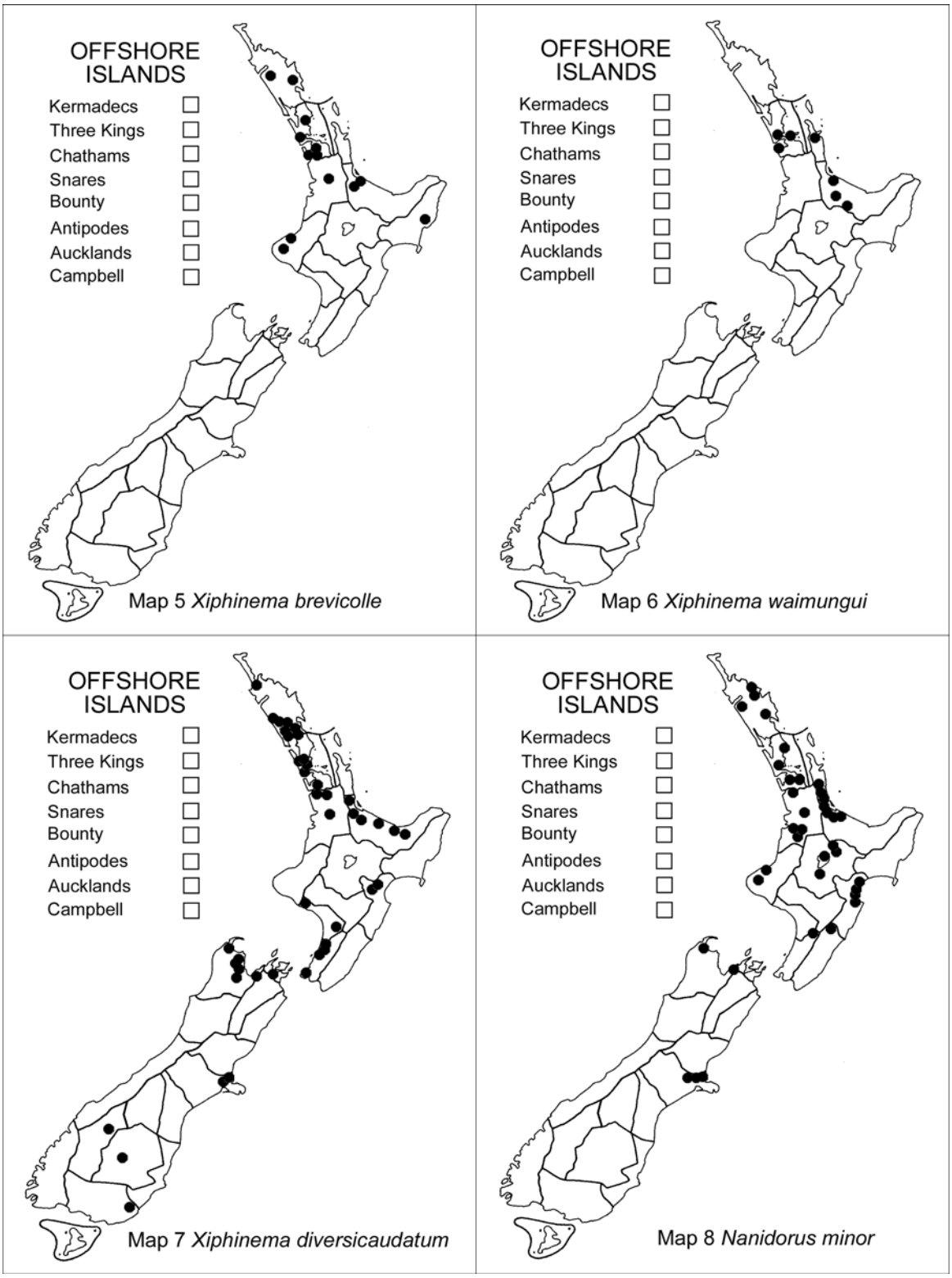


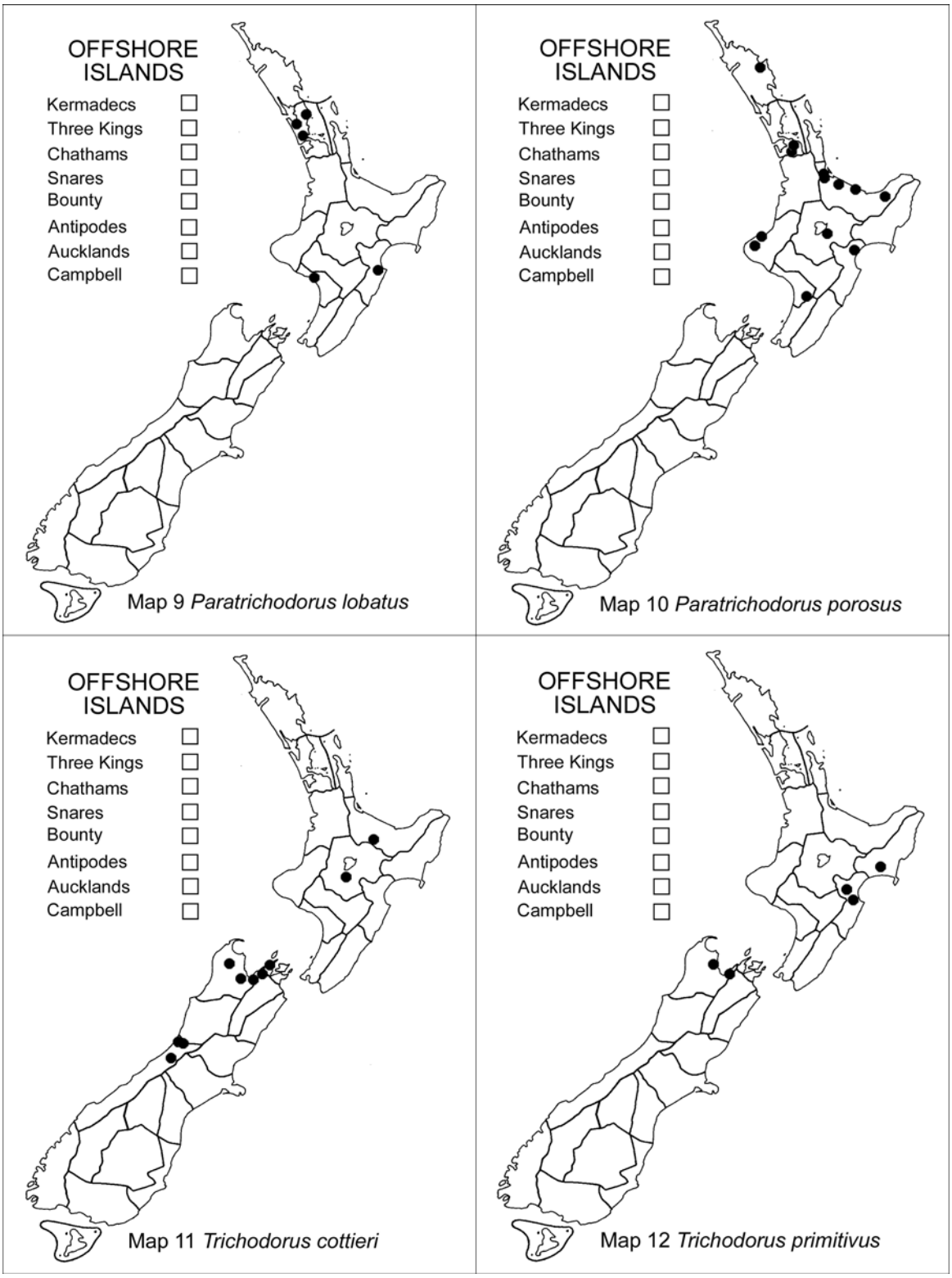
Area codes and boundaries used to categorise specimen locality data (after Crosby *et al.* 1976)



Base-map for plotting collection localities; this may be photocopied without copyright release


OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 1 *Longidorus elongatus*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 2 *Longidorus orongorongensis*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 3 *Longidorus taniwha*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 4 *Longidorus waikouaitii*


OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 5 Xiphinema brevicolle
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 6 Xiphinema waimungui
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 7 Xiphinema diversicaudatum
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 8 Nanidorus minor


OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 9 *Paratrichodorus lobatus*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 10 *Paratrichodorus porosus*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 11 *Trichodorus cottieri*
OFFSHORE ISLANDS
Kermadecs
Three Kings
Chathams
Snares
Bounty
Antipodes
Aucklands
Campbell
Map 12 *Trichodorus primitivus*

TAXONOMIC INDEX

This index covers the nominal taxa mentioned in the text, regardless of their current status in taxonomy. Taxa in bold type are those included in the checklist. Taxa in bold indicate valid taxa. Page number in bold type denotes the start of a description, and in italic type a figure.

HABITAT AND HOST INDEX

FAUNA OF NEW ZEALAND PUBLICATIONS

1 **Terebrantia** (Insecta: Thysanoptera). *Laurence A. Mound & Annette K. Walker.* ISBN 0-477-06687-9, 23 December 1982, 120 pp. $29.95

2 **Osoriinae** (Insecta: Coleoptera: Staphylinidae). *H. Pauline McColl.* ISBN 0-477-06688-7, 23 December 1982, 96 pp. $18.60

3 **Anthribidae** (Insecta: Coleoptera). *B. A. Holloway.* ISBN 0-477-06703-4, 23 December 1982, 272 pp. $41.00

4 **Eriophyoidea except Eriophyinae** (Arachnida: Acari). *D. C. M. Manson.* ISBN 0-477-06745-X,12 November 1984, 144 pp. $29.95

5 **Eriophyinae** (Arachnida: Acari: Eriophyoidea). *D. C. M. Manson.* ISBN 0-477-06746-8, 14 November 1984, 128 pp. $29.95

6 **Hydraenidae** (Insecta: Coleoptera). *R. G. Ordish.* ISBN 0-477-06747-6, 12 November 1984, 64 pp. $18.60

7 **Cryptostigmata** (Arachnida: Acari) — a concise review. *M. Luxton.* ISBN 0-477-06762-X, 8 December 1985, 112 pp. $29.95

8 **Calliphoridae** (Insecta: Diptera). *James P. Dear.* ISBN 0-477-06764-6. 24 February 1986, 88 pp. $18.60

9 **Protura** (Insecta). *S. L. Tuxen.* ISBN 0-477-06765-4, 24 February 1986, 52 pp. $18.60

10 **Tubulifera** (Insecta: Thysanoptera). *Laurence A. Mound & Annette K. Walker.* ISBN 0-477-06784-0, 22 September 1986, 144 pp. $34.65

11 **Pseudococcidae** (Insecta: Hemiptera). *J. M. Cox.* ISBN 0-477-06791-3, 7 April 1987, 232 pp. $49.95

12 **Pompilidae** (Insecta: Hymenoptera). *A. C. Harris.* ISBN 0-477-02501-3, 13 November 1987, 160 pp. $39.95

13 **Encyrtidae** (Insecta: Hymenoptera). *J. S. Noyes.* ISBN 0-477-02517-X, 9 May 1988, 192 pp. $44.95

14 **Lepidoptera** — annotated catalogue, and keys to family-group taxa. *J. S. Dugdale.* ISBN 0-477-02518-8, 23 September 1988, 264 pp. $49.95

15 **Ambositrinae** (Insecta: Hymenoptera: Diapriidae). *I. D. Naumann.* ISBN 0-477-02535-8, 30 December 1988, 168 pp. $39.95

16 **Nepticulidae** (Insecta: Lepidoptera). *Hans Donner & Christopher Wilkinson.* ISBN 0-477-02538-2, 28 April 1989, 92 pp. $22.95

17 **Mymaridae** (Insecta: Hymenoptera) — introduction, and review of genera. *J. S. Noyes & E. W. Valentine.* ISBN 0-477-02542-0, 28 April 1989, 100 pp. $24.95

18 **Chalcidoidea** (Insecta: Hymenoptera) — introduction, and review of genera in smaller families. *J. S. Noyes & E. W. Valentine.* ISBN 0-477-02545-5, 2 August 1989, 96 pp. $24.95

19 **Mantodea** (Insecta), with a review of aspects of functional morphology and biology. *G. W. Ramsay.* ISBN 0-477-02581-1, 13 June 1990, 96 pp. $24.95

20 **Bibionidae** (Insecta: Diptera). *Roy A. Harrison.* ISBN 0-477-02595-1. 13 November 1990, 28 pp. $14.95

21 **Margarodidae** (Insecta: Hemiptera). *C. F. Morales.* ISBN 0-477-02607-9, 27 May 1991, 124 pp. $34.95

22 **Notonemouridae** (Insecta: Plecoptera). *I. D. McLellan,* ISBN 0-477-02518-8, 27 May 1991, 64 pp. $24.95

23 **Sciapodinae**, **Medeterinae** (Insecta: Diptera) with a generic review of the Dolichopodidae. *D. J. Bickel.* ISBN 0-477-02627-3, 13 January 1992, 74 pp. $27.95

24 **Therevidae** (Insecta: Diptera). *L. Lyneborg.* ISBN 0-477- 02632-X, 4 March 1992, 140 pp. $34.95

25 **Cercopidae** (Insecta: Homoptera). *K. G. A. Hamilton & C. F. Morales.* ISBN 0-477-02636-2, 25 May 1992, 40 pp. $17.95

26 **Tenebrionidae** (Insecta: Coleoptera): catalogue of types and keys to taxa. *J. C. Watt.* ISBN 0-477-02639-7, 13 July 1992, 70 pp. $27.95

27 **Antarctoperlinae** (Insecta: Plecoptera). *I. D. McLellan.* ISBN 0-477-01644-8, 18 February 1993, 70 pp. $27.95

28 **Larvae of Curculionoidea** (Insecta: Coleoptera): a systematic overview. *Brenda M. May.* ISBN 0-478-04505-0, 14 June 1993, 226 pp. $55.00

29 **Cryptorhynchinae** (Insecta: Coleoptera: Curculionidae). *C. H. C. Lyal.* ISBN 0-478-04518-2, 2 December 1993, 308 pp. $65.00

30 **Hepialidae** (Insecta: Lepidoptera). *J. S. Dugdale.* ISBN 0-478-04524-7, 1 March 1994, 164 pp. $42.50

31 **Talitridae** (Crustacea: Amphipoda). *K. W. Duncan.* ISBN 0-478-04533-6, 7 October 1994, 128 pp. $36.00

32 **Sphecidae** (Insecta: Hymenoptera). *A. C. Harris,* ISBN 0-478-04534-4, 7 October 1994, 112 pp. $33.50

33 **Moranilini** (Insecta: Hymenoptera). *J. A. Berry.* ISBN 0-478-04538-7, 8 May 1995, 82 pp. $29.95

34 **Anthicidae** (Insecta: Coleoptera). *F. G. Werner & D. S. Chandler.* ISBN 0-478-04547-6, 21 June 1995, 64 pp. $26.50

35 **Cydnidae**, **Acanthosomatidae**, **and Pentatomidae** (Insecta: Heteroptera): systematics, geographical distribution, and bioecology. *M.-C. Larivière.* ISBN 0-478- 09301-2, 23 November 1995, 112 pp. $42.50

36 **Leptophlebiidae** (Insecta: Ephemeroptera). *D. R. Towns & W. L. Peters.* ISBN 0-478-09303-9, 19 August 1996, 144 pp. $39.50

37 **Coleoptera**: family-group review and keys to identification. *J. Klimaszewski & J. C. Watt.* ISBN 0-478- 09312-8, 13 August 1997, 199 pp. $49.50

38 **Naturalised terrestrial Stylommatophora** (Mollusca: Gastropoda). *G. M. Barker.* ISBN 0-478-09322-5, 25 January 1999, 253 pp. $72.50

39 **Molytini** (Insecta: Coleoptera: Curculionidae: Molytinae). R. C. Craw. ISBN 0-478-09325-X, 4 February1999, 68 pp. $29.50

40 **Cixiidae** (Insecta: Hemiptera: Auchenorrhyncha). M.-C. Larivière. ISBN 0-478-09334-9, 12 November 1999, 93 pp. $37.50

41 **Coccidae** (Insecta: Hemiptera: Coccoidea). C. J. Hodgson & R. C. Henderson. ISBN 0-478-09335-7, 23 February 2000, 264 pp. $72.50

42 **Aphodiinae** (Insecta: Coleoptera: Scarabaeidae). Z. T. Stebnicka. ISBN 0-478-09341-1, 15 June 2001, 64 pp. $29.50

43 **Carabidae** (Insecta: Coleoptera): catalogue. A. Larochelle & M.-C. Larivière. ISBN 0-478-09342-X, 15 June 2001, 285 pp. $72.50

44 **Lycosidae** (Arachnida: Araneae). C. J. Vink. ISBN 0-478- 09347-0, 23 December 2002, 94 pp. $37.50

45 **Nemonychidae**, **Belidae**, **Brentidae** (Insecta: Coleoptera: Curculionoidea). G. Kuschel. ISBN 0-478- 09348-9, 28 April 2003, 100 pp. $40.00

46 **Nesameletidae** (Insecta: Ephemeroptera). Terry R. Hitchings & Arnold H. Staniczek. ISBN 0-478-09349-7, 14 May 2003, 72 pp. $32.50

47 **Erotylidae** (Insecta: Coleoptera: Cucujoidea): phylogeny and review. R. A. B. Leschen. ISBN 0-478-09350-0, 5 June 2003,108 pp. $42.50

48 **Scaphidiinae** (Insecta: Coleoptera: Staphylinidae). I. Löbl & R. A. B. Leschen. ISBN 0-478-09353-5,18 November 2003, 94 pp. $37.50

49 **Lithinini** (Insecta: Lepidoptera: Geometridae: Ennominae). J. D. Weintraub & M. J. Scoble. ISBN 0-478- 09357-8, 29 April 2004, 48 pp. $24.50

50 **Heteroptera** (Insecta: Hemiptera): catalogue. M.-C. Larivière & A. Larochelle. ISBN 0-478-09358-6, 14 May 2004, 330 pp. $89.00

51 **Coccidae** (Insecta: Hemiptera: Coccoidea): adult males, pupae and prepupae of indigenous species. C. J. Hodgson & R. C. Henderson. ISBN 0-478-09360-8, 22 June 2004, 228 pp. $65.00

52 **Raphignathoidea** (Acari: Prostigmata). Qing-Hai Fan & Zhi-Qiang Zhang. ISBN 0-478-09371-3, 20 May 2005, 400 pp. $89.00

53 **Harpalini** (Insecta: Coleoptera: Carabidae: Harpalinae). A. Larochelle & M.-C. Larivière. ISBN 0-478-09369-1, 4 July 2005, 160 pp. $55.00

54 ***Hierodoris*** (Insecta: Lepidoptera: Gelechoidea: Oecophoridae), and overview of Oecophoridae. Robert J. B. Hoare. ISBN 0-478-09378-0, 24 December 2005, 100 pp. $40.00

55 **Criconematina** (Nematoda: Tylenchida). W. M. Wouts. ISBN 0-478-09381-0, 24 March 2006, 232 pp. $65.00

56 ***Tyrophagus*** (Acari: Astigmata: Acaridae). Qing-Hai Fan & Zhi-Qiang Zhang. ISBN 978-0-478-09386-5, 4 June 2007, 291 pp. $80.00

57 **Apoidea** (Insecta: Hymenoptera). B. J. Donovan. ISBN 978-0-478-09389-6, 7 September 2007, 295 pp $89.00

58 **Alysiinae** (Insecta: Hymenoptera: Braconidae). J. A. Berry. ISBN 978-0-478-09390-2, 7 September 2007, 95 pp. $45.00

59 **Erotylinae** (Insecta: Coleoptera: Cucujoidea: Erotylidae): taxonomy and biogeography. Paul E. Skelley & Richard A. B. Leschen. ISBN 978-0-478-09391-9, 7 September 2007, 59 pp. $30.00

60 **Carabidae** (Insecta: Coleoptera): synopsis of supraspecific taxa. A. Larochelle & M.-C. Larivière. ISBN 978-0-478-09394-0, 21 November 2007, 188 pp. $54.00

61 **Lucanidae** (Insecta: Coleoptera). B. A. Holloway. ISBN 978-0-478-09395-7, 21 November 2007, 254 pp. $75.00

62 **Trechini** (Insecta: Coleoptera: Carabidae: Trechinae). J. I. Townsend. ISBN 978-0-478-34717-9 (print), 978-0-478-34716-6 (online), 16 June 2010, 101 pp. $49.50

63 **Auchenorrhyncha** (Insecta: Hemiptera): catalogue. M.-C. Larivière, M. J. Fletcher & A. Larochelle. ISBN 978-0-478-34720-3 (print), 978-0-478-34721-0 (online), 16 June 2010, 232 pp. $75.00

64 **Pisauridae** (Arachnida: Araneae). C. J. Vink & N. Dupérré. ISBN 978-0-478-34722-7 (print), 978-0-478- 34723-4 (online), 13 July 2010, 60 pp. $37.50
65 ***Izatha*** (Insecta: Lepidoptera: Gelechioidea: Oecophoridae). Robert J. B. Hoare. ISBN 978-0-478-34724-1 (print), 978-0-478-34725-8 (online), 2 September 2010, 201 pp..... $75.00
66 **Diaspididae** (Insecta: Hemiptera: Coccoidea). R. C. Henderson. ISBN 978-0-478-34726-5 (print), 978-0-478-34727-2 (online), 23 May 2011, 275 pp. $89.00
67 **Peloridiidae** (Insecta: Hemiptera: Coleorrhyncha). M.-C. Larivière, D. Burckhardt & A. Larochelle. ISBN 978-0-478- 34730-2 (print), 978-0-478-34731-9 (online), 14 November 2011, 78 pp. $48.00
68 **Simuliidae** (Insecta: Diptera). Douglas A. Craig, Ruth E. G. Craig & Trevor K. Crosby. ISBN 978-0-478-34734- 0 (print), 978-0-478-34735-7 (online), 29 June 2012, 336 pp. $95.00
69 **Carabidae** (Insecta: Coleoptera): synopsis of species, Cicindelinae to Trechinae (in part) . A. Larochelle & M.-C. Larivière. ISBN 978-0-478-34738-8 (print), 978-0-478- 34739-5 (online), 7 March 2013, 193 pp. $75.00
70 **Periegopidae** (Arachnida: Araneae). C. J. Vink, N. Dupérré & J. Malumbres-Olarte. ISBN 978-0-478-34740- 1 (print), 978-0-478-34741-8 (online), 7 March 2013, 41 pp. $29.00
71 **Fanniidae** (Insecta: Diptera). M. Cecilia Domínguez & Adrian C. Pont. ISBN 978-0-478-34745-6 (print), 978-0-478-34746-3 (online), 30 June 2014, 91 pp. $49.00
72 **Micropterigidae** (Insecta: Lepidoptera). George W. Gibbs. ISBN 978-0-478-34759-3 (print), 978-0-478-34760- 9 (online), 30 June 2014, 127 pp..... $59.00
73 **Noctuinae** (Insecta: Lepidoptera: Noctuidae) part 1: *Austramathes*, *Cosmodes*, *Proteuxoa*, *Physetica*. R.J.B. Hoare, ISBN 978-0-947525-09-5 (print), 978-0-947525-07-1 (online), 23 June 2017, 130 pp $60.00
74 **Ceratomerinae** (Diptera: Empidoidea: Brachystomatidae), B.J. Sinclair, ISBN 978-0-947525-10-1 (print), 978-0-947525-11-8 (online), 23 June 2017, 157 pp $66.00
75 **Licinini** (Insecta: Coleoptera: Carabidae: Harpalinae), R.M. Emberson. ISBN 978-0-947525-13-2 (print), 978-0-947525-12-5 (online), 16 August 2017, 80 pp..... $48.00
76 **Phthiraptera** (Insecta): a catalogue of parasitic lice from New Zealand, Ricardo L. Palma. ISBN 978-0-947525-19-4 (print), 978-0-947525-18-7 (online), 30 September 2017, 400 pp $98.00
77 ***Tenuipalpus*** (Acari: Trombidiformes: Tetranychoidea: Tenuipalpidae), ISBN 978-0-947525-53-8 (print), 978-0-947525-52-1 (online), 12 November 2018, 163 pp..... $68.00
78 Mnesarchaeidae (Insecta: Lepidoptera: Hepialoidea), G. W. Gibbs & N. P. Kristensen, 978-0-947525-60-6 (print), 978-0-947525-61-3 (online), 28 May 2019, 105 pp $60.00
79 Longidoridae and Trichodoridae (Nematoda: Dorylaimida and Triplonchida), Y.-M. Xu & Z.-Q. Zhao, 978-0-947525-65-1 (print), 978-0-947525-66-8 (online), 4 October 2019, 149 pp $66.00

Visit the Landcare Research Website at: http://www.landcareresearch.co.nz/ for further information.
Orders for printed books should be sent to the Library of Landcare Research (library@landcareresearch.co.nz).
To access on-line version of this series visit: http://fnz.landcareresearch.co.nz/ or https://www.biotaxa.org/fnz

Taxonomic groups covered in the *Fauna of New Zealand* series

Insecta

Coleoptera

Family-group review and keys to identification (*J. Klimaszewski & J. C. Watt*, FNZ 37, 1997)
Anthribidae (*B. A. Holloway*, FNZ 3, 1982)
Anthicidae (*F. G. Werner & D. S. Chandler*, FNZ 34, 1995)
Carabidae: catalogue (*A. Larochelle & M.-C. Larivière*, FNZ 43, 2001); synopsis of supraspecific taxa (*A. Larochelle & M.-C. Larivière*, FNZ 60, 2007); synopsis of species, Cicindelinae to Trechinae (in part) (*A. Larochelle & M.-C. Larivière*, FNZ 69, 2013)
Carabidae: Harpalinae: Harpalini (*A. Larochelle & M.-C. Larivière*, FNZ 53, 2005)
Carabidae: Trechinae: Trechini (*J. I. Townsend*, FNZ 62, 2010)
Carabidae: Harpalinae: Licinini (*R.M. Emberson,* FNZ 75, 2017)
Curculionidae: Cryptorhynchinae (*C. H. C. Lyal*, FNZ 29, 1993)
Curculionidae: Molytinae: Molytini (*R. C. Craw*, FNZ 39, 1999)
Curculionoidea: Nemonychidae, Belidae, Brentidae (*G. Ku-schel*, FNZ 45, 2003)
Curculionoidea larvae: a systematic overview (*Brenda M. May*, FNZ 28, 1993)
Erotylidae: phylogeny and review (*Richard A. B. Leschen*, FNZ 47, 2003); Erotylinae: taxonomy and biogeography (*Paul E. Skelley & Richard A. B. Leschen*, FNZ 59, 2007)
Hydraenidae (*R. G. Ordish*, FNZ 6, 1984)
Lucanidae (*B. A. Holloway*, FNZ 61, 2007)
Scarabaeidae: Aphodiinae (*Z. T. Stebnicka*, FNZ 42, 2001)
Staphylinidae: Osoriinae *(H. Pauline McColl,* FNZ 2, 1982)
Staphylinidae: Scaphidiinae (*I. Löbl & Richard A. B. Leschen*, FNZ 48, 2003)
Tenebrionidae: catalogue of types and keys to taxa (*J. C. Watt*, FNZ 26, 1992)

Diptera

Bibionidae (*Roy A. Harrison*, FNZ 20, 1990)
Calliphoridae (*James P. Dear*, FNZ 8, 1986)
Dolichopodidae: Sciapodinae, Medeterinae with a generic review (*D. J. Bickel*, FNZ 23, 1992)
Fanniidae (*M. Cecilia Domínguez, Adrian C. Pont*, FNZ 71, 2014)
Simuliidae (*Douglas A. Craig, Ruth E. G. Craig, Trevor K. Crosby*, FNZ 68, 2012)
Therevidae (*L. Lyneborg*, FNZ 24, 1992)
Ceratomerinae (Diptera: Empidoidea: Brachystomatidae) (*B.J. Sinclair,* FNZ 74, 2017)

Ephemeroptera

Leptophlebiidae (*D. R. Towns & W. L. Peters*, FNZ 36, 1996)
Nesameletidae (*Terry R. Hitchings & Arnold H. Staniczek*, FNZ 46, 2003)

Hemiptera

Auchenorrhyncha: catalogue (*M.-C. Larivière, M. J. Fletcher & A. Larochelle*, FNZ 63, 2010)
Cercopidae (*K. G. A. Hamilton & C. F. Morales*, FNZ 25, 1992)
Cixiidae (*M.-C. Larivière*, FNZ 40, 1999)
Coccidae (*C. J. Hodgson & R. C. Henderson*, FNZ 41, 2000); adult males, pupae and prepupae of indigenous species (*C. J. Hodgson & R. C. Henderson*, FNZ 51, 2004)
Cydnidae, Acanthosomatidae, and Pentatomidae (*M.-C. Larivière*, FNZ 35, 1995)
Diaspididae (*R. C. Henderson*, FNZ 66, 2011)
Heteroptera: catalogue (*M.-C. Larivière & A. Larochelle*, FNZ 50, 2004)
Margarodidae (*C. F. Morales*, FNZ 21, 1991)
Pseudococcidae (*J. M. Cox*, FNZ 11, 1987)
Peloridiidae (*M.-C. Larivière, D. Burckhardt & A. Larochelle*, FNZ 67, 2011).

Hymenoptera

Apoidea (*B. J. Donovan*, FNZ 57, 2007)
Braconidae: Alysiinae (*J. A. Berry*, FNZ 58, 2007)
Chalcidoidea: introduction, and review of smaller families (*J. S. Noyes & E. W. Valentine*, FNZ 18, 1989)
Diapriidae: Ambositrinae (*I. D. Naumann*, FNZ 15, 1988)
Encyrtidae (*J. S. Noyes*, FNZ 13, 1988)
Mymaridae (*J. S. Noyes & E. W. Valentine*, FNZ 17, 1989)

Pompilidae (*A. C. Harris*, FNZ 12, 1987)
Pteromalidae: Eunotinae: Moranilini (*J. A. Berry*, FNZ 33, 1995)
Sphecidae (*A. C. Harris*, FNZ 32, 1994)
Lepidoptera
Annotated catalogue, and keys to family-group taxa (*J. S. Dugdale*, FNZ 14, 1988)
Geometridae: Ennominae: Lithinini (*Jason D. Weintraub & Malcolm J. Scoble*, FNZ 49, 2004)
Hepialidae (*J. S. Dugdale*, FNZ 30, 1994)
Micropterigidae (*George W. Gibbs*, FNZ 72, 2014)
Nepticulidae (*Hans Donner & Christopher Wilkinson*, FNZ 16, 1989)
Oecophoridae: *Hierodoris* (*Robert J. B. Hoare,* FNZ 54, 2005); *Izatha* (*Robert J. B. Hoare*, FNZ 65, 2010).
Noctuinae (Insecta: Lepidoptera: Noctuidae) part 1: *Austramathes*, *Cosmodes*, *Proteuxoa*, *Physetica* (*R.J.B. Hoare*, FNZ 73, 2017)
Mnesarchaeidae (Insecta: Lepidoptera: Hepialoidea) (*G. W. Gibbs & N. P. Kristensen,* FNZ 78, 2019)
Mantodea, with a review of aspects of functional morphology and biology (*G. W. Ramsay*, FNZ 19, 1990)
Phthiraptera (Insecta): a catalogue of parasitic lice from New Zealand (*R. L. Palma,* FNZ 76, 2017)
Plecoptera
Antarctoperlinae (*I. D. McLellan*, FNZ 27, 1993)
Notonemouridae (*I. D. McLellan*, FNZ 22, 1991)
Protura (*S. L. Tuxen*, FNZ 9, 1986)
Thysanoptera
Terebrantia (*Laurence A. Mound & Annette K. Walker*, FNZ 1, 1982)
Tubulifera *(Laurence A. Mound & Annette K. Walker,* FNZ 10, 1986)

Arachnida

Acari
Acaridae: *Tyrophagus (Qing-Hai Fan & Zhi-Qiang Zhang,* FNZ 56, 2007)
Cryptostigmata — a concise review (*M. Luxton,* FNZ 7, 1985)
Eriophyoidea except Eriophyinae (*D. C. M. Manson*, FNZ 4, 1984)
Eriophyinae (*D. C. M. Manson*, FNZ 5, 1984)
Raphignathoidea (*Qing-Hai Fan & Zhi-Qiang Zhang,* FNZ 52, 2005)
Tenuipalpidae: *Tenuipalpus* (*Yun Xu & Zhi-Qiang Zhang,* FNZ 77, 2018)
Araneae
Lycosidae (*C. J. Vink,* FNZ 44, 2002)
Periegopidae (*C. J. Vink, N. Dupérré & Malumbres-Olarte*, FNZ 70, 2013
Pisauridae (*C. J. Vink & N. Dupérré*, FNZ 64, 2010)

Crustacea

Amphipoda
Talitridae (*K. W. Duncan*, FNZ 31, 1994)

Mollusca

Gastropoda
Naturalised terrestrial Stylommatophora (*G. M. Barker*, FNZ 38, 1999)

Nematoda

Tylenchida: Criconematina (*W. M. Wouts*, FNZ 55, 2006)
Dorylaimida and Triplonchida: Longidoridae and Trichodoridae (Y.-M. Xu & Z.-Q. Zhao, FNZ 79, 2019)

NOTICES

This series of refereed publications has been established to encourage those with expert knowledge to publish concise yet comprehensive accounts of elements in the New Zealand fauna. The series is professional in its conception and presentation, yet every effort is made to provide resources for identification and information that are accessible to the non-specialist.

Fauna of N.Z. deals with non-marine invertebrates only, since the vertebrates are well documented, and marine forms are covered by the series *NIWA Biodiversity Memoirs*.

Contributions are invited from any person with the requisite specialist skills and resources. Material from the N.Z. Arthropod Collection is available for study.

Contributors should discuss their intentions with a member of the Editorial Board or with the Series Editor before commencing work; all necessary guidance will be given.

NGĀ PĀNUI

Kua whakatūria tēnei huinga pukapuka hei whakahauhau i ngā tohunga whai mātauranga kia whakaputa i ngā kōrero poto, engari he whaikiko tonu, e pā ana ki ngā aitanga pepeke o Aotearoa. He tōtika tonu te āhua o ngā tuhituhi, engari ko te tino whāinga, kia mārama te marea ki ngā tohu tautuhi o ia ngārara, o ia ngārara, me te roanga atu o ngā kōrero mō tēnā, mō tēnā.

He titiro whāiti tā tēnei pukapuka ki ngā mea noho whenua, kāore he tuarā; i pēnei ai i te mea kei te mōhio whānuitia ngā mea whai tuarā, ā, ko ngā mea noho moana, koirā te tino kaupapa o te huinga pukapuka *NIWA Biodiversity Memoirs*.

Ka āhei te tangata ki te **whakauru tuhituhinga** mehemea kei a ia ngā tohungatanga me ngā rauemi e tutuki pai ai tana mahi. Heoi anō, e wātea ana te Kohinga Angawaho o Aotearoa hei āta tirotiro mā te tangata mehemea he āwhina kei reira.

Me whāki te kaituhi i ōna whakaaro ki tētahi o te Kāhui Ārahi Whakarōpūtanga Tuarā-Kore, ki te Ētita rānei i mua i te tīmatanga, ā, mā rātou a ia e ārahi mō te wāhi ki tana tuhinga.