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Taxonomy and morphology of plant-parasitic nematodes associated with turfgrasses in North and South Carolina, USA

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Abstract

Twenty-nine species of plant-parasitic nematodes were recovered from 282 soil samples collected from turfgrasses in 19 counties in North Carolina (NC) and 20 counties in South Carolina (SC) during 2011 and from previous collections. These nematodes belong to 22 genera in 15 families, including *Belonolaimus longicaudatus, Dolichodorus heterocephalus, Filenchus cylindricus, Helicotylenchus dihystera, Scutellonema brachyurum, Hoplolaimus galeatus, Mesocriconema xenoplax, M. curvatum, M. sphaerocephala, Ogma floridense, Paratrichodorus minor, P. allius, Tylenchorhynchus claytoni, Pratylenchus penetrans, Meloidogyne graminis, M. naasi, Heterodera* sp., *Cactodera* sp., *Hemicycliophora conida, Loofia thienemanni, Hemicaloosia graminis, Hemicriconemoides wessoni, H. chitwoodi, Paratylenchus goldeni, Xiphinema americanum sensu lato, X. bakeri, X. chambersi, Longidorus paralongicaudatus,* and *Aphelenchoides myceliophagus*. Eleven species (*Meloidogyne graminis, M. naasi, Cactodera* sp., *Pratylenchus penetrans, Hemicycliophora conida, Hemicaloosia graminis, Mesocriconema xenoplax, M. sphaerocephala, Ogma floridense, Paratrichodorus allius, Dolichodorus heterocephalus*) were new records from turfgrass in both states; five (*Heterodera* sp., *Loofia thienemanni, M. curvatum, Longidorus paralongicaudatus, Filenchus cylindricus*) were new in SC; and three (*Hemicriconemoides wessoni, Xiphinema bakeri, Aphelenchoides myceliophagus*) were new in NC. The morphological and morphometric characteristics of these species are presented.

Keywords: distribution, identification, plant-parasitic nematode, turfgrass, Carolina

Introduction

Turfgrasses and associated businesses contribute billions of dollars to the economy in the USA and other countries. Plant-parasitic nematodes can be limiting factors in their growth and maintenance, especially in the sandy soils of the southeastern USA (Crow 2005a). Recent restrictions on the application of nematicides to turfgrasses highlight the need for a greater understanding of nematodes infecting turfgrasses so that more sustainable management strategies can be developed.

Over the past 40 years, several research papers on plant-parasitic nematodes associated with turfgrasses have been published in the USA (Smolik & Malek 1972; Lucas *et al*. 1974; Lucas 1982; Chastagner & McElroy 1984; Todd & Tisserat 1990; Giblin-Davis *et al*. 1992; Martin 1997; Sikora *et al*. 2001; Crow & Walker 2003; Hixson *et al*. 2004; Crow 2005b; Mitkowski 2007). Lucas *et al*. (1974) showed that *Mesocriconema ornatus, Helicotylenchus dihystera, Trichodorus christiei, Meloidogyne* sp., *Tylenchorhynchus claytoni, Hoplolaimus galeatus* and *Belonolaimus longicaudatus* were common plant-parasitic nematodes on golf course putting greens in NC, but *Pratylenchus zeae, Xiphinema americanum* and *Paratylenchus* sp. were found infrequently. No extensive survey of plant-parasitic nematodes associated with turfgrasses in North Carolina (NC) has been undertaken since this work

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and no surveys have been reported in South Carolina (SC). In this study, we present the taxonomy and morphology of plant-parasitic nematodes associated with turfgrasses in these two states.

Material and methods

Soil sampling: Two hundred and eighty-two soil samples were collected from 111 golf courses in 39 counties of NC and SC during the summer of 2011 (sampling map shown in Fig. 1 in Ye *et al*. 2012). Sampling locations were selected to represent a range of grass species [hybrid bermudagrass (*Cynodon dactylon* × *transvaalensis*), creeping bentgrass (*Agrostis stolonifera*) and zoysiagrass (Zoysia *matrella* and *Zoysia japonica*)] and management zones (putting greens, fairways, and tees). Each sample consisted of 12 soil cores (1.5 cm diam. × 20 cm deep) sampled at roughly equal intervals in a zig-zag pattern across an area of 1000 m^2 or less. Soil samples were placed in sealed plastic bags, which were then placed in sample boxes and stored at 4ºC before analysis to minimize changes in nematode populations. Some nematode materials collected previously from turfgrasses from NC in 2006-2010 were also used in this study.

Nematode extraction: Nematodes were extracted from soil samples by a combination of elutriation (Byrd *et al*. 1976) and centrifugation (Jenkins 1964). A 500-cm^3 subsample was taken from each composite sample and assayed to identify and count plant-parasitic nematodes. These tests were carried out by the Nematode Assay Laboratory of the North Carolina Department of Agriculture and Consumer Services.

Nematode identification: Individual nematodes representing each genus were picked, killed by heating (70ºC), and then fixed in FG solution (1 ml glycerol, 10 ml formalin, and 89 ml distilled water). Specimens were processed slowly into glycerol and mounted on microscope slides (Southey 1970). Measurements were made with the aid of a drawing tube using a LEICA DM 2500 microscope and a stage micrometer. Morphometric data were processed using Excel software (Ye 1996). Images of key morphological features were taken using an AxioCam MRc5 (Carl Zeiss Microscopy, LLC, Thornwood, NY 10594, USA) attached to an Axio Imager Carl Zeiss microscope, and edited using Photoshop CS2. In addition to morphological identification, most of the species were confirmed in a separate study by analysis of the near-full-length small subunit (SSU) and internal transcribed spacer region (ITS) rDNA sequences.

The abbreviations and their definitions for the de Man's ratios and other indices used in tables are as follows:

n = number of specimens on which measurements are based
L = overall body length
V = % distance of vulva from anterior
a = body length / greatest body diameter
b = body length / distance from anterior to esophago-intestinal valve
b' = body length / distance from anterior to base of esophageal glands
c = body length / tail length
c' = tail length / tail diameter at anus or cloaca
m = % length of shaft relative to stylet length
VA= distance from vulva to anus
VBD = diameter of body at vulva
PUS= postuterine sac
R= ring number of body cuticle
Rs= ring number from anterior to base of stylet base
Rex= ring number from anterior to excretory pore
Roes= ring number from anterior to base of esophageal glands

Results

Twenty-nine species of plant-parasitic nematodes, representing 22 genera in 15 families, were identified from the samples collected during this project. Of these nematodes, 24 species were found in SC, 22 species in NC, and 18 species in both states.

Systematics

The classification of nematodes associated with turfgrasses is based on the classification systems of Siddiqi (2000), Hunt (1993) and Decraemer (1995).

Tylenchida
- Tylenchina
  - Tylenchidae
    - *Filenchus cylindricus* (Thorne & Malek, 1968) Siddiqi, 1986
- Hoplolaimina
  - Hoplolaimidae
    - *Hoplolaimus galeatus* (Cobb, 1913) Thorne, 1935
    - *Scutellonema brachyurum* (Steiner, 1938) Andrássy, 1958
    - *Helicotylenchus dihystera* (Cobb, 1893) Sher, 1961
  - Pratylenchidae
    - *Pratylenchus penetrans* (Cobb, 1917) Chitwood & Oteifa, 1952
  - Meloidogynidae
    - *Meloidogyne graminis* (Sledge & Golden) Whitehead, 1968
    - *Meloidogyne naasi* Franklin, 1965
  - Heteroderidae
    - *Heterodera* sp.
    - *Cactodera* sp.
  - Dolichodoridae
    - *Dolichodorus heterocephalus* Cobb, 1914
  - Belonolaimidae
    - *Belonolaimus longicaudatus* Rau, 1958
  - Telotylenchidae
    - *Tylenchorhynchus claytoni* Steiner, 1937
- Criconematina
  - Criconematidae
    - *Ogma floridense* Vovlas, Inserra & Esser, 1991
    - *Mesocriconema xenoplax* (Raski, 1952) Loof & De Grisse, 1989
    - *Mesocriconema curvatum* (Raski, 1952) Loof & DeGrisse, 1989
    - *Mesocriconema sphaerocephala* (Taylor, 1936) Loof & De Grisse, 1989
    - *Hemicriconemoides chitwoodi* Esser, 1960
    - *Hemicriconemoides wessoni* Chitwood & Birchfield, 1957
  - Hemicycliophoridae
    - *Hemicycliophora conida* Thorne, 1955
    - *Loofia thienemanni* (Schneider, 1925) Siddiqi, 1980
  - Caloosiidae
    - *Hemicaloosia graminis* Zeng, Ye, Tredway, Martin & Martin, 2012
  - Paratylenchidae
    - *Paratylenchus goldeni* Raski, 1975

Aphelenchida
- Aphelenchina
  - Aphelenchoididae
    - *Aphelenchoides myceliophagus* (Thorne & Malek, 1968) Siddiqi, 1986

Dorylaimida
- Dorylaimina
  - Longidoridae
    - *Longidorus paralongicaudatus* Ye & Robbins, 2003
    - *Xiphinema americanum sensu lato* Cobb, 1913

Xiphinema bakeri Williams, 1961
Xiphinema chambersi Thorne, 1939

Triplonchida
Diphtherophorina
Trichodoridae
Paratrichodorus allius (Jensen, 1963) Siddiqi, 1974
Paratrichodorus minor (Colbran, 1956) Siddiqi, 1974

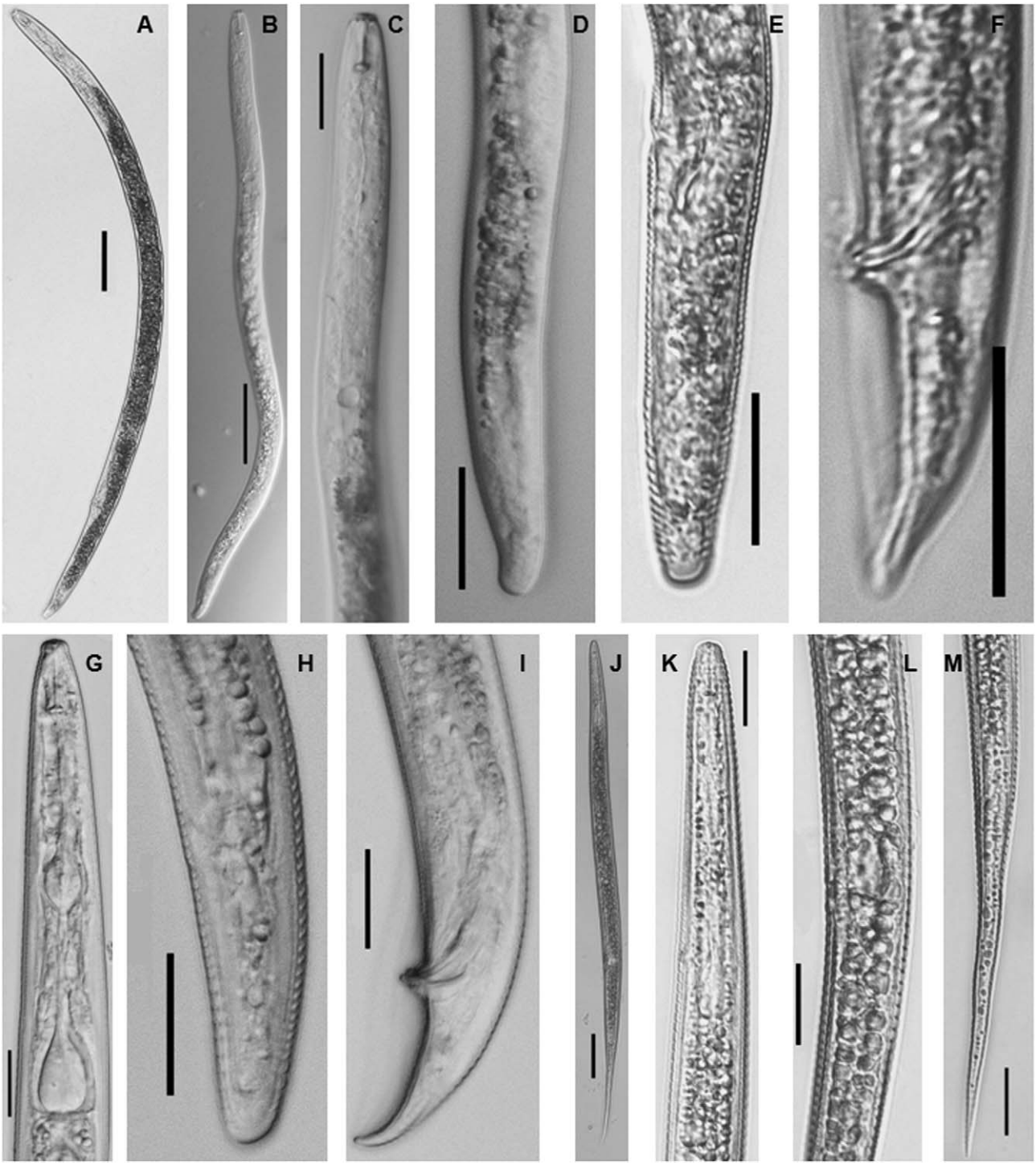

FIGURE 1. Micrographs of *Pratylenchus penetrans*, *Tylenchorhynchus claytoni* and *Filenchus cylindricus* from turfgrasses in NC and SC. Scale bars: A, B, J=50 µm; C-I, K-M=20µm. A,B. Entire body of *P. penetrans*. C. Pharyngeal region of *P. penetrans*. D,E. Female tails of *P. penetrans*. F. Male tail of *P. penetrans*. G. Pharyngeal region of *T. claytoni*. H. Female tail of *T. claytoni*. I. Male tail of *T. claytoni*. J. Entire body of *F. cylindricus*. K. Pharyngeal region of *F. cylindricus*. L. Vulval region of *F. cylindricus*. M. Female tail of *F. cylindricus*.

TABLE 1. *Filenchus cylindricus* and *Aphelenchoides myceliophagus*: morphometrics of male and females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***F. cylindricus*** **Female**	***A. myceliophagus*** **Male**	***A. myceliophagus*** **Female**
Lab ID	11-30748	11-29913	11-29913
Host	Bermudagrass	Centipedegrass	Centipedegrass
Location	Horry, SC	Cumberland, NC	Cumberland, NC
n	6	1	6
L	544.0 ± 12.3 (531.0–560.5)	541.0	509.4 ± 39.7 (463.0–559.9)
a	24.5 ± 1.2 (23.1–26.0)	30.8	26.9 ± 1.0 (25.7–28.2)
b	5.7 ± 0.2 (5.4–5.9)	8.0	9.9 ± 0.1 (9.8–10.1)
c	5.4 ± 0.6 (4.8–6.3)	14.0	15.6 ± 1.3 (14.5–17.3)
c’	8.5 ± 1.2 (6.8–9.6)	3.5	3.0 ± 0.1 (2.9–3.1)
V	66.3 ± 1.6 (64.4–68.2)	–	70.2 ± 0.3 (69.9–70.5)
Body width at vulva or greatest body width	19.1 ± 1.4 (17.5–20.8)	17.5	18.9 ± 0.8 (18.0–19.9)
Stylet length	13.1 ± 0.3 (12.9–13.5)	11.0	11.3 ± 0.1 (11.1–11.4)
Stylet shaft length	7.0 ± 0.1 (6.9–7.2)	5.8	5.4 ± 0.2 (5.2–5.5)
Pharynx length (Head to metacorpus base)	95.1 ± 2.6 (92.0–98.3)	67.6	51.5 ± 4.7 (45.9–57.3)
Anal body width	12.1 ± 0.5 (11.4–12.7)	11.0	10.9 ± 0.6 (10.2–11.6)
Tail length	101.5 ± 12.4 (95.8–116.2)	38.6	32.8 ± 0.9 (31.9–34.1)
Excretory pore from anterior end	80.6 ± 0.8 (79.7–81.7)	70.2	59.8 ± 4.9 (53.8–65.7)
Lip width	7.0 ± 0.0 (6.9–7.0)	4.4	5.8 ± 0.2 (5.5–6.1)
Lip height	3.8 ± 0.1 (3.7–3.9)	2.1	2.8 ± 0.1 (2.7–3.0)
Metacorpus length	–	11.4	11.5 ± 0.5 (10.8–11.9
Metacorpus width	–	8.0	9.6 ± 0.1 (9.5–9.7)
VA	82.2 ± 3.7 (77.3–86.0)	–	118.8 ± 10.6 (107.6–133.1)
PUS	6.4 ± 1.1 (5.1–7.8)	–	17.6 ± 2.4 (14.2–19.4)
Spicule length	–	21.5	–
Gubernaculum length	–	10.2	–
Annule width at mid-body	2.5 ± 0.1 (2.4–2.5)	–	–
Metacorpus L/W	–	1.4	1.2 ± 0.0 (1.1–1.2)
Gubernaculum %Spicule	–	47.4	–
PUS/VBD	–	–	0.9 ± 0.1 (0.8–1.0)
Lip W/H	1.8 ± 0.0 (1.8–1.9)	2.1	2.1 ± 0.1 (2.0–2.2)
M	53.4 ± 1.8 (51.4–55.7)	52.7	47.6 ± 0.8 (46.8–48.2)

Filenchus cylindricus
(Fig. 1 J–M)

Measurements. See Table 1.

Remarks. The type population of *F. cylindricus* was first described as *Tylenchus cylindricus* from natural grassland adjacent to wheat fields near Presho and Winner, South Dakota, and Holbrook, Nebraska, by Thorne & Malek (1968). Elmiligy (1971) described another population from loamy sand around roots of *Zea mays* in Iowa as *T. hageneri*. Raski & Geraert (1987) synonymized *T. hageneri* with *T. cylindricus* and transferred both species to the genus *Filenchus*. This species has also been recorded from Bulgaria (Katalan-Gateva & Tsoneva 1977), Romania (Dobrin & Rosca 1996), Turkey (Erdogus *et al*. 2010) and Pakistan (Erum & Shahina, 2010). In the present study, *F. cylindricus* was found in samples from a bermudagrass tee in Horry County, SC. The morphological characteristics fit well with the description by Zeidan & Geraert (1991), but the morphometrics showed smaller body length and *a* value in females than in the described populations (Zeidan & Geraert 1991). This is the first record of *F. cylindricus* from turfgrasses in SC.

Hoplolaimus galeatus
(Fig. 2 A–E)

Measurements. See Table 2.

Remarks. *Hoplolaimus galeatus* was described from soil at Arlington Farms, Arlington, Virginia, USA (Cobb 1913). It has been reported from SC (Lewis *et al*. 1993; Martin *et al*. 1994; Koenning & Barker 1998), NC (Lucas *et al*. 1974), Florida (Crow 2005b), Kansas (Todd & Tisserat 1990), Arkansas (Robbins *et al*. 1987), Tennessee (Ponchillia 1975), Alabama (Rodriguez-Kabana & Thurlow 1980), Minnesota (Wallace & MacDonald 1979), Virginia (Niles *et al*. 1985), Maryland (Feldmesser & Golden 1972), Indiana (Alby *et al*. 1983), Mississippi (Bost 1985), Kentucky (Chapman 1976), Louisiana (McGawley *et al*. 1984), Illinois (Allen *et al*. 2005), Michigan (Olsen 1983), Texas (Heald *et al*. 1991), Missouri (Wrather *et al*. 1992) and Iowa (Norton & Hinz 1976) in USA. This species has been reported in Trinidad (Singh 1973), Costa Rica (Tarjan & Jimenez 1973), Argentina (Doucet 1980), Peru (Ciancio *et al*. 1998), Brazil (Torres *et al*. 2007), Turkey (Kepenekci & Ökten 2000), Pakistan (Goswami *et al*. 2008) and Australia (Nambiar *et al*. 2008). *Hoplolaimus galeatus* feeds and reproduces on a wide range of plant hosts. It can cause serious damage to cotton (Krusberg & Sasser 1956; Wrather *et al*. 1992; Martin *et al*. 1994; Gazaway & Mclean 2003), soybean (Lewis *et al*. 1993; Koenning & Barker 1998), banana (Torres *et al*. 2007) and corn (Norton & Hinz 1976). It is also considered to be an economically important pest of turfgrasses such as St. Augustine grass (*Sternotaphrum secundatum*) and bermudagrass (*Cynodon dactylon*) (Henn & Dunn 1989; Giblin-Davis *et al*. 1990, 1995). In this survey, this species was found in 22 counties in NC and SC. It was found with high prevalence in all three management zones (green, fairway and tee) and two grass species (bentgrass and zoysiagrass). The morphological characteristics agreed well with the population described by Sher (1963).

Scutellonema brachyurum
(Fig. 2 F–H)

Measurements. See Table 3.

Remarks. *Scutellonema brachyurum* was described from red spiderlily (*Lycoris radiata*) in Hamlet, Richmond County, NC, and was also documented in SC (Kraus-Schmidt & Lewis 1979). CABI (2006) recorded *S. brachyurum* in six countries in Europe, 11 in Asia, 15 in Africa, two in North America (Canada, USA including Arkansas, California, Florida, NC, SC), four in Central America and the Caribbean, four in South America, and five in Oceania. A series of studies on the host range of *S. brachyurum* in South Africa was carried out from 1988 to 2001 (Waele & Jordaan 1988a; 1988b; Bolton *et al*. 1989; Jordaan *et al*. 1992; Venter *et al*. 1992; Fourie *et al*. 2001). Tarjan (1964a) reported it on bermudagrass in Egypt. Agudelo & Harshman (2011) first found it on lilyturf (*Liriope muscari*) in SC. In the present study, *S. brachyurum* was found only in Beaufort County, SC, in samples from a bermudagrass putting green. The morphology and morphometrics of the identified population did not differ from other populations (Siddiqi 1974b).

TABLE 2. *Hoplolaimus galeatus*: morphometrics of males and females mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Sex	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Lab ID	09-23920	09-23920	06-12319	06-12319	07-00334	07-00334
Host	Turf	Turf	Turf	Turf	Turf	Turf
Location	Moore, NC	Moore, NC	Moore, NC	Moore, NC	Moore, NC	Moore, NC
n	15	8	1	10	1	10
L	1200.0 ± 100.3 (1110.0–1340.0)	1462.8 ± 77.9 (1326.0–1591.0)	1120.0	1385.9 ± 102.8 (1219.0–1520.0)	1110.0	1372.4 ± 76.9 (1321.0–1505.0)
a	31.2 ± 3.2 (27.4–35.3)	32.1 ± 2.4 (29.1–36.2)	31.1	32.5 ± 2.8 (28.0–36.1)	30.8	30.5 ± 3.0 (27.6–35.0)
b	7.0 ± 0.7 (6.5–8.0)	8.9 ± 0.9 (7.8–10.1)	7.5	8.5 ± 1.5 (5.8–10.8)	6.0	8.1 ± 0.6 (7.1–8.5)
c	40.5 ± 6.2 (31.9–46.3)	43.4 ± 5.0 (37.6–53.1)	37.3	57.6 ± 6.9 (46.9–69.1)	30.8	46.0 ± 10.2 (30.1–55.0)
c’	1.4 ± 0.1 (1.2–1.5)	1.0 ± 0.1 (0.7–1.2)	1.5	0.8 ± 0.1 (0.6–0.9)	1.6	0.9 ± 0.2 (0.6–1.2)
V	–	55.0 ± 1.5 (52.5–57.8)	–	54.8 ± 2.5 (52.7–60.4)	–	54.3 ± 1.1 (53.4–56.2)
Body width	38.7 ± 2.5 (36.0–42.0)	45.6 ± 2.1 (43.0–49.0)	36.0	42.7 ± 2.2 (40.0–47.0)	36.0	45.3 ± 2.8 (42.0–48.0)
Stylet length	45.3 ± 0.9 (44.0–46.0)	47.5 ± 3.0 (45.0–55.0)	39.5	50.1 ± 2.6 (48.0–56.0)	41.5	46.5 ± 1.5 (45.0–49.0)
Stylet cone length	27.0 ± 2.2 (24.0–29.0)	28.3 ± 3.5 (26.0–37.0)	20.5	29.0 ± 1.6 (27.0–32.0)	22.5	26.3 ± 1.1 (25.0–28.0)
Pharynx length (Head to metacorpus base)	170.7 ± 5.2 (166.0–178.0)	165.5 ± 13.3 (142.0–190.0)	150.0	167.1 ± 25.6 (120.0–210.0)	184.0	170.3 ± 13.8 (156.0–186.0)
Spicule length	48.7 ± 0.9 (48.0–50.0)	–	44.0	–	42.0	–
Anal body width	22.0 ± 1.6 (20.0–24.0)	36.0 ± 3.4 (33.0–44.0)	20.0	31.4 ± 2.3 (27.0–34.0)	23.0	35.6 ± 1.8 (34.0–38.5)
Tail length	30.3 ± 4.9 (24.0–36.0)	34.1 ± 4.0 (28.0–39.0)	30.0	24.3 ± 2.2 (22.0–28.0)	36.0	31.6 ± 8.2 (24.0–44.0)
Excretory pore from anterior end	141.0 ± 4.5 (135.0–146.0)	144.4 ± 13.8 (120.0–166.0)	132.0	159.8 ± 8.6 (150.0–172.0)	146.0	147.5 ± 12.3 (130.0–160.0)
Lip width	15.8 ± 0.2 (15.5–16.0)	16.3 ± 1.5 (14.0–18.0)	14.0	15.4 ± 1.3 (13.5–17.0)	14.0	15.3 ± 1.9 (13.0–18.0)
Lip height	8.7 ± 0.9 (8.0–10.0)	8.4 ± 0.4 (8.0–9.0)	8.0	8.1 ± 0.2 (8.0–8.5)	8.0	7.9 ± 0.5 (7.0–8.5)
Metacorpus length	22.0 ± 1.4 (21.0–24.0)	22.5 ± 1.4 (20.0–24.0)	16.0	21.2 ± 1.9 (20.0–25.0)	23.0	22.3 ± 1.5 (20.0–24.0)
Metacorpus width	14.0 ± 2.8 (10.0–16.0)	17.7 ± 0.7 (16.0–18.0)	12.0	16.5 ± 2.0 (14.0–20.0)	19.0	17.3 ± 0.8 (16.0–18.0)
Lip L/W	1.8 ± 0.2 (1.6–2.0)	1.9 ± 0.1 (1.8–2.1)	1.8	1.9 ± 0.2 (1.7–2.1)	1.8	2.1 ± 0.2 (1.8–2.3)
Metacorpus L/W	1.7 ± 0.5 (1.3–2.4)	1.3 ± 0.1 (1.1–1.4)	1.3	1.3 ± 0.1 (1.1–1.4)	1.2	1.3 ± 0.0 (1.3–1.3)

TABLE 3. *Helicotylenchus dihystera* and *Scutellonema brachyurum*: morphometrics of females mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Species	***H. dihystera***	***H. dihystera***	***S. brachyurum***
Lab ID	09-23983	12-59	11-29736
Host	Turf	Bermudagrass	Turf
Location	Wayne, NC	Pickens, SC	New Hanover, NC
n	15	15	15
L	648.0 ± 33.1 (609.0–698.0)	649.8 ± 27.9 (620.2–693.3)	794.3 ± 63.3 (720.2–906.6)
a	25.8 ± 1.7 (24.3–28.6)	21.9 ± 1.4 (19.8–23.6)	26.8 ± 2.3 (22.8–29.4)
b	7.9 ± 1.0 (6.2–8.8)	4.9 ± 0.2 (4.7–5.2)	5.4 ± 0.6 (4.7–6.3)
c	38.3 ± 5.0 (34.9–46.8)	36.1 ± 0.9 (35.2–37.2)	81.5 ± 11.4 (63.4–101.1)
c’	1.1 ± 0.1 (1.0–1.3)	1.1 ± 0.1 (1.0–1.2)	0.6 ± 0.0 (0.5–0.6)
V	62.4 ± 0.8 (61.1–63.4)	61.7 ± 1.7 (58.8–63.2)	60.6 ± 1.1 (58.7–61.8)
Body width	25.3 ± 2.4 (22.0–28.0)	29.8 ± 1.5 (27.7–31.4)	29.9 ± 4.0 (24.5–36.7)
Stylet length	24.3 ± 1.4 (23.0–26.5)	23.7 ± 0.4 (23.0–24.0)	27.7 ± 0.4 (27.2–28.4)
Stylet shaft length	12.6 ± 0.5 (12.0–13.5)	12.8 ± 0.4 (12.1–13.5)	15.6 ± 0.3 (15.1–16.0)
Pharynx length (Head to metacorpus base)	84.0 ± 14.2 (70.0–105.0)	131.8 ± 7.8 (119.5–140.4)	147.3 ± 13.3 (132.1–169.0)
Anal body width	15.0 ± 1.6 (13.0–17.0)	16.2 ± 0.8 (14.9–16.8)	17.6 ± 1.0 (15.8–18.6)
Tail length	17.3 ± 2.6 (13.0–20.0)	18.0 ± 0.7 (17.1–18.7)	9.9 ± 1.0 (8.4–11.7)
Excretory pore from anterior end	105.7 ± 3.3 (102.0–110.0)	109.0 ± 5.7 (101.0–116.6)	132.6 ± 9.5 (118.5–144.7)
Lip width	5.0 ± 0.0 (5.0–5.0)	6.0 ± 0.3 (5.6–6.4)	9.4 ± 0.4 (8.9–9.9)
Lip height	3.0 ± 0.0 (3.0–3.0)	3.2 ± 0.2 (2.9–3.5)	5.9 ± 0.1 (5.7–6.1)
Metacorpus length	14.5 ± 0.5 (14.0–15.0)	12.8 ± 0.4 (12.3–13.2)	14.0 ± 1.8 (11.4–16.2)
Metacorpus width	10.5 ± 0.5 (10.0–11.0)	9.9 ± 0.6 (9.2–10.7)	10.8 ± 1.4 (8.9–12.5)
m	–	–	43.6 ± 0.9 (42.1–45.2)
Lip W/H	1.7 ± 0.0 (1.7–1.7)	1.8 ± 0.1 (1.7–1.9)	1.6 ± 0.1 (1.5–1.7)
Metacorpus L/W	1.4 ± 0.0 (1.4–1.4)	1.3 ± 0.0 (1.2–1.4)	1.3 ± 0.1 (1.2–1.6)

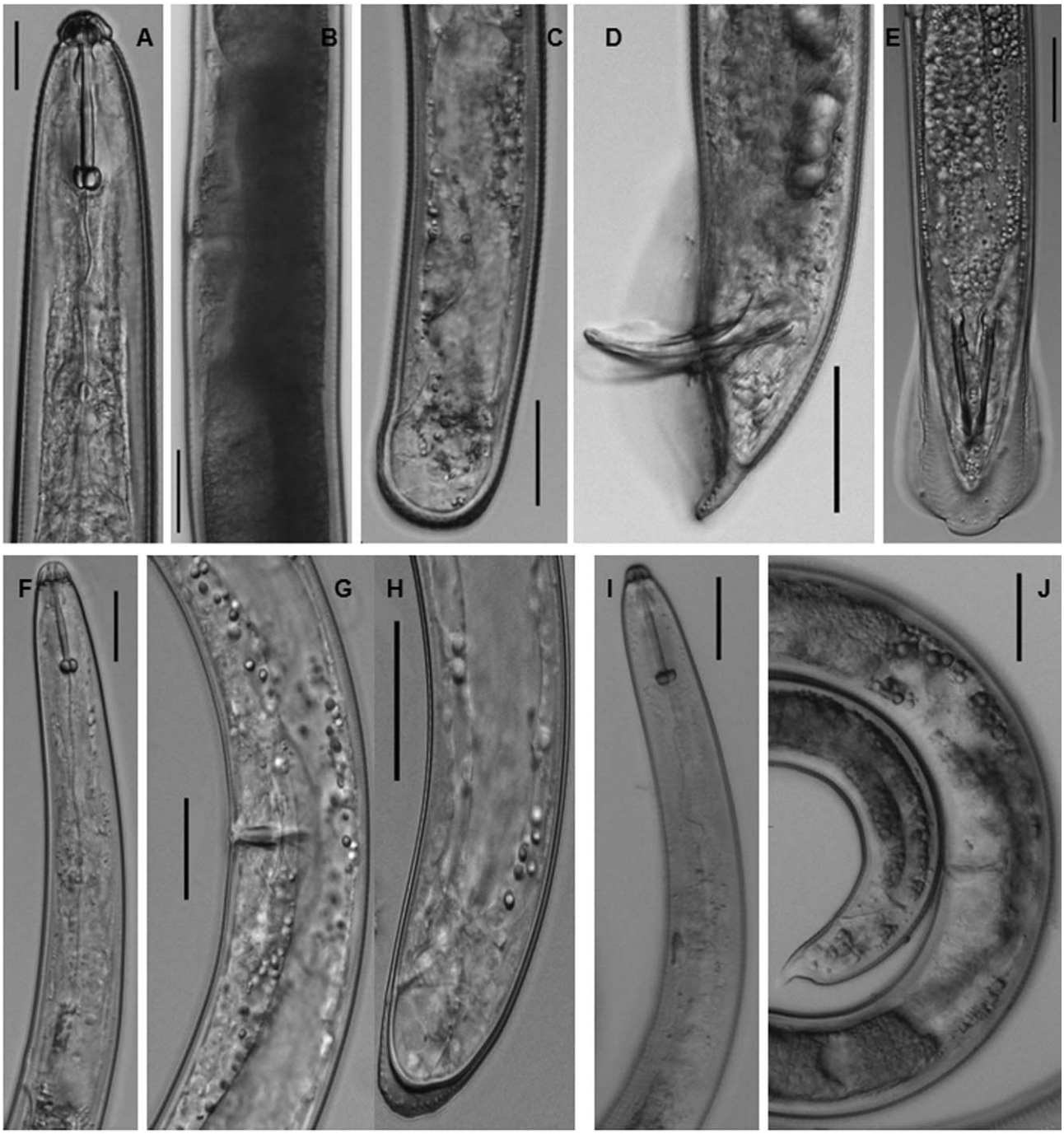

FIGURE 2. Micrographs of *Hoplolaimus galeatus*, *Scutellonema brachyurum* and *Helicotylenchus dihystera* from turfgrasses in NC and SC. All scale bars =20 µm. A. Pharyngeal region of *H. galeatus*. B. Vulval region of *H. galeatus*. C. Female tail of *H. galeatus*. D,E. Male tails of *H. galeatus*. F. Pharyngeal region of *S. brachyurum*. G. Vulval region of *S. brachyurum*. H. Female tail of *S. brachyurum*. I. Pharyngeal region of *H. dihystera*. J. Vulva and tail region of *H. dihystera*.

Helicotylenchus dihystera
(Fig. 2 I, J)

Measurements. See Table 3.

Remarks. *Helicotylenchus dihystera* was described from soil around sugarcane roots (*Saccharum officinarum*) in Harwood, Australia. It is a cosmopolitan species with a wide geographical distribution,

occurring in 17 countries in Europe, 28 in Asia, 30 in Africa, three in North America, 18 in Central America and Caribbean, eight in South America, and eight in Oceania (CABI 2010). In the USA, it occurs in Alabama, Arkansas, California, Colorado, Florida, Georgia, Hawaii, Louisiana, Maryland, Mississippi, Missouri, NC, South Dakota and Texas (CABI 2010). This species has a wide host range including sugarcane, potato, banana, rice, tea, avocado, coffee, maize, beans, wheat, rye, oat, sorghum, and turfgrass (Kinloch 1971; Siddiqi 1972; Lucas *et al*. 1974). There was a significant correlation between numbers of *H. dihystera* and reduced growth of Kentucky bluegrass in a landscape setting in Lincoln, Nebraska (Sumner 1967) and of turf in bowling greens in Adelaide, Australia (Wallace 1971). In this study, *H. dihystera* was found in 34 counties in both NC and SC. It had high prevalence in all three management zones (green, fairway and tee) and two grass species (bentgrass and zoysiagrass). Both morphology and morphometrics fit the description of other populations (Sher 1966; Siddiqi 1972).

Pratylenchus penetrans
(Fig. 1 A–F)

Measurements. See Table 4.
Remarks. *Pratylenchus penetrans* was described from greenhouse soil around roots of cotton and potato in Rhinebeck, New York (Cobb 1917). It has been reported from 25 countries in Europe, 16 in Asia, 11 in Africa, 3 in North America, 3 in Central America and Caribbean, 3 in South America, and 3 in Oceania (CABI, 2003; Deimi *et al*. 2008). In the USA, it occurs in 38 mainland states and Hawaii (CABI 2003; Wang & Hooks 2009). Simard *et al*. (2008) reported that *P. penetrans* was uncommon in golf courses in Ontario and Québec, Canada. Here, *P. penetrans* was found in 36 samples taken in 23 counties in NC and SC, in three turf management zones (green, fairway and tee) and two grass species (bermudagrass and creeping bentgrass) in both states. The morphology and morphometrics of the identified population did not differ from previously described populations (Corbett 1973). This is the first record of *P. penetrans* from turfgrasses in NC and SC.

Meloidogyne graminis
(Fig. 3 A–D)

Measurements. See Table 5.

Remarks. *Meloidogyne graminis* was described from grass in Florida by Sledge (1962) and has been reported from the southeastern, midwestern, and mid-Atlantic USA (Sledge 1962; Bell & Krusburg 1964; Sledge & Golden 1964; Dickerson 1966; Southard 1967; Williams & Laughlin 1968; Grisham *et al*. 1974). It has also been recorded from Germany (Sturhan 1976b), China (Zhuo *et al*. 2011), India (Kaul & Chhabra 1988) and Libya (Fourgani & Edongali 1989). It feeds and reproduces on some turfgrasses, including bermudagrass (Burton & Hanna 1977; Murray *et al*. 1986), zoysiagrass (Grisham *et al*. 1974; Murray *et al*. 1986), tall fescue (Elmi *et al*. 1990), *Paspulum notatum*, *Stenotaphrum secundatum*, *Oryza sativa*, *Digitaria sanguinalis* and *Ammophila arenaria* (Jepson 1987). It is considered the most widespread and potentially destructive turfgrass nematode (Murray *et al*. 1986). In the present study, the second-stage juveniles (J2) of *M. graminis* were found in 104 turfgrass samples collected in 30 counties in three turf management zones (green, fairway and tee) and two grass species (bermudagrass and zoysiagrass) in both states. No adult female was detected. The morphology and morphometricsof J2s did not differ from those described by Karssen & Hoenselaar (1998). However, the morphometrics for several characters (*a, c'*, stylet, tail length, and hyaline tail part) of J2s showed a smaller range than the originally described population. The 18S rDNA sequences from isolates 11-30688 (1968 bp sequenced) and 11-30365 (1987 bp sequenced) had 99% identity with an isolate from a golf course in Pinal County, Arizona (JN241837, 609 bp sequenced) (http://www.ncbi.nlm.nih.gov/nuccore/JN241837). This is the first record of *M. graminis* from turfgrasses in NC and SC.

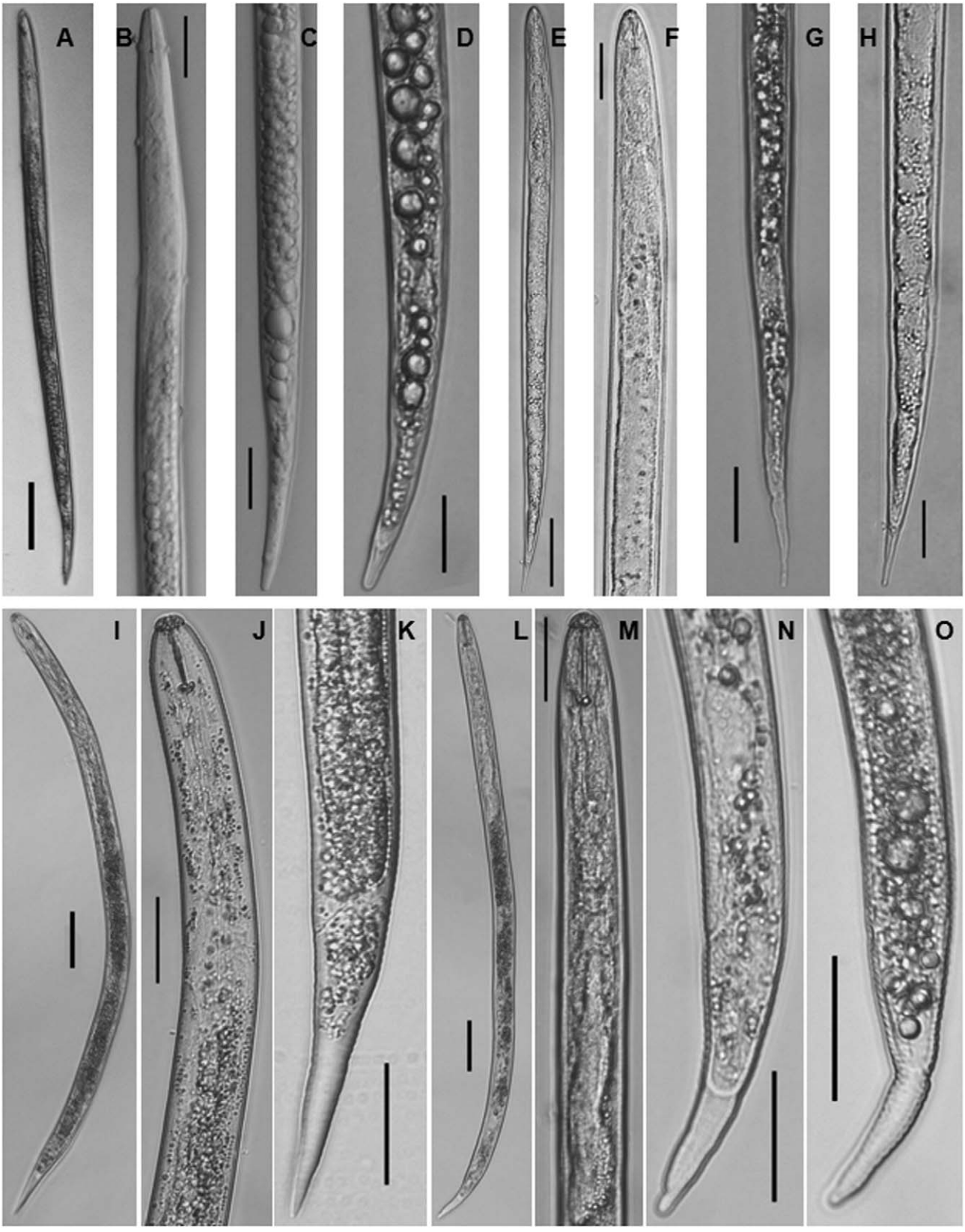

FIGURE 3. Micrographs of J2 of *Meloidogyne graminis*, *M. naasi*, *Heterodera* sp. and *Cactodera* sp. from turfgrasses in NC and SC. Scale bars: A, E, I, L=50µm; B–D, F–H, J, K, M–O=20µm. A. Entire body of *M. graminis*. B. Pharyngeal region of *M. graminis*. C,D. Tail of *M. graminis*. E. Entire body of *M. naasi*. F. Pharyngeal region of *M. naasi*. G,H. Tails of *M. naasi*. I. Entire body of *H*. sp. J. Pharyngeal region of H. sp. K. Tail of H. sp. L. Entire body of *C*. sp. M. Pharyngeal region of *C*. sp. N,O. Tails of *C.* sp.

TABLE 4. *Pratylenchus penetrans*: morphometrics of males and females mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Sex	**Female**	**Male**
Lab ID	11-30392	11-30392
Host	Boxwood	Boxwood
Loccation	Graham, NC	Graham, NC
n	10	10
L	597.5 ± 21.0 (568.7–618.1)	476.4 ± 46.5 (410.6–510.7)
a	31.3 ± 0.8 (30.3–32.3)	30.1 ± 1.6 (28.8–32.4)
b’	4.8 ± 0.2 (4.6–5.0)	4.0 ± 0.1 (3.8–4.1)
c	20.9 ± 0.9 (19.6–21.7)	19.2 ± 0.4 (18.7–19.6)
c’	2.4 ± 0.2 (2.3–2.7)	2.1 ± 0.1 (2.0–2.2)
V	81.4 ± 1.1 (79.9–82.6)	–
Body width	25.3 ± 2.4 (22.0–28.0)	15.8 ± 1.3 (14.3–17.4)
Stylet length	16.1 ± 0.3 (15.8–16.5)	14.6 ± 0.5 (13.9–15.1)
Stylet shaft length	7.3 ± 0.1 (7.2–7.4)	6.8 ± 0.5 (6.1–7.3)
Pharynx length (Head to metacorpus base)	125.5 ± 2.8 (123.5–129.5)	120.2 ± 12.8 (102.9–133.2)
Anal body width	11.8 ± 0.9 (10.7–12.9)	11.9 ± 0.6 (11.1–12.4)
Tail length	28.6 ± 0.5 (27.9–29.0)	24.7 ± 2.0 (22.0–26.4)
Excretory pore from anterior end	83.3 ± 5.0 (76.3–87.4)	71.9 ± 3.4 (69.3–76.7)
Lip width	8.0 ± 0.1 (7.9–8.1)	7.6 ± 0.3 (7.1–7.9)
Lip height	2.6 ± 0.0 (2.6–2.7)	2.5 ± 0.3 (2.1–2.7)
Metacorpus length	11.3 ± 0.9 (10.0–12.2)	10.7 ± 0.5 (10.0–11.3)
Metacorpus width	9.2 ± 1.0 (7.8–10.0)	7.9 ± 0.2 (7.6–8.1)
VA	82.4 ± 8.0 (75.1–93.6)	–
VBD	17.6 ± 1.3 (15.9–19.2)	–
PUS	19.4 ± 2.3 (16.8–22.4)	–

.....continued on next page

TABLE 4. (Continued)

Sex	Female	Male
Spicule length	–	15.0 ± 1.0 (14.3–16.5)
Gubernaculum length	–	4.3 ± 0.4 (3.8–4.7)
Lip W/H	3.0 ± 0.0 (3.0–3.1)	3.1 ± 0.2 (2.9–3.3)
Metacorpus L/W	1.2 ± 0.0 (1.2–1.3)	1.4 ± 0.0 (1.3–1.4)
Gubernaculum %Spicule	–	28.9 ± 2.6 (26.8–32.6)
PUS/VBD	1.1 ± 0.1 (1.0–1.3)	–

Meloidogyne naasi

(Fig. 3 E–H)

Measurements. See Table 5.

Remarks. *Meloidogyne naasi* was described from spring-sown barley (*Hordeum vulgare*) in Gloucestershire, England by Franklin (1965) and has been reported from Kansas (Michell 1972; Ediz & Dickerson 1976), Illinois (Michell *et al*. 1973), the southern USA (Crow 2005b), Canada (Bélair *et al*. 2006), Argentina (Echeverría & Chaves 1998; Chaves & Torres 2000), Chile (Kilpatrick *et al*. 1976), United Kingdom and Ireland (Franklin 1965, 1973; Cook *et al*. 1992; Karnkowski 2005), Poland (Kornobis 2001), Belgium (Vandenbossche *et al*. 2011), Hungary (Amin & Budai 1992; Amin 1994), the Netherlands (Maas & Maenhout 1978), Germany (Sturhan 1973; Thomas 1981), Italy and Malta (Inserra *et al*. 1975, 1978; Lamberti & Dandria 1979;), France (Person-Dedryver *et al*. 1987), Yugoslavia (Grujicic 1969), the SR Serbia (Jovicic & Grujicic 1986), Libya (Siddiqui & Khan 1986) and New Zealand (Sheridan & Grbavac 1979). It was pathogenic to creeping bentgrass in greenhouse experiments at the University of Illinois, Urbana-Champaign (Sikora *et al*. 1972). In this study, *M. naasi* was found in nine counties in NC and SC. It occurred in three turf management zones (green, fairway and tee) in both states, two grass species (bermudagrass and bentgrass) in SC and three (bermudagrass, bentgrass and zoysiagrass) in NC. No adult female was detected. The morphological characteristics of the J2 did not differ from those described by Franklin (1965). The 18S rDNA sequence 11-30383 also confirmed this species with 99% identity (2015 bases sequenced, compared with AY593901) (http://www.ncbi.nlm.nih.gov/nuccore/AY593901). This is the first record of *M. naasi* from turfgrasses in NC and SC.

Heterodera sp.

(Fig. 3 I–K)

Measurements. See Table 6.

Remarks. The J2 of an unidentified species of *Heterodera* was found in golf course tees established with bermudagrass in Horry County, SC. No cysts or white females were found. The morphology and morphometrics of J2's were similar to those of *H. mani*, which was described from perennial rye-grass (*Lolium perenne*) in Magilligan, Northern Ireland by Mathews (1971) and has been recorded from the Western Hemisphere and California (Golden 1979), Northern Ireland (Mowat 1974), Germany (Sturhan 1976a; 2006), Belgium (Vandenbossche *et al*. 2011), the Netherlands (Maas & Brinkman 1977), Estonia (Krall *et al*. 1999), Iran (Moghaddam & Kheiri 1995) and Pakistan (Maqbool 1980). The 18S rDNA and ITS sequence (2289 bp sequenced) had 99% identity with a European population of *H. mani* (EU669916 1700 bp sequenced) (Holterman *et al*. 2009). However, as no cysts were detected in this study, the species of *Heterodera* could not be determined. This is the first record of *Heterodera* from turfgrasses in SC.

TABLE 5. *Meloidogyne* spp.: morphometrics of second stage juveniles mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***M. graminis***	***M. graminis***	***M. naasi***
Lab ID	11-30385	11-30368	11-30383-384
Host	Bentgrass	Bermudagrass	Bentgrass
Location	Avery, NC	Richland, SC	Avery, NC
n	15	15	15
L	411.7 ±19.3 (391.4–441.1)	392.4 ± 16.8 (368.2–420.2)	431.9 ± 13.4 (414.6–449.6)
a	28.1 ± 1.3 (26.4–30.0)	24.9 ± 1.8 (22.7–27.9)	28.8 ± 1.0 (27.5–30.1)
b’	4.2 ± 0.5 (3.6–4.7)	4.3 ± 0.2 (4.1–4.7)	4.7 ± 0.2 (4.5–4.9)
c	6.8 ± 0.2 (6.4–7.9)	6.5 ± 0.4 (6.0–6.9)	8.0 ± 0.2 (7.9–8.4)
c’	5.9 ± 0.3 (5.6–6.2)	5.5 ± 0.6 (4.8–6.4)	6.1 ± 0.2 (0.7–1.2)
Body width	14.7 ± 0.8 (13.9–15.8)	15.9 ± 1.3 (13.9–17.7)	15.0 ± 0.3 (14.5–15.4)
Stylet length	11.9 ± 0.4 (11.4–12.3)	11.7 ± 0.4 (11.0–12.0)	11.1 ± 0.6 (10.2–11.5)
Body diam. at stylet basal knob	9.4 ± 0.5 (9.0–10.2)	9.7 ± 0.3 (9.3–10.0)	9.6 ± 0.3 (9.4–10.2)
Pharynx length (Head to metacorpus base)	98.1 ± 7.2 (90.2–108.6)	90.7 ± 5.2 (81.3–96.2)	92.8 ± 4.9 (84.4–96.2)
Anal body width	10.3 ± 0.6 (9.7–11.3)	11.2 ± 0.9 (10.0–12.6)	8.9 ± 0.5 (8.4–9.6)
Tail length	61.1 ± 5.1 (56.0–69.4)	61.0 ± 3.8 (53.9–64.5)	53.9 ± 1.9 (52.2–57.1)
Hyaline tail part	11.7 ± 1.1 (10.6–13.3)	11.5 ± 0.8 (10.2–12.6)	22.1 ± 1.8 (20.2–24.4)
Lip width	5.7 ± 0.5 (5.0–6.3)	5.4 ± 0.2 (5.1–5.6)	5.4 ± 0.2 (5.2–5.6)
Lip height	2.6 ± 0.2 (2.3–2.9)	2.2 ± 0.1 (2.2–2.3)	2.3 ± 0.2 (2.1–2.7)
Metacorpus length	10.0 ± 0.4 (9.4–10.6)	10.0 ± 0.7 (9.1–10.8)	10.0 ± 0.4 (9.3–10.4)
Metacorpus width	7.5 ± 0.4 (7.0–8.2)	7.8 ± 0.5 (7.1–8.3)	7.2 ± 0.3 (6.8–7.6)
LipL/W	2.2 ± 0.2 (2.0–2.5)	2.4 ± 0.1 (2.3–2.5)	2.4 ± 0.2 (2.1–2.6)
Metacorpus L/W	1.3 ± 0.1 (1.3–1.4)	1.3 ± 0.0 (1.2–1.3)	1.4 ± 0.1 (1.3–1.5)
H %tail	23.2 ± 3.9 (18.1–29.1)	18.9 ± 2.0 (16.7–21.8)	41.1 ± 4.0 (35.3–45.4)

TABLE 6. *Heterodera* sp. and *Cactodera* sp.: morphometrics of second stage juveniles mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***Heterodera* sp.**	***Cactodera* sp.**
Lab ID	11-30748	11-30146
Host	Bermudagrass	Turfgrass
Location	Horry, SC	Cumberland, NC
n	10	10
L	558.7 ± 28.4 (518.7–582.3)	570.3 ± 34.1 (536.3–628.7)
a	24.5 ± 2.0 (22.0–26.9)	23.7 ± 2.8 (20.8–28.5)
b’	4.0 ± 0.2 (3.8–4.3)	3.3 ± 0.2 (3.0–3.6)
c	8.9 ± 0.1 (8.9–9.0)	9.4 ± 0.7 (8.2–10.2)
c’	3.7 ± 0.3 (3.3–4.1)	3.5 ± 0.2 (3.1–3.7)
Body width	23.0 ± 2.5 (20.9–26.5)	24.3 ± 1.7 (21.2–26.3)
Stylet length	24.7 ± 0.2 (24.4–24.8)	27.7 ± 0.6 (26.9–28.9)
Body diam. at stylet basal knob	18.9 ± 2.2 (16.8–21.9)	21.2 ± 0.9 (20.2–22.5)
Pharynx length (Head to metacorpus base)	139.2 ± 4.9 (134.3–145.9)	171.8 ± 21.7 (147.2–212.4)
Anal body width	17.0 ± 1.9 (15.6–19.7)	17.2 ± 0.5 (16.5–17.7)
Tail length	62.4 ± 2.8 (58.4–64.5)	60.5 ± 3.8 (54.9–65.5)
Hyaline tail terminus	33.7 ± 3.6 (29.9–38.6)	28.2 ± 2.6 (23.5–31.8)
Lip width	10.1 ± 0.2 (9.9–10.4)	10.5 ± 0.5 (10.0–11.5)
Lip height	4.7 ± 0.4 (4.1–5.0)	5.3 ± 0.4 (4.5–6.0)
Metacorpus length	15.4 ± 2.2 (12.9–18.3)	13.6 ± 1.6 (12.0–17.0)
Metacorpus width	10.4 ± 1.9 (8.4–12.9)	9.2 ± 1.7 (7.3–12.7)
LipL/W	2.2 ± 0.2 (2.1–2.4)	2.0 ± 0.2 (1.7–2.2)
Metacorpus L/W	1.5 ± 0.1 (1.4–1.5)	1.5 ± 0.1 (1.3–1.7)
H%tail	53.9 ± 4.2 (50.9–59.8)	46.6 ± 3.8 (42.5–53.9)
m	54.7 ± 2.4 (52.1–57.9)	55.2 ± 2.9 (50.3–58.2)
Stylet basal knob diam.	6.0 ± 0.1 (5.9–6.1)	5.9 ± 0.7 (4.9–6.8)
Stylet basal knob height	3.3 ± 0.1 (3.2–3.4)	3.1 ± 0.6 (2.4–4.0)
Stylet basal knob W/H	1.8 ± 0.0 (1.8–1.9)	1.9 ± 0.2 (1.6–2.2)

***Cactodera* sp.**
(Fig. 3 L–O)

Measurements. See Table 6.

Remarks. Only the J2 of a *Cactodera* species was found from a zoysiagrass tee in Moore County, NC, and from a bermudagrass fairway in Florence County, SC. No cysts or white females were detected. The morphological characteristics of the J2 were similar to those of *C. thornei*, which was first described from the roots of Miner's lettuce (*Montia perloliata*) in California by Golden & Raski (1977). This species has been recorded from China (Peng & Vovlas 1994). However, the species found here could not be identified since no cysts were collected and DNA sequences for comparison are unavailable. This is the first record of the genus *Cactodera* from turfgrasses in NC and SC.

Dolichodorus heterocephalus
(Fig. 4 F–I)

Measurements. See Table 7.

Remarks. *Dolichodorus heterocephalus* was described from specimens collected from fresh water at Silver Springs, Florida, and Douglas Lake, Michigan, by Cobb (1914). It was reported from Massachusetts (Paracer 1968) and New Jersey (Hutchinson *et al*. 1961). It is also known from South Africa (Heyns 1971) and Italy (D'Errico *et al*. 1977). Golden *et al*. (1986) designated a lectotype of *D. heterocephalus* and presented detailed morphometric data from its type locality and several other populations including ones from Sanford and Gainesville, Florida, and East Wareham, Massachusetts, which revealed some differences in morphometrics among populations. Perry (1953) reported that *D. heterocephalus* caused severe stunting accompanied by depleted root systems of celery and corn in Florida. In the current study, *D. heterocephalus* was only found in a bermudagrass tee in Beaufort County, SC. The morphological features did not differ from the original and other populations (Cobb 1914; Orton Williams 1974b). The morphometrics of the identified population matched the type population in Gainesville, Florida (Golden *et al*. 1986), except for a slightly smaller range in body lengths for males and females, and a greater *a* value for females. This is the first record of *D. heterocephalus* from turfgrasses in SC.

Belonolaimus longicaudatus
(Fig. 4 A–E)

Measurements. See Table 8.

Remarks. *Belonolaimus longicaudatus* was described from soil around the roots of *Zea mays* in Sanford, Florida, by Rau (1958). It is a major plant parasite in the southeastern USA, with widespread distribution throughout the Atlantic Coastal Plain from Virginia to Florida (Orton Williams 1974a). It has been recorded from NC (Lucas *et al*. 1974, 1978), Connecticut, Louisiana, Texas (Christie 1959), New Jersey (Myers 1979), Oklahoma (Russell *et al*. 1969), Arkansas (Riggs 1961), Kansas (Dickerson *et al*. 1972) and California (Mundo-Ocampo *et al*. 1994). Holdeman (1955) reported *B. longicaudatus* in Florida, Georgia, NC, SC and Virginia. It has a wide host range including citrus (Duncan *et al*. 1996), soybean (Handoo *et al*. 2010), corn (Rhoades 1986), cotton (Koenning *et al*. 2004), carrot (Rhoades 1975) and turfgrasses (Robbins & Barker 1973). It is considered the most important pest of turf and pasture grasses (Heald & Perry 1970; Crow 2005b). This species has been documented in association with many grass species, including bermudagrass, creeping bentgrass, zoysiagrass, crabgrass (*Digitaria sanguinalis*), pangolagrass (*D. decumbens*), Pensacola bahiagrass (*Paspalum notatum*), centipedegrass (*Eremochloa ophiuroides*), tall fescue (*Festuca arundinacea*), Italian ryegrass (*Lolium multiflorum*), sudangrass (*Sorghum vulgare* var. *sudanense*), limpograss (*Hemarthria altissima*) and St. Augustine grass (*Stenotaphrum secundatum*) (Johnson 1970; Orton Williams 1974a; Busey *et al*. 1991; Giblin-Davis *et al*. 1992). In this survey, *B. longicaudatus* was found in 131 turfgrass samples in three turf management zones (green, fairway and tee) in both NC and SC and three grass species (bermudagrass, creeping bentgrass, zoysiagrass) from 24 counties. There was no difference in morphology and morphometrics compared to the original and other descriptions of the species (Rau 1958; Han *et al*. 2006).

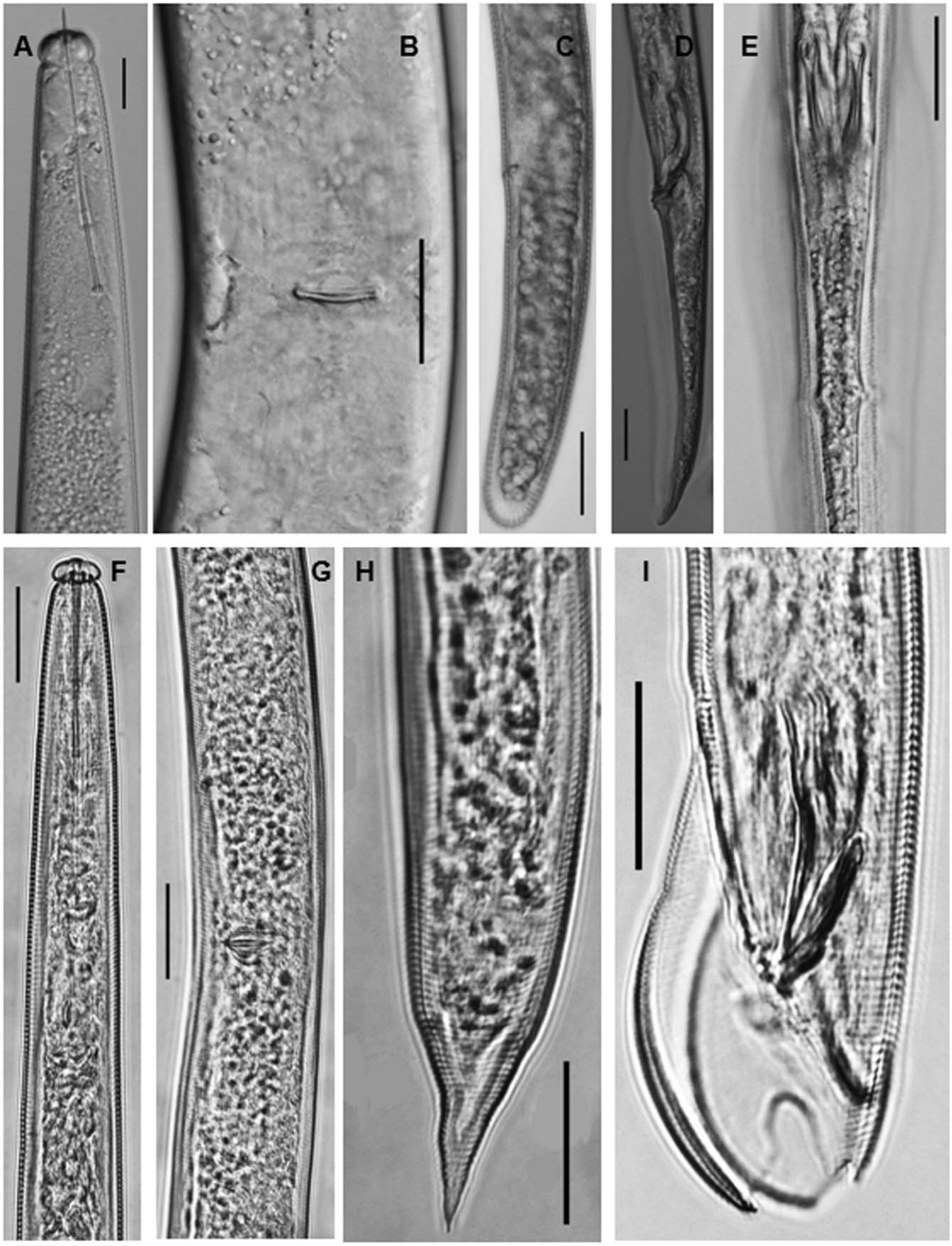

FIGURE 4. Micrographs of *Belonolaimus longicaudatus* and *Dolichodorus heterocephalus* from turfgrasses in NC and SC. All scale bars=20µm. A. Pharyngeal region of *B. longicaudatus.* B. Vulva region of *B. longicaudatus*. C. Female tail of *B. longicaudatus.* D,E. Male tails of *B. longicaudatus.* F. Pharyngeal region of *D. heterocephalus*. G. Vulval region of *D. heterocephalus*. H. Female tail of *D. heterocephalus*. I. Male tails of *D. heterocephalus.*

TABLE 7. *Dolichodorus heterocephalus*: morphometrics of male and female mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Sex	**Male**	**Female**
Lab ID	08-01320	08-01320
Host	Grass	Grass
Location	Brunswick, NC	Brunswick, NC
n	3	1
L	1607.2 ± 7.0 (1600.2–1614.2)	1912. 9
a	42.9 ± 6.5 (36.5–49.4)	49.0
b	7.7 ± 0.2 (7.5–8.0)	7.7
c	60.2 ± 9.4 (50.8–69.5)	43.6
c’	1.5 ± 0.1 (1.4–1.6)	2.1
V	–	55.3
Body width	38.3 ± 5.9 (32.4–44.3)	43.9
Stylet length	100.3 ± 0.1 (100.2–100.4)	100.0
Stylet shaft length	38.2 ± 1.9 (36.3–40.1)	39.3
Pharynx length (Head to dorsal grand base)	209.4 ± 4.9 (204.5–214.2)	247.9
Spicule length	47.1 ± 0.1 (46.9–47.2)	-
Anal body width	18.5 ± 2.0 (16.5–20.5)	26.7
Tail length	27.4 ± 4.4 (23.0–31.8)	54.0
Excretory pore from anterior end	142.8 ± 5.0 (137.8–147.8)	157.5
Center of metacorpus from anterior end	134.5 ± 1.4 (133.0–135.9)	141.4
Lip width	14.2± ± 0.7 (13.5–14.9)	14.6
Lip height	6.6 ± 0.4 (6.2–7.0)	7.3
Metacorpus length	23.0 ± 1.2 (21.8–24.3)	25.8
Metacorpus width	16.4 ± 3.1 (13.2–19.5)	14.3
Lip D/H	2.2 ± 0.2 ± (1.9–2.4)	2.0
Metacorpus L/W	1.4 ± 0.2 (1.2–1.7)	1.8
m	61.9 ± 1.9 (60.1–63.8)	60.7 (1.2–1.7)
Gubernaculum L/Spicule L	51.6 ± 1.5 (50.0–53.1)	-

TABLE 8. *Belonolaimus longicaudatus*: morphometrics of males and females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Sex	**Male**	**Female**	**Male**	**Female**
Lab ID	11-30008	11-30008	11-30020	11-30020
Host	Bentgrass	Bentgrass	Soybean	Soybean
Location	Wilson, NC	Wilson, NC	Robeson, NC	Robeson, NC
n	15	15	15	15
L	1950.0 ± 21.6 (1930.0–1980.0)	2367.5 ± 184.3 (2040.0–2650.0)	1885.0 ± 70.2 (1740.0–1960.0)	2386.7 ± 160.6 (2140.0–2600.0)
a	50.5 ± 1.6 (48.3–52.1)	50.5 ± 5.4 (43.2–60.2)	60.3 ± 3.1 (56.5 – 65.3)	63.8 ± 1.9 (61.9 – 67.6)
b	7.2 ± 0.9 (6.4–8.4)	7.8 ± 0.9 (6.3–9.3)	8.7 ± 0.3 (8.4–9.4)	10.8 ± 1.0 (9.5 – 12.2)
c	13.0 ± 0.5 (12.5–13.6)	18.2 ± 1.7 (15.1–20.7)	15.1 ± 0.7 (14.0 – 16.4)	17.0 ± 0.9 (15.9 – 18.6)
c’	5.7 ± 0.4 (5.4–6.2)	3.7 ± 0.3 (3.3–4.3)	5.5 ± 0.5 (4.8–6.4)	4.5 ± 0.4 (4.1 – 5.1)
V	-	50.9 ± 1.2 (49.5–53.5)	-	47.5 ± 0.8 (46.5 – 48.6)
Body width	26.3 ± 1.2 (25.5–28.0)	47.3 ± 5.5 (39.0–56.0)	31.3 ± 1.5 (30.0–34.0)	37.4 ± 2.4 (34.0 – 42.0)
Stylet length	119.0 ± 1.4 (117.0–120.0)	129.8 ± 5.7 (120.0–140.0)	111.2 ± 4.6 (102.0–116.0)	117.3 ± 5.2 (109.0–124.0)
Stylet cone length	88.3 ± 1.2 (87.0–90.0)	93.3 ± 4.7 (86.0–100.0)	84.2 ± 5.3 (76.0–92.0)	85.5 ± 3.8 (80.0 – 92.0)
Pharynx length (Head to metacorpus base)	273.0 ± 28.1 (235.0–302.0)	304.7 ± 31.1 (270.0–378.0)	217.3 ± 10.2 (204.0–232.0)	222.2 ± 9.9 (210.0–242.0)
Spicule length	54.3 ± 1.7 (52.0–56.0)	-	45.3 ± 2.4 (42.0–48.0)	-
Anal body width	26.3 ± 1.2 (25.0–28.0)	35.8 ± 2.5 (33.0–40.0)	22.8 ± 1.9 (20.0–26.0)	31.2 ± 2.3 ± (28.0–34.0)
Tail length	150.3 ± 3.7 (146.0–155.0)	131.1 ± 15.6 (110.0–160.0)	125.0 ± 4.5 (117.0–132.0)	140.7 ± 4.3 (135.0–148.0)
Excretory pore from anterior end	225.3 ± 3.4 (222.0–230.0)	259.8 ± 14.9 (240.0–290.0)	188.8 ± 5.0 (184.0–198.0)	212.7 ± 18.9 (187.0–232.0)
Lip width	20.0 ± 0.0 (20.0–20.0)	22.8 ± 1.5 (20.0–25.0)	15.8 ± 1.1 (14.0-17.0)	19.9 ± 0.7 (19.0–21.0)
Lip height	13.3 ± 1.7 (11.0–15.0)	14.0 ± 0.9 (12.0–16.0)	10.8 ± 0.8 (10.0–12.0)	10.6 ± 0.8 (10.0–12.0)
Metacorpus length	24.7 ± 3.8 (22.0–30.0)	29.7 ± 3.1 (26.0–35.0)	23.2 ± 1.6 (21.0–26.0)	26.3 ± 1.7 (23.0–28.0)
Metacorpus diameter	18.3 ± 0.5 (18.0–19.0)	22.7 ± 1.6 (20.0–25.0)	17.1 ± 0.8 (16.0–18.0)	20.2 ± 1.5 (18.0–22.0)
Lip L/W	1.5 ± 0.2 (1.3–1.8)	1.6 ± 0.2 (1.4–2.0)	1.4 ± 0.1 (1.2–1.5)	1.9 ± 0.1 (1.8–2.0)
Metacorpus L/W	1.3 ± 0.2 (1.2–1.6)	1.3 ± 0.1 (1.2–1.4)	1.5 ± 0.1 (1.3–1.6)	1.3 ± 0.1 (1.2–1.4)

Tylenchorhynchus claytoni
(Fig. 1 G–I)

Measurements. See Table 9.

Remarks. *Tylenchorhynchus claytoni* was described from soil around roots of tobacco in SC by Steiner (1937). It has been recorded from 10 countries in Europe, 6 in Asia, 1 in Africa, 2 in North America, 1 in Central America, and 1 in Oceania (CABI 2009). In the USA, it occurs in 25 states (Barker & Clayton 1973; Lucas *et al*. 1974; CABI 2009). *Tylenchorhynchus claytoni* occurred commonly in turf soils from Rhode Island (Troll & Tarjan, 1954), Massachusetts (Troll & Rohde 1966) and NC (Lucas *et al*. 1974). In the present study, it was recovered from 25 counties in NC and SC. It was found in three turf management zones (green, fairway and tee) and three grass species (bermudagrass, creeping bentgrass, zoysiagrass) in SC and two turf management zones (green, fairway) and two grass species (bermudagrass and creeping bentgrass) in NC. The morphological features and morphometrics of these populations did not differ from previously described populations (Steiner 1937; Loof 1974b; Golden *et al*. 1987).

Ogma floridense
(Fig. 5 E, J)

Measurements. See Table 10.

Remarks. *Ogma floridense* was described from specimens collected around the roots of *Liquidambar styraciflua* in swamps in the Aucilla Wildlife Management Area northwest of Perry in Taylor County, Florida (Vovlas *et al*. 1991). In this survey, *O. floridense* was found in a golf course tee in Wake County, NC, and a golf course fairway in Beaufort County, SC, both established with bermudagrass. The male of *O. floridense* was not found. Only one male was described in the original description (Vovlas *et al*. 1991). The morphology and morphometrics of the identified population did not differ from the population first described (Vovlas *et al*. 1991). This is the first record of *O. floridense* from turfgrasses in NC and SC.

Mesocriconema xenoplax
(Fig. 5 B, D, G)

Measurements. See Table 11.

Remarks. *Mesocriconema xenoplax* was first documented from grapevines (*Vitis vinifera* var. *sultanina*) in California (Raski 1952). It has been recorded from North America (Nyczepir *et al*. 1985; Okie *et al*. 2009), South America (Crozzoli & Lamberti 2001; Aballay *et al*. 2009), Europe (Ciancio *et al*. 1996; Escuer *et al*. 1999; Nico *et al*. 2002; Abrantes *et al*. 2008; Karanastasi *et al*. 2008), South Africa (Van den Berg 1980), Australia (Stirling 1976), New Zealand (Loof *et al*. 1997), India (Gupta & Gupta 1981), Iran (Loof & Barooti 1991), Japan (Orton Williams 1972), China (Xie *et al*. 2007) and Iran (Deimi *et al*. 2008). Ring nematodes, including *M. xenoplax*, are important pathogens of peach in the USA and other parts of the world (Walters *et al*. 2008; Nyczepir and Esmenjaud 2008; Gomes *et al*. 2000). Nyczepir (2011) reported that tall fescue was a good host for this species. *Mesocriconema xenoplax* developed more rapidly and caused greater damage in grape than other species of *Mesocriconema* (McKenry & Anwar 2006). In this study, *M. xenoplax* was detected in 30 counties in NC and SC. It was found in high numbers in three turf management zones (green, fairway and tee) and three grass species (bermudagrass, creeping bentgrass, zoysiagrass) in both states. The overall morphology and morphometrics were similar to the type population, except that the female has a smaller stylet compared to the population first described (Raski 1952). This is the first record of *M. xenoplax* from turfgrasses in NC and SC.

TABLE 9. *Tylenchorynchus claytoni*: morphometrics of males and females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Sex	Male	Female	Male	Female
Lab ID	11-29736	11-29736	12-65	12-65
Host	Turfgrass	Turfgrass	Bermudagrass	Bermudagrass
Location	New Hanover, NC	New Hanover, NC	York, SC	York, SC
n	15	15	10	10
L	652.2 ± 25.8 (607.6–687.5)	676.4 ± 48.6 (602.9–736.7)	646.7 ± 15.7 (625.6–667.0)	627.5 ± 65.9 (537.6–710.2)
a	28.2 ± 1.9 (25.1–31.3)	26.2 ± 1.4 (24.2–28.6)	25.6 ± 2.4 (21.3–28.2)	23.3 ± 2.3 (18.6–25.6)
b	4.7 ± 0.3 (4.1–5.1)	4.9 ± 0.2 (4.5–5.3)	4.8 ± 0.2 (4.7–5.1)	4.6 ± 0.5 (3.9–5.4)
c	15.6 ± 0.9 (14.0–17.2)	18.9 ± 2.0 (15.0–23.4)	15.1 ± 0.5 (14.4–15.9)	18.6 ± 1.8 (17.1–22.0)
c’	2.5 ± 0.1 (2.2–2.6)	2.2 ± 0.1 (2.0–2.4)	2.4 ± 0.1 (2.2–2.5)	2.1 ± 0.1 (2.0–2.3)
V	–	57.4 ± 2.8 (53.1–62.4)	–	49.5 ± 5.4 (43.2–57.1)
Body width	23.2 ± 1.3 (21.2–25.8)	25.9 ± 1.3 (23.4–27.4)	25.5 ± 2.8 (23.3–31.0)	27.0 ± 1.6 (24.5–29.0)
Stylet length	20.5 ± 0.3 (20.2–21.0)	20.9 ± 0.4 (20.3–21.6)	19.9 ± 0.3 (19.4–20.2)	20.2 ± 0.4 (19.8–20.9)
Stylet shaft length	9.6 ± 0.3 (9.1–10.0)	9.5 ± 0.4 ± (9.0–10.1)	9.7 ± 0.4 (9.1–10.2)	9.5 ± 0.9 (8.3–10.7)
Pharynx length (Head to metacorpus base)	138.1 ± 10.8 (126.0–166.0)	138.4 ± 7.1 (126.2–150.0)	133.8 ± 2.5 (130.2–137.8)	136.9 ± 3.9 (131.4–143.0)
Spicule length	25.3 ± 1.3 (23.9–27.2)	–	26.4 ± 1.1 (25.5–28.5)	–
Anal body width	17.1 ± 0.9 (15.9–18.6)	16.3 ± 1.1 (15.0–18.0)	18.2 ± 0.7 (17.1–19.4)	15.8 ± 0.8 (14.6–16.8)
Tail length	42.0 ± 2.7 (37.8–45.6)	36.1 ± 3.5 (30.8–40.7)	42.9 ± 1.9 (40.8–46.2)	33.7 ± 2.3 (31.2–38.1)
Excretory pore from anterior end	106.2 ± 2.9 (101.9–111.1)	108.3 ± 3.9 (104.2–115.8)	105.4 ± 3.5 (101.4–111.4)	105.7 ± 3.2 (98.7–108.2)
Lip width	7.3 ± 0.8 (6.4–8.8)	7.7 ± 0.6 (6.7–8.6)	8.4 ± 0.4 (7.9–8.9)	8.3 ± 0.4 (7.8–8.7)
Lip height	3.7 ± 0.4 (3.1–4.4)	3.6 ± 0.3 (3.1–4.1)	4.6 ± 0.2 (4.4–4.9)	4.2 ± 0.5 (3.3–4.9)
Metacorpus length	13.8 ± 0.9 (12.4–15.4)	14.4 ± 0.4 (13.7–15.0)	13.5 ± 0.7 (12.3–14.5)	14.3 ± 0.9 (12.6–15.3)
Metacorpus width	9.8 ± 1.0 (8.1–10.5)	10.0 ± 0.5 (9.3–10.6)	9.6 ± 0.5 (8.7–10.4)	11.0 ± 0.8 (9.9–12.1)
Lip L/W	2.0 ± 0.2 (1.6–2.2)	2.1 ± 0.2 (1.8–2.5)	1.8 ± 0.1 ± (1.7–1.9)	2.0 ± 0.2 (1.8–2.4)
Metacorpus L/W	1.4 ± 0.1 (1.3–1.7)	1.4 ± 0.1 (1.3–1.5)	1.4 ± 0.0 (1.4–1.4)	1.3 ± 0.1 (1.2–1.4)
m	47.0 ± 1.4 (44.4–48.7)	45.6 ± 1.9 (42.6–48.2)	48.8 ± 1.4 (47.1–51.1)	46.8 ± 3.5 (41.6–51.3)
Gubernaculum length	10.8 ± 1.0 (9.2–12.0)	–	13.9 ± 0.8 (12.5–14.7)	–
Gubernaculum%Spicule	42.6 ± 2.6 (38.5–46.2)	–	52.7 ± 3.8 (46.9–57.4)	–
VA	–	255.5 ± 22.6 (210.7–279.4)	–	237.0 ± 30.9 (199.3–276.6)

TABLE 10. *Paratylenchus goldeni* and *Ogma floridense:* morphometrics of females mounted in temporary water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***P. goldeni***	***O. floridense***
Lab ID	11-29913	08-26310
Host	Centipedegrass	Bermudagrass
Location	Cumberland, NC	Beaufort, NC
n	10	1
L	374.9 ± 17.1 (358.9 ± 399.8)	391.5
a	21.4 ± 1.3 (20.2 – 23.6)	8.6
b	4.1 ± 0.2 (3.8–4.4)	3.2
c	9.7 ± 0.9 (8.9–11.2)	10.7
c’	4.1 ± 0.4 (3.6–4.7)	2.4
V	78.9 ± 0.9 (78.1–80.3)	83.3
Body width	17.5 ± 0.4 (16.9–18.1)	45.3
Stylet length	19.5 ± 0.8 (18.2–20.2)	100.2
Stylet conus length	–	78.4
Stylet knob width	–	10.2
Stylet knob height	–	2.6
Pharynx length (Head to metacorpus base)	90.6 ± 4.7 (82.9–94.8)	122.4
Anal body width	9.6 ±0.4 (9.1–10.3)	15.6
Tail length	39.0 ± 3.2 (34.2–43.0)	36.6
Excretory pore from anterior end	74.8 ± 4.1 (68.5–79.2)	–
VA	40.3 ± 2.8 (37.6–44.4)	28.8
VB	14.1 ± 0.6 (13.5–15.0)	32.1
First lip annulus width	–	16.7
Second lip annulus width	–	14.8
R	–	55
Rs	–	15
Ran	–	8
Reso	–	17
RV	–	12
RVan	–	4
Body annulus width	–	7.3
Scale length	–	11.3
VL	–	65.5
VL/VB	–	2.0
St%L	–	25.6
St%Oes	-	81.9
m	-	78.2

TABLE 11. *Mesocriconema* spp.: morphometrics of females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***M. curvatum***	***M. sphaerocephala***	***M. sphaerocephala***	***M. xenoplax***	***M. xenoplax***
Lab ID	11-29913	11-29593	11-30664	12-44-46	11-30213
Host	Centipedegrass	Turfgrass	Bermudagrass	Bentgrass	Bentgrass
Location	Cumberland, NC	New Hanover, NC	Beaufort, SC	Greenville, SC	Moore, NC
n	10	10	10	15	15
L	436.8 ± 12.6 (424.21–449.3)	382.0 ± 53.3 (326.0–500.0)	369.8 ± 30.9 (338.8–400.8)	573.8 ± 31.0 (518.9–618.5)	532.8 ± 44.7 (472.7–632.2)
a	9.0 ± 0.5 (8.5–9.4)	11.0 ± 1.3 (9.6–13.9)	10.4 ± 0.3 (10.1–10.7)	13.2 ± 0.6 (12.1–13.9)	12.6 ± 0.9 (11.3–14.1)
b	3.9 ± 0.1 (3.8–4.0)	3.7 ± 0.4 (3.2–4.5)	3.3 ± 0.2 (3.1–3.5)	4.6 ± 0.3 (4.3–5.5)	4.7 ± 0.3 (4.2–5.2)
c	30.5 ± 2.0 (28.5–32.4)	32.9 ± 7.0 (24.7–42.2)	42.7 ± 4.8 (37.9–47.5)	33.3 ± 5.9 (24.7–43.2)	29.1 ± 3.4 (23.9–35.3)
c’	0.8 ± 0.1 (0.7–0.8)	0.6 ± 0.1 (0.4–0.8)	0.5 ± 0.1 (0.4–0.6)	0.7 ± 0.1 (0.6–0.9)	0.8 ± 0.1 (0.7–0.9)
V	94.1 ± 0.3 (93.7–94.4)	93.5 ± 1.1 (91.8–94.9)	94.5 ± 0.1 (94.4–94.6)	93.0 ± 0.8 (91.2–94.0)	92.3 ± 0.4 (91.7–92.9)
Body width	48.7 ± 1.1 (47.7–49.8)	34.6 ± 1.5 (32.0–37.0)	35.6 ± 2.0 (33.6–37.6)	43.4 ± 2.7 (38.2–47.5)	42.5 ± 2.2 (39.1–46.0)
Stylet length	51.3 ± 1.3 (50.0–52.6)	54.4 ± 1.7 (52.0–58.0)	54.6 ± 2.0 (52.6–56.5)	60.5 ± 1.6 (57.4–62.5)	55.3 ± 1.6 (52.3–58.2)
Stylet shaft length	–	15.7 ± 1.4 (13.0–18.0)	16.6 ± 0.4 (16.2–17.0)	–	18.1 ± 1.3 (16.7–21.0)
Pharynx length (Head to metacorpus base)	112.4 ± 0.2 (112.2–112.6)	103.1 ± 6.7 (91.0–112.0)	112.9 ± 2.9 (110.0–115.8)	126.2 ± 8.0 (112.4–138.4)	114.2 ± 5.1 (109.6–122.9)
Anal body width	18.3 ± 0.5 (17.8–18.8)	19.4 ± 1.7 (18.0–23.0)	18.3 ± 0.6 (17.7–18.9)	23.9 ± 2.1 (21.8–30.0)	23.5 ± 1.3 (21.5–26.0)
Tail length	14.4 ± 0.5 (13.9–14.9)	12.3 ± 3.6 (8.0–19.0)	8.9 ± 1.7 (7.1–10.6)	17.7 ± 2.9 (13.1–23.4)	18.5 ± 2.1 (15.2–21.9)
Excretory pore from anterior end	143.7 ± 2.8 (141.0–146.5)	113.5 ± 4.5 (109.0–118.0)	–	139.4 ± 8.0 (131.6–155.5)	127.7 ± 5.0 (120.6–133.8)
R	79.5 ± 1.5 (78.0–81.0)	72.1 ± 7.7 (66.0–90.0)	73.5 ± 1.5 (72.0–75.0)	101.5 ± 3.3 (96.0–108.0)	102.8 ± 4.2 (96.0–112.0)
Rs	12.5 ± 0.5 (12.0–13.0)	11.3 ± 0.5 (11.0–12.0)	11.5 ± 0.5 (11.0–12.0)	12.9 ± 0.5 (12.0–14.0)	13.4 ± 0.5 (13.0–14.0)
Roes	22.0 ± 1.0 (21.0–23.0)	20.7 ± 1.0 (19.0–22.0)	23.0 ± 1.0 (22.0–24.0)	24.9 ± 1.5 (22.0–27.0)	25.5 ± 0.9 (23.0–26.0)
Rex	28.0 ± 1.0 (27.0–29.0)	22.0 ± 0.0 (22.0–22.0)	–	28.0 ± 0.8 (27.0–29.0)	28.2 ± 1.3 (25.0–30.0)
Ran	4.5 ± 0.5 (4.0–5.0)	2.4 ± 0.5 (2.0–3.0)	2.5 ± 0.5 (2.0–3.0)	4.5 ± 1.0 (2.0–6.0)	4.3 ± 0.5 (4.0–5.0)
RV	6.5 ± 0.5 (6.0–7.0)	5.0 ± 1.3 (4.0–7.0)	4.5 ± 0.5 (4.0–5.0)	8.2 ± 0.9 (7.0–10.0)	8.6 ± 0.7 (8.0–10.0)
RVan	2.0 ± 0.0 (2.0–2.0)	5.0 ± 0.9 (2.0–4.0)	2.0 ± 0.9 (1.0–3.0)	3.7 ± 0.9 (2.0–5.0)	4.3 ± 0.6 (3.0–5.0)
VL	25.9 ± 0.8 (25.1–26.6)	25.1 ± 6.5 (17.0–36.0)	20.4 ± 2.0 (18.4–22.5)	40.2 ± 4.4 (35.5–48.6)	41.4 ± 4.8 (33.4–50.0)
VB	27.2 ± 0.4 (26.8–27.6)	27.9 ± 1.3 (24.0–32.0)	22.8 ± 0.4 (22.4–23.2)	32.9 ± 2.7 (30.9–39.7)	32.3 ± 1.4 (30.7–34.9)
VL/VB	1.0 ± 0.0 (0.9–1.0)	0.9 ± 0.2 (0.6–1.2)	0.9 ± 0.1 (0.8–1.0)	1.2 ± 0.1 (1.1–1.5)	1.3 ± 0.1 (1.1–1.4)
m	–	28.9 ± 2.9 (24.1 –34.6)	30.4 ± 0.3 (30.1–30.8)	–	–
St% L	11.7 ± 0.0 (11.7–11.8)	14.5 ± 1.7 (10.8–16.6)	14.8 ± 0.7 (14.1–15.5)	10.6 ± 0.4 (9.7–11.3)	10.4 ± 0.7 (8.9–11.4)
St% Oes	45.6 ± 1.2 (44.4–46.9)	53.0 ± 3.7 (48.2–59.3)	48.3 ± 0.5 (47.8–48.8)	48.1 ± 2.3 (44.8–53.8)	48.5 ± 2.3 (45.8–52.5)

Mesocriconema curvatum
(Fig. 5 A, F)

Measurements. See Table 11.

Remarks. *Mesocriconema curvatum* was first described from soil around the roots of snapdragon (*Antirrhinum* sp.) in California. It has been recorded from other western states including Nevada (Raski 1952), as well as from New York, New Jersey, NC and Maryland (Loof 1974a). It has also been reported from Europe, in Spain (Alcala *et al*. 1970; Castillo & Gomez-Barcina 1993; Escuer *et al*. 1999), the Netherlands, Belgium, Germany, Poland and France (Loof 1974a); from Asia, in India (De Grisse & Loof 1970), Thailand (Timm 1965), Korea (Choi & Geraert 1975), Iran (Jabbari & Niknam 2007) and Pakistan (Khan *et al*. 2011); and from Africa, in Guinea, Ivory Coast Senegal and Togo (Luc 1959, 1970) and Namibia (Waele *et al*. 1998). In this study, *M. curvatum* occurred in nine turfgrass samples taken in six counties in NC and SC. It was found in creeping bentgrass putting greens in both states and in bermudagrass and zoysiagrass fairways and tees in NC. The morphology and morphometrics of the identified populations did not differ from previously described populations (Loof 1974a), except for a smaller stylet and a greater Rex in females. This is the first record of *M. curvatum* from turfgrasses in SC.

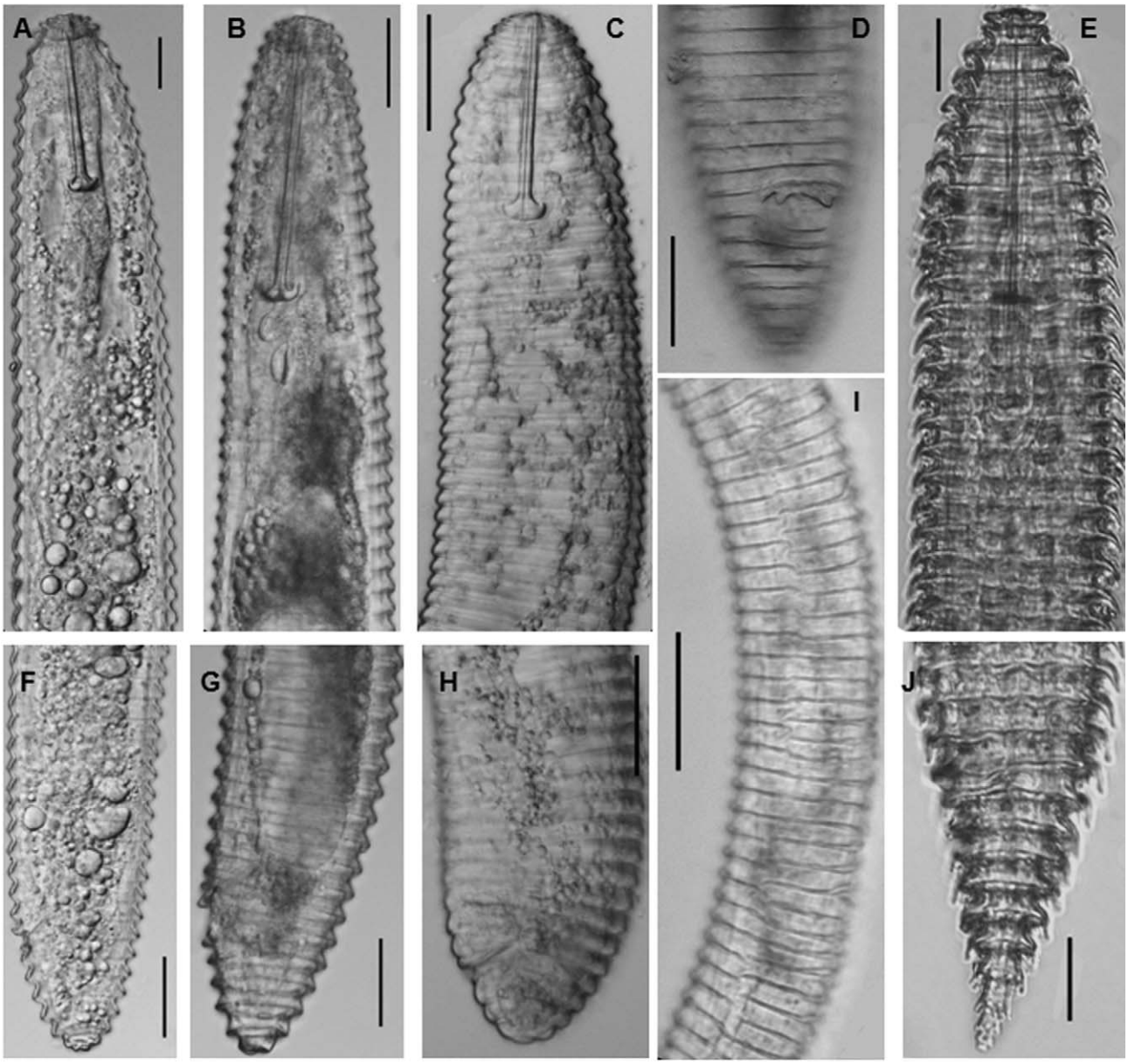

FIGURE 5. Micrographs of *Mesocriconema curvatum*, *M. xenoplax*, *M. sphaerocephala* and *Ogma floridense* from turfgrasses in NC and SC. All scale bars=20µm. A. Pharyngeal region of *M. curvatum*. B. Pharyngeal region of *M. xenoplax*. C. Pharyngeal region of *M. sphaerocephala*. D,G. Female tail of *M. xenoplax*. E. Pharyngeal region of *O. floridense*. F. Female tail of *M. curvatum*. H. Female tail of *M. sphaerocephala*. I. Body with anastomoses of *M. sphaerocephala*. J. Vulva and tail region of *O. floridense*.

Mesocriconema sphaerocephala
(Fig. 5 C, H, I)

Measurements. See Tables 11.

Remarks. *Mesocriconema sphaerocephala* was first described from soil around the roots of a grass on Trinidad by Taylor (1936). It has been found with centipedegrass (*Eremochloa ophiuroides*) in Florida (Tarjan 1964b; Tarjan & Frederick 1981), bermudagrass in India (Siddiqi 1961), grasslands in Spain (Escuer *et al*. 1999), and other plants in many countries. In the present study, *M. sphaerocephala* was found in Montgomery County, NC, and Beaufort County, SC. It occurred mainly in the warm-season (C4) grasses (bermudagrass and zoysiagrass), but not in the cool-season (C3) grasses such as creeping bentgrass. The morphology and morphometrics fit the description of previously described populations (Orton Williams 1973b). This is the first record of *M. sphaerocephala* from turfgrasses in NC and SC.

Diagnosis of three *Mesocriconema* species from turfgrasses

Ring nematodes are the most common species encountered in golf courses and occur at fairly high densities, but species identification is challenging. The three ring nematodes identified above (*M. xenoplax, M. curvatum* and *M. sphaerocephala*) are similar in general morphology. They can be distinguished from each other using the characteristics listed in Table 12. *Mesocriconema sphaerocephala* is the shortest of these species, lacks labial plates, and has the least body annulations with posterior margins and anastomoses, hemispherical head and bluntly rounded or hemispherical tail. *Mesocriconema xenoplax* is the longest of the three species and has rounded, retrorse body annulations that may be smooth or slightly rough, a broad head and four distinct and well-separated labial plates, a sigmoid vagina and broadly rounded to more conoid tail. *Mesocriconema curvatum* has smooth body annulations without posterior margins and anastomoses, more or less rectangular labial disc with slit-like apertures along its lateral margins, a distinctly lower labial disc than *M. xenoplax* and a conoid-rounded tail, head not offset and vagina not sigmoid.

Hemicriconemoides chitwoodi
(Fig. 6 A–C)

Measurements. See Table 12.

Remarks. *Hemicriconemoides chitwoodi* was described from *Camellia* sp. in Florida (Esser 1960). It has been reported from California, Georgia, Louisiana, New Jersey, New York, NC and SC (Siddiqi 1974a; Ye & Robbins 2000), as well as from China (Wang 1993), Iran (Afshar *et al*. 2006) and Japan (Toida 1983; Hirata & Yuhara 1986). Economically important hosts include camellia in Florida, grape in California, mulberry and bonsai in Japan, jiroft in Iran, and fruit trees in China. In this study, it was found in samples taken in Cumberland County, NC, from turfgrass. Both morphology and morphometrics fit previous descriptions of this species (Esser 1960; Ye & Robbins 2000).

Hemicriconemoides wessoni
(Fig. 6 D–F)

Measurements. See Table 13.

Remarks. *Hemicriconemoides wessoni* was first documented in Alturas, Florida by Chitwood & Birchfield (1957) from around the roots of *Myrica cerifera* L. It has also been found in Georgia (Dasgupta *et al*. 1969), Alabama (USDA collection, Beltsville), and SC (Ye & Robbins 2000). Pinochet & Raski (1975) described *H. annulatus* collected from St. Augustine grass at the Crago Sod Farm (South Bay, Florida) as being closest to *H. wessoni*. Ye & Robbins (2000) examined several populations of *H. wessoni* from different geographical origins, compared them with the type specimens of *H. annulatus*, and found that the small differences observed in *H. annulatus* were within the intraspecific variation of *H. wessoni*, thus supporting the synonymy of these two species. They found *H. wessoni* in samples from creeping bentgrass in SC. In the present survey, *H. wessoni* was only found in association with bermudagrass fairways and tees in SC and greens, fairways and tees in NC. Bermudagrass was not previously known to be a host. *Hemicriconemoides wessoni* was obtained from 50 bermudagrass samples taken in 13 counties in both NC and SC. Both morphology and morphometrics fit previous descriptions (Esser 1960; Ye & Robbins 2000). This is the first record of *H. wessoni* from bermudagrass, and also the first record of this nematode in NC.

TABLE 12. Species comparision of three common *Mesocriconem*a species from golf courses (all measurements in μm).

Characters	*M. curvatum*	*M. sphaerocephala*	*M. xenoplax*
L	320–450	300	400–780
Stylet	56–70	30–69	55–101
a	8.4–11.2	5.4–13.0	7.6–17.0
b	3.2–4.2	2.3–4.3	3.1–5.9
c	22.0–38.0	19.0–122.0	17.0–55.6
V	92.0–95.0	85.0–97.0	90.0–96.0
R	78–83	55–79	74–118
Rex	22–24	17–28	19–35
Ran	4–6	2–5	4–8
RV	6–8	3–7	6–11
RVan	0–2	0–2	0–3
Body	Stout, curved ventrally, tapering slightly to both extremities, head not offset	Cuticle thick, curved ventrally, anterior end tapering slightly to bluntly rounded or hemispherical head	Head broad, body cylindroid except extremities
Body annule	Smooth, no cuticular markings, no posterior margins and generally without anastomoses	Course with smooth posterior margins and rounded profiles, typically many anastomoses producing a zig–zag line laterally	Rounded, retrorse with smooth or slightly rough
Labial disc	Distinctly lower than *M. xenoplax*, more or less rectangular with slit–like apertures along its lateral margins	Labial plates generally lacking, submedian lobes present	Typically 4 distinct and well separated labial plates
First annule	Broken up into labial plates, often irregular	Anterior annules to about level of stylet base	First annule entire or indented laterally, not circular
Lip region	4 well developed, separate submedian lobes with rounded anterior margins	Anterior lip lacking spines or processes	Conspicuous, elevated
Vagina	Not sigmoid	About half as long as body width	Always sigmoid
Vulva	Generally on 7–7th annule from end of body, anterior flap variable, usually present a slightly bilobed appearance but may be simple	With conspicusly large prevulvar annule on ventral side	Usually on 6–7th annule from terminus
Excretory pore	On 21–29th annule from anterior end near base of pharynx		Not observed
Tail	Conoid–rounded	Bluntly rounded or hemispherical	Broadly rounded to more conoid, terminus generally a simple rounded or lobed
Anus	on 5–6th annule from end of body	At next to last annule	Not definitely seen

TABLE 13. *Hemicriconemoides* spp.: morphometrics of females mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Species	***H. chitwoodi***	***H. chitwoodi***	***H. wessoni***	***H. wessoni***	***H. wessoni***
Lab ID	06-26301	11-29905	07-27685	08-25063	11-30664
Host	Grass	Boxwood	Bermudagrass	Bermudagrass	Bermudagrass
Location	Cumberland, NC	Cumberland, NC	Onslow, NC	New Hanover, NC	Beaufort, SC
n	4	4	7	5	10
L	450.0 ± 18.7 (430.0–480.0)	459.0 ± 56.3 (370.0–514.0)	453.3 ± 22.2 (422.0–480.0)	453.4 ± 37.3 (402.0–500.0)	434.3 ± 46.2 (355.7–506.5)
a	14.4 ± 0.8 (13.4–15.5)	16.3 ± 2.1 (13.2–19.0)	13.1 ± 0.7 (12.4–14.6)	15.0 ± 0.9 (14.1–16.7)	12.6 ± 1.1 (10.4–13.9)
b	3.4 ± 0.3 (3.2–3.8)	4.1 ± 0.1 (4.0–4.2)	4.3 ± 0.6 (3.5–4.9)	4.7 ± 0.3 (4.2–5.0)	4.3 ± 0.3 (3.7–4.8)
c	16.5 ± 2.3 (13.6–20.0)	16.9 ± 2.3 (13.9–19.2)	19.5 ± 1.4 (17.6–20.9)	22.2 ± 2.5 (19.6–26.6)	23.7 ± 2.4 (20.3–28.6)
c’	1.6 ± 0.2 (1.2–1.8)	1.5 ± 0.2 (1.3–1.8)	1.2 ± 0.1 (1.1–1.3)	1.2 ± 0.2 (1.0–1.5)	1.2 ± 0.1 (1.0–1.4)
V	90.6 ± 0.6 (90.0–91.7)	90.4 ± 0.7 (89.5–91.3)	92.3 ± 0.6 (91.2–93.0)	93.0 ± 0.8 (91.8–94.0)	93.8 ± 0.7 (92.8–94.9)
Body width	31.3 ± 0.8 (30.0–32.0)	28.3 ± 1.1 (27.0–30.0)	34.7 ± 1.1 (33.0–36.0)	30.2 ± 1.8 (27.0–32.0)	34.5 ± 2.7 (28.0–38.3)
Stylet length	85.8 ± 5.9 (80.0–93.0)	84.0 ± 4.2 (80.0–91.0)	55.2 ± 2.1 (52.0–58.0)	53.1 ± 3.4 (48.0–58.5)	55.0 ± 2.4 (50.8–58.4)
Stylet shaft length	15.8 ± 3.1 (14.0–16.0)	15.3 ± 0.9 (14.2–16.8)	15.6 ± 1.0 (14.0–17.0)	14.3 ± 3.1 (9.5–19.0)	14.9 ± 0.8 (13.1–15.4)
Pharynx length (Head to metacorpus base)	131.0 ± 5.8 (125.0–140.0)	113.0 ± 14.0 (92.0–130.0)	106.8 ± 12.7 (92.0–128.0)	97.0 ± 12.5 (85.0–120.0)	101.3 ± 8.0 (89.5–117.1)
Anal body width	17.9 ± 2.2 (15.0–21.0)	18.6 ± 1.5 (16.5–20.0)	20.0 ± 1.2 (18.0–22.0)	17.4 ± 1.0 (16.0–19.0)	16.1 ± 1.7 (13.0–18.5)
Tail length	27.8 ± 4.2 (22.0–33.0)	27.6 ± 5.0 (23.5–36.0)	23.3 ± 0.8 (22.0–24.0)	20.8 ± 3.7 (16.0–25.0)	18.5 ± 2.1 (14.8–21.1)
Excretory pore from anterior end	130.0	101.0	–	–	122.6 ± 16.4 (96.9–143.6)
R	118.3 ± 4.9 (111.0–124.0)	118.8 ± 3.8 (115.0–123.0)	89.2 ± 2.9 (85.0–93.0)	87.0 ± 1.4 (85.0–89.0)	87.0 ± 3.8 (83.0–95.0)
Rs	24.5 ± 2.1 (23.0–28.0)	22.5 ± 1.7 (21.0–25.0)	11.2 ± 0.4 (11.0–12.0)	11.2 ± 0.8 (10.0–12.0)	11.2 ± 1.2 (10.0–14.0)
Roes	36.0 ± 3.4 (31.0–40.0)	29.5 ± 0.5 (29.0–30.0)	20.2 ± 3.1 (17.0–25.0)	19.2 ± 1.9 (18.0–23.0)	19.7 ± 2.7 (17.0–26.0)
Rex	33	33	–	–	23.1 ± 2.4 (19.0–28.0)
RV	14.3 ± 1.9 (12.0–17.0)	13.8 ± 0.8 (13.0–15.0)	7.8 ± 0.7 (7.0–9.0)	7.6 ± 0.5 (7.0–8.0)	9.7 ± 0.6 (8.0–10.0)
Ran	9.5 ± 1.7 (7.0–11.0)	9.0 ± 0.0 (9.0–10.0)	5.7 ± 0.8 (5.0–7.0)	5.8 ± 0.4 (5.0–6.0)	8.0 ± 0.8 (7.0–9.0)
RVan	4.8 ± 1.3 (3.0–6.0)	4.5 ± 0.5 (4.0–5.0)	2.2 ± 0.7 (1.0–3.0)	1.8 ± 0.8 (1.0–3.0)	1.7 ± 0.6 (1.0–3.0)
VL	42.0 ± 1.4 (40.0–44.0)	43.8 ± 3.7 (39.0–49.0)	35.0 ± 2.5 (32.0–38.0)	31.6 ± 4.5 (27.0–40.0)	26.6 ± 2.7 (22.2–31.0)
VB	25.3 ± 1.6 (24.0–28.0)	23.0 ± 1.0 (22.0–24.0)	28.2 ± 2.0 (24.0–30.0)	24.0 ± 1.3 (22.0–26.0)	20.2 ± 2.0 (16.7–23.1)
VL/VB	1.7 ± 0.1 (1.5–1.8)	1.9 ± 0.1 (1.8–2.0)	1.3 ± 0.1 (1.1–1.4)	1.3 ± 0.1 (1.1–1.5)	1.3 ± 0.1 (1.2–1.6)
m	18.4 ± 1.7 (17.2 –17.6)	18.2 ± 0.9 (17.8–18.5)	28.3 ± 2.2 (25.4 –31.4)	26.7 ± 4.3 (19.8 –32.5)	27.8 ± 2.0 (18.7 –24.1)
St% L	19.1 ± 1.5 (11.7–12.6)	19.1 ± 1.5 (11.7–12.6)	12.2 ± 0.3 (11.7–12.6)	11.8 ± 1.1 (9.8–12.9)	12.8 ± 1.2 (10.6–14.7)
St% Oes	65.7 ± 6.0 (57.1–72.0)	75.4 ± 9.1 (63.9–89.1)	52.4 ± 6.6 (42.5–58.7)	55.4 ± 5.8 (48.0–61.2)	54.5 ± 2.9 (48.0–57.8)
Spermatheca length	19.7 ± 1.3 (18.0–21.0)	24.0	20	–	19.5 ± 4.2 (12.3–25.9)
Spermatheca width	13.0 ± 1.4 (11.0–14.0)	12.0	10	–	14.0 ± 2.6 (9.0–17.0)

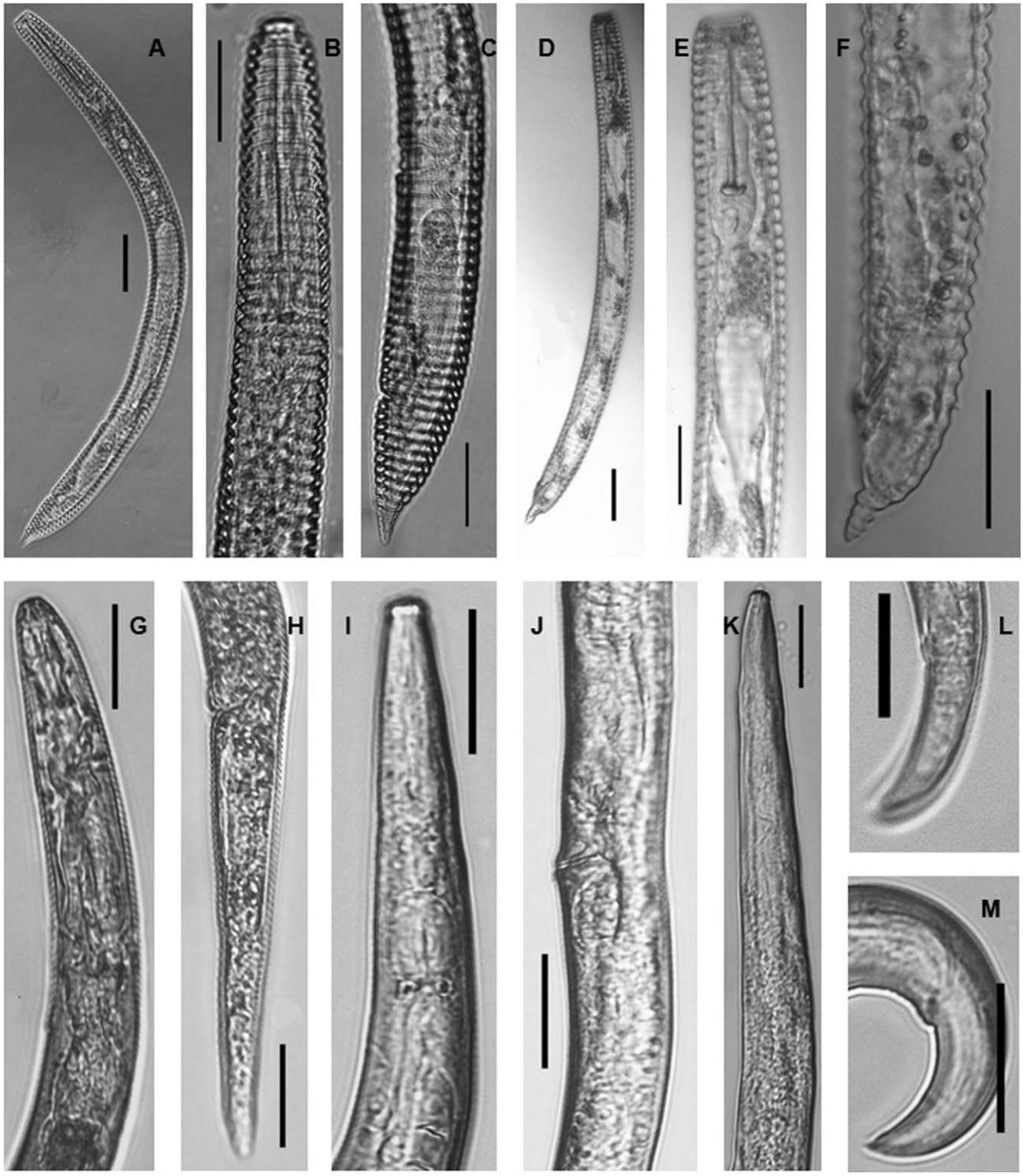

FIGURE 6. Micrographs of *Hemicriconemoides chitwoodi*, *H. wessoni*, *Paratylenchus goldeni* and *Aphelenchoides myceliophagus* from turfgrasses in NC and SC. Scale bars: A, D=50µm; B, C, E–M=20µm. A. Entire body of *H. chitwoodi*. B. Pharyngeal region of *H. chitwoodi*. C. Vulva and tail region of *H. chitwoodi*. D. Entire body of *H. wessoni*. E. Pharyngeal region of *H. wessoni*. F. Vulva and tail region of *H. wessoni*. G. Pharyngeal region of *P. goldeni*. H. Vulva and tail region of *P. goldeni*. I. Pharyngeal region of *A. myceliophagus*. J. Vulval region of *A. myceliophagus*. K. Pharyngeal region of *A. myceliophagus*. L. Female tail of *A. myceliophagus*. M. Male tail of *A. myceliophagus*.

Hemicycliophora conida
(Fig. 7 D–F)

Measurements. See Table 14.

Remarks. *Hemicycliophora conida* was described from sugar beet in Ireland (Thorne 1955). It has been documented in Belgium, England, Germany, Italy, the Netherlands, Poland, Switzerland (Loof 1968; Brzeski 1974), Iran (Loof 1984), Spain (Castillo *et al*. 1989), South Africa (Van den Berg 1981), and UK (Spaull & Mewton 1982). In the present study, *H. conida* was detected in five counties in NC and SC. It was found in bermudagrass fairways and tees in SC and bentgrass putting greens and tees in NC. It was not found in zoysiagrass in either state. The morphology and morphometrics of the identified population did not differ from other populations (Loof 1968). *Hemicycliophora conida* was divided into two morphological forms (Forms I and II) differing in the number of annuli (230 or more vs 180 to 220), the excretory pore position (about 50 annuli from the head *vs 40*), female stylet length (average about 90 *vs* 80 µm), and spicule length (23 *vs* 19 µm). These forms were regarded as conspecific (Loof 1968). The type populations were Form II. The populations in this study were primarily Form I. This is the first record of *H. conida* from turfgrasses in NC and SC.

Loofia thienemanni
(Fig. 7 A–C)

Measurements. See Table 14.

Remarks. *Loofia thienemanni* was described from a compost heap in Bergen-op-Zoom, the Netherlands (Schneider 1925). It has been reported from France, Italy, the Netherlands, Peru, Poland (Brzeski 1974; Kuiper 1977), South Africa (Van den Berg 1987), Argentina (Chaves 1983), the Solomon Islands (Coomans *et al*. 1985), Greece (Koliopanos & Vovlas 1977), and Czechoslovakia (Valocka & Sabova 1978). In this study, *L. thienemanni* was detected only in Charleston County, SC, in a bermudagrass fairway and a zoysiagrass tee. The morphology and morphometrics of the identified population did not differ from those previously described (Brzeski 1974). This is the first record of *L. thienemanni* from turfgrasses in SC.

Hemicaloosia graminis
(Fig. 7 G–K)

Measurements. See Table 14.

Remarks. *Hemicaloosia graminis* was collected from a bermudagrass tee in Charleston County, SC, a bermudagrass zoysiagrass tee in Beaufort County, SC, and from turfgrass in New Hanover County, NC. The species description, using morphological and molecular approaches, was presented in a separate study (Zeng *et al*., 2012).

Paratylenchus goldeni
(Fig. 6 G–H)

Measurements. See Table 10.

Remarks. *Paratylenchus goldeni* was described from specimens collected from boxwood (*Buxus* sp.) in Salemburg, NC. In this study, it was found in a centipedegrass turf area sampled in Cumberland County, NC. No males of *P. goldeni* were found, although seven males were observed in the original description (Raski 1975). The morphology and morphometrics of the females fit with the original description.

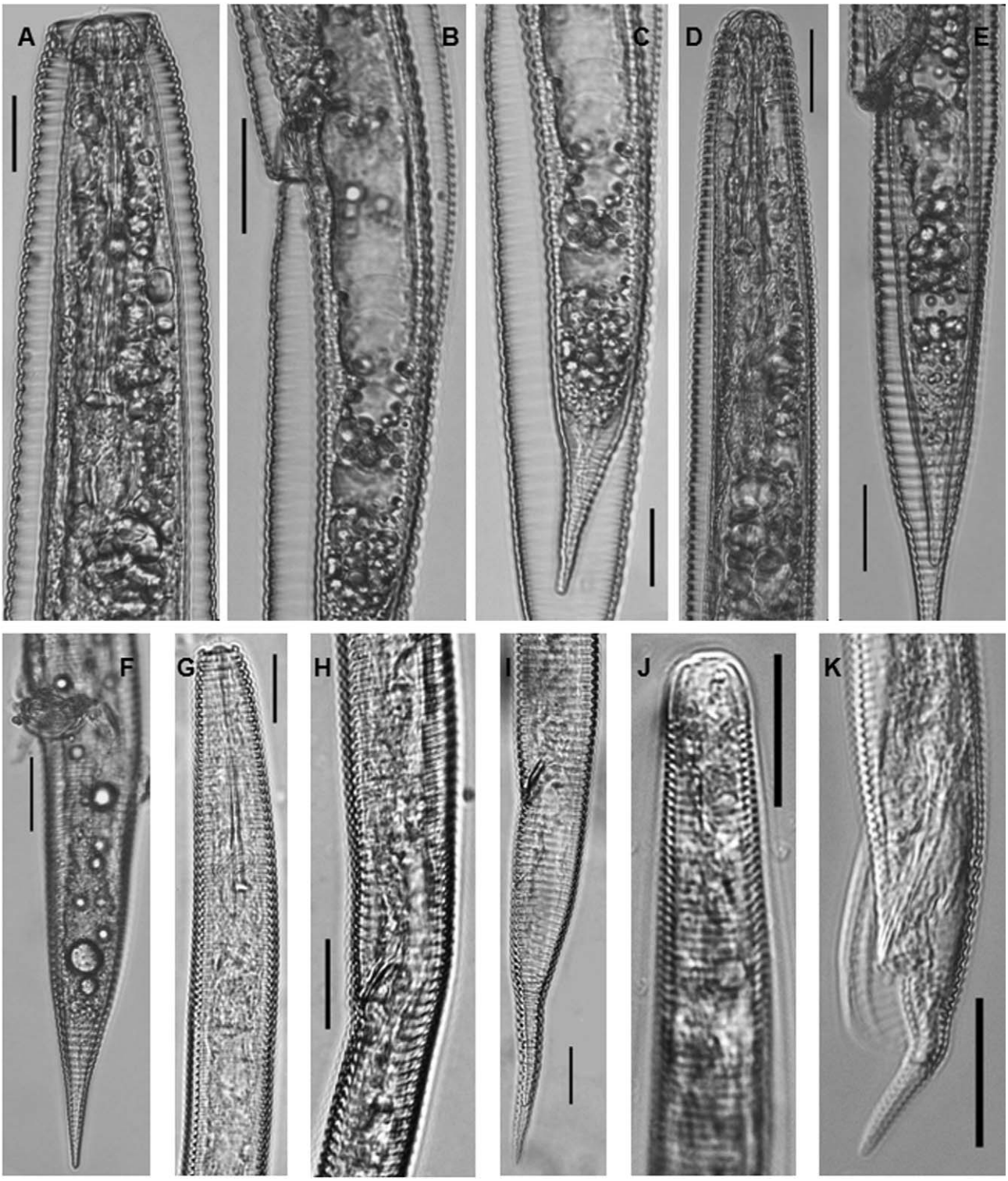

FIGURE 7. Micrographs of *Hemicycliophora thienemanni*, *H. conida*, *Hemicaloosia graminis* from turfgrasses in NC and SC. All scale bars =20µm. A. Female esophageal region of *H. thienemanni*. B. Vulva region of *H. thienemanni*. C. Female tail of *H. thienemanni*. D. Female esophageal region of *H. conida*. E,F. Vulva region of *H. conida*. G. Female esophageal region of *Hemicaloosia graminis*. H. Vulva region of *Hemicaloosia graminis*. I. Female tail of *Hemicaloosia graminis*. J. Male esophageal region of *Hemicaloosia graminis*. K. Male tail of *Hemicaloosia graminis*.

TABLE 14. *Hemicycliophora* spp. and *Hemicaloosia graminis*: morphometrics of females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***Hemicycliophora thienemanni***	***Hemicycliophora conida***	***Hemicycliophora conida***	***Hemicycliophora conida***	***Hemicaloosia graminis***
Lab ID	11-29594	11-29736	11-30286	11-30321	10-27720
Host	Bermudagrass	Bermudagrass	Bermudagrass	Bermudagrass	Bermudagrass
Location	New Hanover, NC	New Hanover, NC	New Hanover, NC	New Hanover, NC	New Hanover, NC
n	10	10	10	10	6
L	1008.4 ± 19.4 (981.4–1026.1)	1024.3 ± 37.6 (957.8–1071.4)	1053.5 ± 45.9 (1003.2–1120.7)	987.4 ± 41.2 (925.8–1037.8)	712.3 ± 70.1 (610.4–805.4)
a	26.6 ± 3.2 (22.2–29.1)	27.2 ± 2.5 (22.8–30.3)	25.2 ± 1.8 (23.1–27.2)	25.9 ± 1.4 (23.4–27.1)	28.8 ± 0.9 (27.2–29.5)
b	5.8 ± 0.2 (5.6–6.1)	6.2 ± 0.2 (5.9–6.4)	6.5 ± 0.1 (6.4–6.8)	6.3 ± 0.2 (6.0–6.5)	5.8 ± 0.4 (5.1–6.2)
c	12.0 ± 1.4 (10.1–13.5)	8.7 ± 0.5 (8.1–9.5)	9.8 ± 0.6 (8.8–10.4)	8.4 ± 0.2 (8.1–8.7)	9.0 ± 0.6 (8.3–10.0)
c’	3.3 ± 0.2 (3.1–3.6)	4.0 ± 0.2 (3.8–4.2)	3.3 ± 0.3 (2.8–3.6)	3.8 ± 0.1 (3.7–3.9)	4.3 ± 0.3 (4.0–4.6)
V	82.5 ± 1.2 (81.0–83.8)	82.9 ± 1.0 (81.5–84.3)	83.2 ± 1.2 (81.9–85.1)	83.6 ± 0.7 (82.9–84.5)	84.7 ± 0.7 (84.1–85.8)
Body width	38.5 ± 5.3 (33.7–45.9)	37.8 ± 2.5 (35.3–42.1)	41.9 ± 1.5 (40.0–44.1)	38.2 ± 1.4 (36.1–39.6)	25.3 ± 3.1 (20.9–29.6)
Stylet length	94.7 ± 1.3 (93.1–96.2)	87.0 ± 1.5 (85.3–89.3)	86.3 ± 4.9 (78.3–90.4)	83.1 ± 2.7 (79.3–86.8)	69.0 ± 3.3 (66.8–74.6)
Stylet shaft length	16.3 ± 0.7 (15.5–17.2)	15.2 ± 0.7 (13.9–15.9)	17.0 ± 1.2 (15.4–18.5)	16.6 ± 1.3 (15.7–18.8)	57.8 2.8 (55.3–62.5)
Stylet knobW/H	2.0 ± 0.1 (1.9–2.1)	1.9 ± 0.1 (1.7–2.1)	2.0 ± 0.1 (1.8–2.1)	1.8 ± 0.1 (1.7–1.8)	2.8 ± 0.4 (2.2–3.1)
Body width at stylet base	34.3 ± 2.7 (30.5–36.5)	32.1 ± 1.0 (30.9–33.7)	34.0 ± 0.6 (33.3–34.9)	32.4 ± 1.3 (30.3–33.6)	22.2 ± 2.4 (19.4–25.9)
Pharynx length (Head to metacorpus base)	173.2 ± 5.8 (168.6–181.4)	166.6 ± 4.7 (160.3–172.2)	161.2 ± 4.8 (155.4–166.1)	157.7 ± 3.7 (152.0–161.6)	123.6 ± 5.9 (119.5–133.8)
Anal body width	26.2 ± 2.1 (23.4–28.3)	29.6 ± 0.6 (28.8–30.2)	33.3 ± 2.1 (31.2–35.7)	31.0 ± 1.0 (30.0–32.7)	18.5 ± 1.2 (17.0–20.4)
Tail length	85.5 11.9 (72.8–101.3)	117.8 6.0 (109.5–126.4)	108.3 ± 6.7 (100.5–116.3)	117.7 ± 6.2 (112.4–128.2)	79.3 ± 7.0 (67.5–84.8)
VA	90.7 ± 19.1 (65.0–111.4)	57.2 ± 4.0 (52.0–63.4)	57.3 ± 1.7 (56.0–60.0)	48.6 ± 2.7 (45.0–52.8)	29.4 ± 3.6 (26.0–33.3)
Excretory pore from anterior end	187.2 ± 6.5 (179.5–195.5)	197.6 ± 13.6 (179.2–217.5)	198.8 ± 6.0 (193.0–207.1)	202.2 ± 5.8 (195.5–209.1)	131.0 ± 6.5 (122.3–138.1)
Ring width at mid-body	4.0 ± 0.1 (3.9–4.2)	3.7 ± 0.5 (3.2–4.5)	3.2 ± 0.2 (3.0–3.5)	3.1 ± 0.2 (2.9–3.4)	2.8 ± 0.1 (2.7–2.9)
R	248.7 ± 4.5 (245.0–255.0)	255.0 ± 2.7 (251.0–258.0)	253.8 ± 5.4 (248.0–262.0)	264.3 ± 4.3 (259.0–269.0)	269.3 ± 11.4 (254.0–283.0)
Rs	28.3 ± 1.3 (27.0–30.0)	23.0 ± 0.6 (22.0–24.0)	22.3 ± 1.1 (21.0–24.0)	23.8 ± 1.5 (22.0–26.0)	24.5 ± 1.7 (23.0–27.0)
Reso	48.0 ± 3.3 (44.0–52.0)	45.4 ± 1.0 (44.0–47.0)	47.8 ± 6.5 (43.0–59.0)	47.3 ± 1.6 (46.0–50.0)	45.5 ± 3.4 (42.0–51.0)

.....continued on next page

TABLE 14. (Continued)

Species	*Hemicycliophora thienemanni*	*Hemicycliophora conida*	*Hemicycliophora conida*	*Hemicycliophora conida*	*Hemicaloosia graminis*
Rex	51.7 ± 2.5 (49.0–55.0)	54.0 ± 1.9 (52.0–57.0)	57.3 ± 7.4 (49.0–67.0)	60.0 ± 1.6 (58.0–62.0)	48.0 ± 4.1 (43.0–54.0)
RV	191.3 ± 2.6 (189.0–195.0)	205.2 ± 2.0 (202.0–208.0)	204.0 ± 3.3 (200.0–208.0)	211.8 ± 4.4 (205.0–217.0)	47.3 ± 5.6 (38.0–53.0)
Ran	33.3 ± 2.4 (30.0–35.0)	34.0 ± 1.3 (32.0–35.0)	35.3 ± 3.4 (32.0–40.0)	39.5 ± 2.1 (37.0–42.0)	34.3 ± 5.1 (26.0–39.0)
RVan	24.0 ± 4.3 (20.0–30.0)	15.8 ± 0.8 (15.0–17.0)	15.7 ± 1.7 (14.0–18.0)	13.0 ± 0.7 (12.0–14.0)	13.0 ± 1.0 (12.0–14.0)
VL	176.2 ± 12.5 (166.6–193.8)	175.0 ± 8.4 (164.2–189.8)	176.4 ± 11.9 (159.2–191.5)	161.6 ± 9.4 (151.7–177.0)	108.7 ± 9.4 (93.2–117.6)
VB	36.0 ± 4.4 (31.5–42.0)	34.2 ± 0.9 (33.2–35.9)	41.3 ± 0.9 (40.0–42.3)	36.8 ± 2.1 (34.2–39.6)	19.4 ± 1.9 (18.1–22.7)
VL/VB	4.9 ± 0.3 (4.6–5.3)	5.1 ± 0.2 (4.8–5.3)	4.3 ± 0.2 (4.0–4.6)	4.4 ± 0.3 (4.0–4.7)	5.6 ± 0.6 (5.0–6.5)
m	17.2 ± 0.6 (16.7–18.1)	17.4 ± 0.8 (16.3–18.2)	19.8 ± 1.7 (17.9–22.3)	20.0 ± 1.8 (18.1–22.6)	83.8 ± 0.9 (82.3–84.7)
St% L	9.4 ± 0.3 (9.1–9.7)	8.5 ± 0.3 (8.2–8.9)	8.2 ± 0.3 (7.8–8.4)	8.4 ± 0.3 (8.0–8.6)	9.8 ± 0.8 (9.1–11.0)
St% Eso	54.7 ± 1.4 (53.0–56.3)	52.3 ± 0.7 (51.1–53.2)	53.5 ± 1.8 (50.4–54.6)	52.7 ± 1.6 (51.6–55.4)	55.8 ± 0.2 (55.6–55.9)

Aphelenchoides myceliophagus
(Fig. 6 I–M)

Measurements. See Table 1.

Remarks. *Aphelenchoides myceliophagus* was described from a cropping bed of the common mushroom, *Agaricus bisporus*, in Saproon, Solan (H. P.), India (Seth & Sharma 1986). Khanna & Sharma (1988) reported strong pathogenicity of this species toward *Agaricus bisporus*. In this survey, *A. myceliophagus* was found only in Cumberland County, NC. The morphological characteristics did not differ from the original description. This is the first record of *A. myceliophagus* from turfgrasses in NC.

Longidorus paralongicaudatus
(Fig. 8 K–N)

Measurements. See Table 15.

Remarks. *Longidorus paralongicaudatus* was described from sandy soil around American elm (*Ulmus Americana*), maple (*Acer*), and oak (*Quercus*) trees in Arkansas, and in Georgia, Iowa and Tennessee (Ye & Robbins 2003). In this study, *L. paralongicaudatus* was found only in a bermudagrass tee in Beaufort County, SC. The morphology and morphometrics of the identified population did not differ from original description. This is the first record of *L. paralongicaudatus* from turfgrasses in SC.

Xiphinema americanum sensu lato
(Fig. 8 A, B, G)

Measurements. See Table 15.

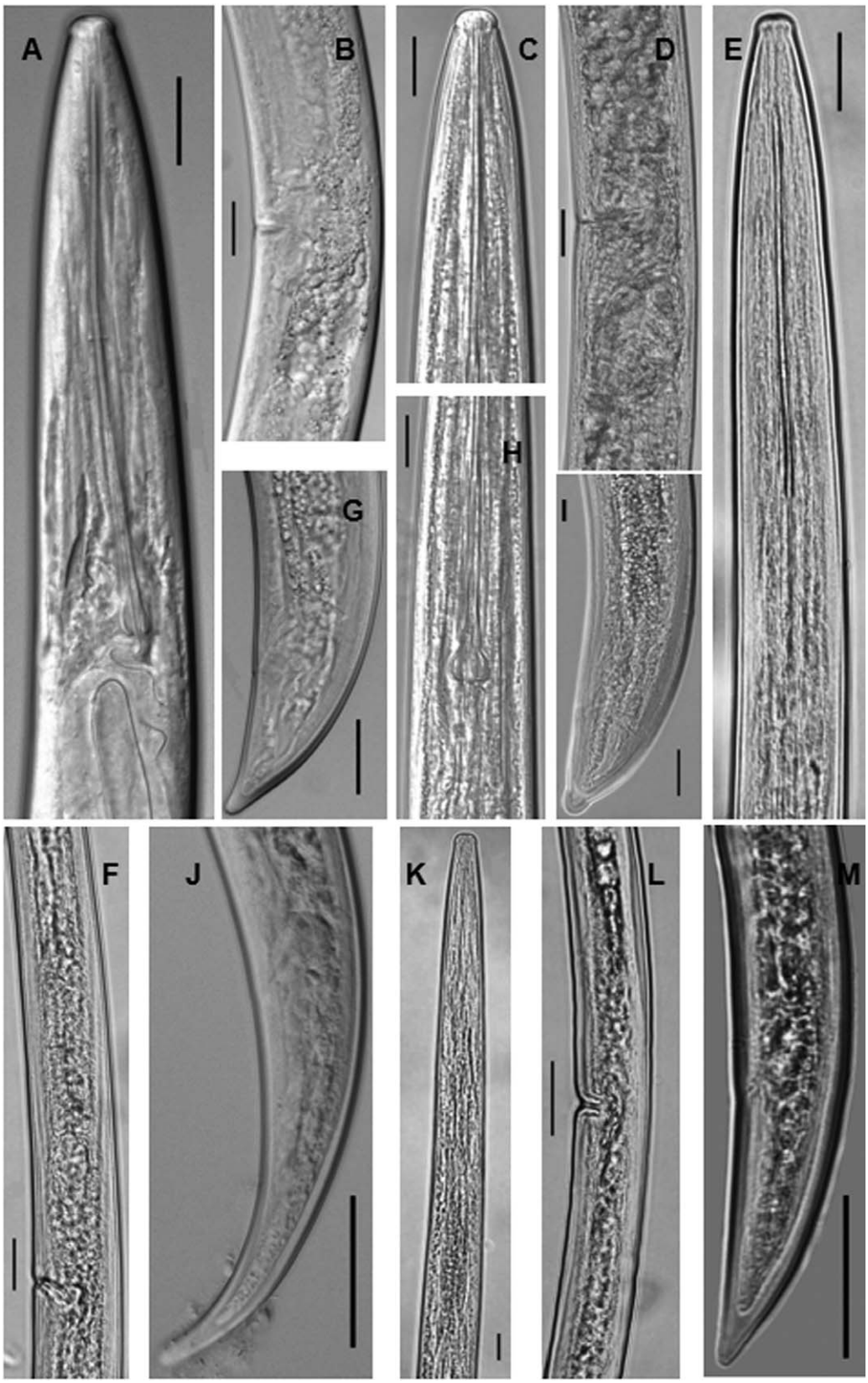

FIGURE 8. Micrographs of *Xiphinema americana*, *X. bakeri*, *X. chambersi*, *Longidorus paralongicaudatus* from turfgrasses in NC and SC. All scale bars =20µm. A. Female esophageal region of *X. americana*. B. Vulva region of *X. americana*. C,H. Female esophageal region of *X. bakeri*. D. Vulva region of *X. bakeri*. E. Female esophageal region of *X. chambersi*. F. Vulva region of *X. chambersi*. G. Female tail region of *X. americana*. I. Female tail region of *X. bakeri*. J. Female tail region of *X. chambersi*. K. Female esophageal region of *L. paralongicaudatus*. L. Vulva region of *L. paralongicaudatus*. M,N. Female tail region of *L. paralongicaudatus*.

Remarks. *Xiphinema americanum sensu lato* is a cosmopolitan species, and has been reported from North America (Canada, Mexico and USA), Australia, Belize, Chile, Egypt, Guatemala, India, Japan, Korea, Iran, New Zealand, Pakistan, South Africa, Sri Lanka and Uruguay and the EPPO region (Poland, USSR and the Mediterranean region) (EPPO 1984; Fadaei *et al*. 2003; Ye & Robbins 2010). It is a very common species in Arkansas (Ye & Robbins 2010), also in NC and SC. In the present study, *X. americanum sensu lato* was detected in 13 counties in NC and SC. The morphological features of the identified populations did not differ from other populations and the morphometrics did not differ from populations Xiph-4 and Xiph-16 (Ye & Robbins 2010). It is pathogenic to a wide range of field crops, ornamentals, native plants and shade trees. In the USA, it causes damage to strawberries, fruit trees, forage legumes and forest trees. In this study, it was found in golf course greens, fairways and tees established with bermudagrass but was not found in creeping bentgrass or zoysiagrass. This nematode is most important as a vector of damaging nepoviruses, including tomato ringspot virus (Forer & Stouffer 1981), tobacco ringspot virus (TRSV) (McGuire 1964), and cherry rasp leaf virus (EPPO 1984). Sammons & Barnett (1987) firstly reported TRSV from squash in SC. Due to its economic importance, it is listed as an A1 quarantine organism by the European and Mediterranean Plant Protection Organization and many other countries (Kulinich *et al*. 2003; Brito *et al*. 2005; Bello *et al*. 2005). *Xiphinema americanum sensu lato* is considered to be a species complex (Lima 1965). By 2000, the number of species in the *X. americanum*-group had expanded to 49 (Lamberti *et al*. 2000), 20 of which have been reported in North America (Robbins & Brown 1991; Luc *et al*. 1998). However, separation of the species within the group is questionable as it is based on minor differences in head and tail shapes (Ye & Robbins 2010).

Xiphinema bakeri
(Fig. 8 C, D, H, I)

Measurements. See Table 15.

Remarks. *Xiphinema bakeri* was first described form British Columbia, Canada by Williams (1961). It has been reported from Arkansas (Ye & Robbins 2010), Iowa (Norton *et al*. 1982), Florida (Tarjan 1974), California, Illinois, Indiana, Kentucky, Oregon, Tennessee, Washington (Norton *et al*. 1984; Tarjan 1964b), Korea (Lee & Han 1976) and Japan (Yokoo 1970). *Xiphinema bakeri* was considered to be the primary pathogen in corky root etiology (Sutherland 1977) and acquired and transmitted arabis mosaic nepovirus in laboratory experiments (Iwaki & Komuro 1974). In this study, *X. bakeri* was found in golf course fairways established with bermudagrass in Lee County, NC. The morphological characteristics differed from those described by Williams (1961) in body length and *a* value in females. This is the first record of *X. bakeri* from turfgrasses in NC.

Xiphinema chambersi
(Fig. 8 E, F, J)

Measurements. See Table 15.

Remarks. *Xiphinema chambersi* was described from specimens collected in Virginia (Thorne, 1939). It has been recorded in Arkansas (Robbins *et al*. 1987; Ye & Robbins 2010), Florida (Tarjan 1974; Lamberti *et al*. 2002), Iowa (Norton & Hoffmann 1974; Norton *et al*. 1982), Connecticut, Georgia, Illinois, Louisiana, Maryland, Minnisota, NC, New Jersey, SC, Tennessee, Wisconsin, and West Virginia (Norton *et al*. 1984), and in Canada (Yu *et al*. 2010), Japan (Yokoo, 1970; Shishida 1983) and Korea (Choi *et al*. 1992). In the present study, *X. bakeri* was found in bermudagrass fairways in Lee County, NC. The morphology and morphometrics of the identified population did not differ from those of previously described populations (Ye & Robbins 2010).

TABLE 15. *Xiphinema* spp. and *Longidorus paralongicaudatus*: morphometrics of females mounted in water. All measurements in μm and in the format: mean ± S.D. (range).

Species	***X. americanum***	***X. americanum***	***X. chambersi***	***X. bakeri***	***L. paralongicaudatus***
Lab ID	11-29987	06-27878	11-27763	11-30099	08-09943
Host	Bermudagrass	Bermudagrass	Grass	Bermudagrass	Bermudagrass
Location	Moore, NC	Sampson, NC	Cumberland, NC	Lee, NC	Cumberland, NC
n	10	10	3	3	3
L	1506.6 ± 82.1 (1374.7–1637.4)	1585.8 ± 50.8 (1497.0–1639.0)	2137.0 ± 58.0 (2079.0–2195.0)	2437.5 ± 95.0 (2342.4–2532.5)	2551.4 ± 233.6 (2265.1–2837.3)
a	40.0 ± 3.4 (35.4–45.0)	50.5 ± 2.7 (46.4–53.5)	63.8 ± 0.8 (63.0–64.6)	41.7 ± 1.6 (41.0–43.4)	77.4 ± 3.3 (73.8–81.7)
b	7.2 ± 0.3 (6.6–7.5)	5.9 ± 0.2 (5.6–6.1)	5.2 ± 0.4 (4.9–5.6)	5.6 ± 0.4 (5.2–6.0)	9.9 ± 0.6 (9.2–10.7)
c	45.8 ± 1.3 (43.8–47.8)	47.9 ± 3.8 (40.6–52.7)	23.6 ± 1.2 (22.4–24.8)	62.1 ± 2.7 (59.4–64.9)	61.8 ± 3.5 (57.0–65.3)
c’	1.7 ± 0.1 (1.5–1.9)	1.8 ± 0.1 (1.6–2.0)	4.2 ± 0.3 (3.9–4.4)	1.2 ± 0.1 (1.1–1.3)	2.0 ± 0.1 (1.8–2.0)
V	51.3 ± 0.4 (50.5–51.8)	51.2 ± 1.3 (49.5–53.7)	22.9 ± 0.4 (22.5–23.3)	34.1 ± 0.4 (33.8–34.5)	46.6 ± 1.0 (45.6–48.0)
Body width	37.8 ± 2.6 (34.1–41.0)	31.5 ± 2.4 (28.0–35.0)	33.5 ± 0.5 (33.0–34.0)	58.6 ± 4.6 (54.0–63.2)	33.1 ± 3.9 (29.6–38.5)
Stylet length	116.0 ± 5.3 (104.7–121.1)	115.3 ± 2.7 (113.0–120.0)	162. 0 ± 4.0 (158.0–166.0)	182.1 ± 0.2 (181.9–182.3)	151.1 ± 2.0 (149.1–153.8)
Odontophore length	42.7 ± 2.4 (37.8–45.1)	47.2 ± 1.5 (46.0–50.0)	58.5 ± 0.5 (58.0–59.0)	72.8 ± 1.8 (71.0–74.6)	47.5 ± 4.3 (41.6–45.9)
Odontostyle length	73.3 ± 3.7 (66.9–78.6)	68.2 ± 1.5 (66.0–70.0)	103.5 ± 3.5 (100.0–107.0)	109.3 ± 1.7 (107.6–111.0)	103.6 ± 3.7 (100.0–108.7)
Guiding ring from anterior end	53.3 ± 2.4 (50.9–57.0)	61.5 ± 6.8 (54.0–76.0)	97.0 ± 5.0 (92.0–102.0)	97.5 ± 0.6 (97.0–98.1)	22.2 ± 1.4 (20.6–24.0)
Pharynx length (Head to metacorpus base)	210.8 ± 11.5 (198.2–231.0)	268.0 ± 12.3 (244.0–278.0)	409.5 ± 18.5 (391.0–428.0)	436.5 ± 16.5 (420.0–453.0)	256.8 ± 8.1 (245.8–265.2)
Anal body width	20.0 ± 1.8 (17.5–22.2)	18.7 ± 0.9 (18.0–20.0)	22.0 ± 3.0 (19.0–25.0)	33.1 ± 1.8 (31.3–34.9)	21.2 ± 1.9 (20.6–24.0)
Tail length	32.9 ± 1.4 (32.0–34.3)	33.3 ± 3.2 (110.0–160.0)	91.0 ± 7.0 (84.0–98.0)	39.2 ± 0.2 (39.0–39.4)	32.9 ± 1.4 (32.0–34.3)
Excretory pore from anterior end	–	–	–	198.0 ± 0.0 (197.9–198.0)	123.0
Lip width	10.4 ± 0.3 (10.2–11.0)	9.3 ± 1.1 (8.0–11.0)	8.0 ± 1.1 (7.0–9.0)	14.0 ± 0.1 (13.9–14.1)	10.4 ± 0.3 (10.2–11.0)
Lip height	4.1 ± 0.3 (3.4–4.4)	4.4 ± 0.8 (3.0–5.0)	4.3 ± 0.9 (3.0–5.0)	5.7 ± 0.1 (5.6–5.8)	4.1 ± 0.3 (3.4–4.4)
G1	–	530.0 ± 5.0 (525.0–535.0)	–	–	–
G2	–	477.5 ± 42.5 (435.0–520.0)	–	–	–
Hyaline tail tip	11.9 ± 0.6 (11.1–12.8)	10.3 ± 0.7 (10.0–12.0)	20.5 ± 2.5 (18.0–23.0)	15.4 ± 1.4 (14.1–16.8)	11.9 ± 0.6 (11.1–12.8)
Lip D / H	2.6 ± 0.3 (2.3–3.2)	2.2 ± 0.4 (1.8–2.7)	2.0 ± 0.1 (2.0–2.2)	2.5 ± 0.0 (2.4–2.5)	2.2 ± 0.1 (2.0–2.3)
H%	36.0 ± 1.3 (33.7–37.4)	31.3 ± 3.8 (25.0–37.5)	22.9 ± 4.5 (18.4–27.4)	39.3 ± 3.7 (35.6–43.1)	23.1 ± 2.0 (20.5–25.3)

Paratrichodorus allius
(Fig. 9 A–C)

Measurements. See Table 16.

Remarks. *Paratrichodorus allius* was described from Oregon by Jensen (1963). It has been recorded in Washington (Mojtahedi & Santo 1999), Chile (Aballay & Eriksson 2006), Israel (Waele & Cohn 1992), and Hong Kong (Xie & Feng 1996). In this study, *P. allius* was found in seven counties in NC and SC, in creeping bentgrass putting greens in both states and in bermudagrass fairways and tees in SC. The morphology and morphometrics of the identified population did not differ from the original description. This is the first record of *P. allius* from turfgrasses in NC and SC.

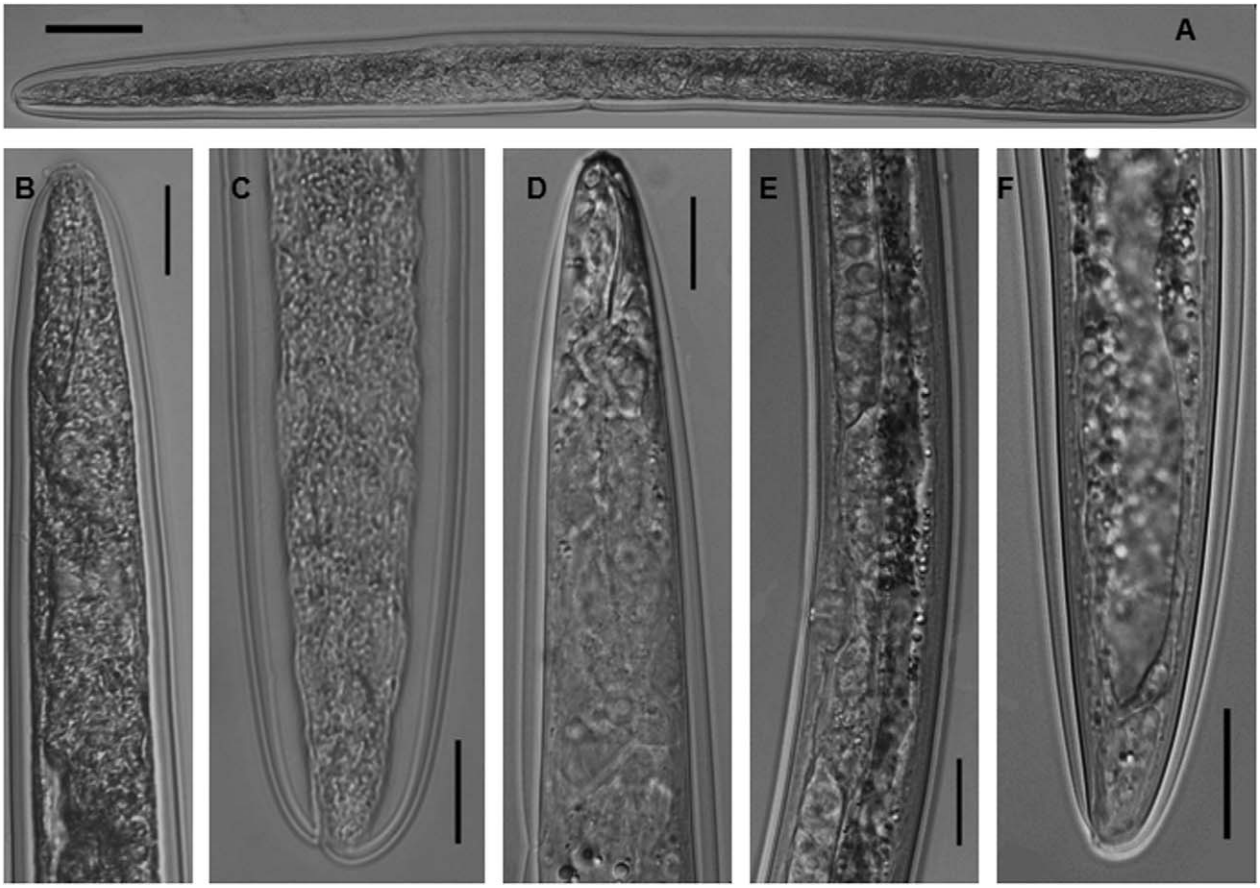

FIGURE 9. Micrographs of *Paratrichodorus allius*, *Paratrichodorus minor* from turfgrasses in NC and SC (Scale bars: A=100µm; B-F= 20µm). A. Female entire body of *P. allius*. B. Female esophageal region of *P. allius*. C. Female tail region of *P. allius*. D. Female esophageal region of *P. minor*. E. Vulva and tail region of *P. minor*. F. Female tail region of *P. minor*.

Paratrichodorus minor
(Fig. 9 D–F)

Measurements. See Table 16.

Remarks. *Paratrichodorus minor* was described from Queensland, Australia (Colbran 1956). The type host was not indicated. The names of this species have changed from *Trichodorus christiei* to *Paratrichodorus christiei* to *Paratrichodorus Nanidorus minor* to *Nanidorus minor* (Rafael Rodriguez) to *Paratrichodorus minor*. It has been documented in many countries worldwide, including 11 in Europe, 11 in Asia, 13 in Africa, two in North America, five in Central America and Caribbean, six in South America, and four in Oceania (CABI 2002). In the USA, it has been found in 22 states (CABI 2002; Crow 2005c; Hooper 1977; Karanastasi *et al*. 2006; Li *et al*. 2010). In this survey, *P. minor* was found in 121 turfgrass samples taken in 33 counties in both states. It was common in three turf management zones (green, fairway and tee) and three grass species (bermudagrass, creeping bentgrass, zoysiagrass) in both states. The morphology and morphometrics of the identified population did not differ from previously described populations (Bell & Watson 2001).

TABLE 16. *Paratrichodorus* spp.: morphometrics of females mounted in formalin-glycerin. All measurements in μm and in the format: mean ± S.D. (range).

Species	***P. minor***	***P. allius***
Lab ID	11-30365	11-30383
Host	Bermudagrass	Bentgrass
Location	Kershaw, SC	Avery, NC
n	15	15
L	692.9 ± 50.6 (646.8–763.4)	636.4 ± 13.5 (619.3–652.3)
a	16.9 ± 2.9 (13.8–20.9)	15.0 ± 1.1 (13.7–16.3)
b’	6.4 ± 1.0 (5.6–7.8)	5.7 ± 0.3 (5.3–6.0)
c	194.0 ± 1.5 (192.3–196.0)	176.5 ± 14.2 (160.0–194.7)
c’	0.3 ± 0.0 (0.3–0.4)	0.3 ± 0.0 (0.3–0.3)
V	52.4 ± 0.4 (52.0–52.9)	54.3 ± 0.7 (53.5–55.3)
Body width	41.6 ± 4.2 (36.6–46.9)	42.8 ± 4.0 (38.0–47.7)
Stylet length	32.7 ± 1.2 (31.1–33.9)	46.5 ± 2.2 (43.4–48.5)
Pharynx length (Head to metacorpus base)	109.3 ± 8.8 (97.6–118.7)	112.1 ± 6.0 (106.6– 120.4)
Anal body width	10.7 ± 0.8 (9.6–11.4)	11.7 ± 0.8 (10.8–12.8)
Tail length	3.6 ± 0.3 (3.3–4.0)	3.6 ± 0.2 (3.3–3.9)

Discussion

This survey revealed that turfgrasses including bermudagrass, creeping bentgrass, and zoysiagrass in NC and SC support a wide variety of plant-parasitic nematodes. Twenty nine nematode species were identified from turfgrasses in the Carolinas. Among them, 11 species (*M. graminis, M. naasi, Cactodera* sp., *P. penetrans, H. conida, H. graminis, M. xenoplax, M. sphaerocephala, O. floridense, P. allius,* and *D. heterocephalus*) were new records from turfgrass in both states; five (*Heterodera* sp., *L. thienemanni, M. curvatum, L. paralongicaudatus,* and *F. cylindricus*) were new in SC; and three (*H. wessoni, X. bakeri* and *A. myceliophagus*) were new in NC. The results also revealed a relatively wide distribution of eight species including *B. longicaudatus, P. minor, M. graminis, M. xenoplax, H. dihystera, T. claytoni, H. galeatus* and *P. penetrans* in golf courses.

This survey clarified the identity of the soil-inhabiting nematodes that parasitize golf course turf in the Carolinas. The prevalence, population level, and distribution map of each nematode species, hazard species, damage threshold and standard management recommendations were presented in Ye *et al.* (2012). This work was a first step for future study to provide more precise and effective management options to golf-course superintendents.

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References

Aballay, E. & Eriksson, B. (2006) Trichodorid nematodes in the central area of Chile. *Nematologia Mediterranea*, 34, 43–48.

Aballay, E., Persson, P. & Martensson, A. (2009) Plant-parasitic nematodes in Chilean vineyards. *Nematropica*, 39, 85–97.

Abrantes, I.M.de O., Santos, M.C.V.dos, Conceição, I.L.P.M.da, Santos, M.S.N.de A. & Vovlas, N. (2008) Root-knot and other plant-parasitic nematodes associated with fig trees in Portugal. *Nematologia Mediterranea*, 36, 131–136.

Afshar, F.J., Pourjam, E. & Kheiri, A. (2006) Tylenchs associated with Jiroft orchards and a description of four newly found species for the nematode fauna of Iran. *Iranian Journal of Agricultural Sciences*, 37, 529–543.

Agudelo, P. & Harshman, D. (2011) First report of the spiral nematode *Scutellonema brachyurum* on lilyturf in the United States. *Plant Disease*, 95, 74–75.

Alby, T., Ferris, J.M. & Ferris, V.R. (1983) Dispersion and distribution of *Pratylenchus scribneri* and *Hoplolaimus galeatus* in soybean fields. *Journal of Nematology*,15, 418–426.

Alcala J.V., Tobar-Jimenez, A. & Munoz Medina, J.M. (1970) Lesions and reactions caused by some nematodes in the roots of certain plants. *Revista Iberica de Parasitologia*, 30, 547–566.

Allen, J.B., Bond, J.P. & Schmidt, M.E. (2005) Incidence of *Meloidogyne incognita* and development of resistant soybean germplasm in Illinois. *Plant Health Progress*, 1–9.

Amin, A.W. (1994) Root-knot nematodes (*Meloidogyne* spp.) in Hungary. *Bulletin EPPO*, 24, 417–422.

Amin, A.W. & Budai, C. (1992) A new pest in the Hungarian fauna: the root-knot eelworm *Meloidogyne naasi* Franklin (1965). *Növényvédelem*, 28, 462–463.

Barker, K.R. & Clayton, C.N. (1973) Nematodes attacking cultivars of peach in North Carolina. *Journal of Nematology*, 5, 265–271.

Bélair, G. & Simard, L. (2008) Effect of the root-lesion nematode (*Pratylenchus penetrans*) on annual bluegrass (*Poa annua*). *Phytoprotection*, 89, 37–39.

Bélair, G., Simard, L. & Eisenback, J.D. (2006) First report of the barley root-knot nematode *Meloidogyne naasi* infecting annual bluegrass on a golf course in Quebec, Canada. *Plant Disease*, 90, 1109.

Bell, A.A. & Krusburg, L.R. (1964) Occurrence and control of a nematode of the genus *Hypsoperine* on zoysia and Bermuda grasses in Maryland. *Plant Disease Reporter*, 48, 721–722.

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

Bello, A., Robertson, L., Díez-Rojo, M.A. & Arias, M. (2005) A re-evaluation of the geographical distribution of quarantine nematodes reported in Spain. *Nematologia Mediterranea*, 33, 209–216.

Bolton, C., de Waele, D. & Loots, G.C. (1989) Plant-parasitic nematodes on field crops in South Africa. 3. Sunflower. *Revue de Nématologie*, 12, 69–76.

Bost, S. C. (1985) Evaluation of nematicides for control of lesion and lance nematodes on grain sorghum, 1984. *Fungicide and Nematicide Tests*, 40, 98.

Brito, G.G.de, Costa, E.C., Antoniolli, Z.I., Dörr, F. & Maziero, H. (2005) *Xiphinema americanum* Cobb, 1913 (Dorylaimida: Longidoridae): quarantine pest for Brazil. *Ciência Rural*, 35, 239–244.

Brzeski, M.W. (1974) Taxonomy of Hemicycliophorinae (Nematoda, Tylenchida). *Zeszyty Problemowe Postępów Nauk Rolniczych*, 154, 237–330.

Burton, G.W. & Hanna, W.W. (1977) Performance of mutants induced in sterile triploid turf bermudagrass. *Mutation Breeding Newsletter*, (9), 4.

Busey, P., Giblin-Davis, R.M., Riger, C.W. & Zaenker, E.I. (1991) Susceptibility of diploid St. Augustinegrasses to *Belonolaimus longicaudatus*. *Supplement to the Journal of Nematology*, 23, 604–610.

Byrd, D.W., Jr. Barker, K.R., Ferris, H., Nusbaum, C.J., Griffin, W.E., Small, R.H. & Stone, C.A. (1976) Two semi-automatic elutriators for extracting nematodes and certain fungi from soil. *Journal of Nematology*, 8, 206–212.

CABI. (2002) *Paratrichodorus minor.* [Distribution map]. Distribution Maps of Plant Diseases, (Edition 1), Map 870.

CABI. (2003) *Pratylenchus penetrans*. [Distribution map]. Distribution Maps of Plant Diseases, (Edition 1), Map 888.

CABI. (2006) *Scutellonema brachyurum*. [Distribution map]. Distribution Maps of Plant Diseases (October) (Edition 1), Map 990.

CABI. (2009) *Tylenchorhynchus claytoni*. [Distribution map]. Distribution Maps of Plant Diseases (October) (Edition 1), Map 1072.

CABI. (2010) *Helicotylenchus dihystera*. [Distribution map]. Distribution Maps of Plant Diseases (April) (Edition 1), Map 1077.

Castillo, P., Gomez-Barcina, A. & Loof, P.A.A. (1989) On two species of *Hemicycliophora* de Man 1921 (Nematoda, Criconematoidea) found in Spain. *Nematologia Mediterranea*, 17, 77–82.

Castillo, P. & Gomez-Barcina, A. (1993) Plant-parasitic nematodes associated with tropical and subtropical crops in southern Spain. *Nematologia Mediterranea*, 21, 45–47.

Chapman, R.A. (1976) Population dynamics of *Hoplolaimus galeatus* in sod. *Journal of Nematology*, 8, 282.

Chastagner, G.A. & McElroy, F.D. (1984) Distribution of plant-pararsitic nematodes in putting green turfgrass in Washington. *Plant Disease*, 68, 151–153.

Chaves, E. (1983) Criconematoidea (Nematoda) from Argentina. *Nematologica*, 29, 404–424.

Chaves, E. & Torres, M.S. (2000) Nematode fauna associated with golf courses in the south-eastern region of the Buenos Aires province. Nematofauna asociada a campos de golf en el sudeste de la provincia de Buenos Aires. *Revista de la Facultad de Agronomía (Universidad de Buenos Aires)*, 20, 379–386.
Chitwood, B.G. & Birchfield, W. (1957) A new genus, *Hemicriconemoides* (Criconematidae, Tylenchida). *Proceedings of the Helminthological Society of Washington*. 24, 80–86.
Choi Y.E. & Geraert, E. (1975) Criconematids from Korea with the description of eight new species (Nematoda: Tylenchida). *Nematologica*, 21, 35–52.
Choi Y.E., Choi Y.S. & Choi M.R. (1992) Nematodes associated with forest trees in Korea. III. A new species of *Xiphinemella* Loos, 1950, and four unrecorded species of *Xiphinema* Cobb, 1913. *Korea Journal of Applied Entomology*, 31, 416–426.
Christie, J.R. (1959) *Plant Nematodes: their bionomics and control*. Gainesville, Fla: University of Florida, 256 pp.
Ciancio, A., Farfan, V.V., Torres, E.C. & Grasso, G. (1998) Observations on a *Pasteuria* isolate parasitic on *Hoplolaimus galeatus* in Peru. *Journal of Nematology*, 30, 206–210.
Cobb, N.A. (1914) The North American freeliving fresh water nematodes. Contributions to a science of Nematology II. *Transactions of American Microscopical Society*, 33, 69–134.
Cobb, N.A. (1913) New nematode genera found inhabiting fresh water and non-brackish soils. *Journal of the Washington Academy of Science*, 3, 438.
Cobb, N.A. (1917) A new parasitic nema found infesting cotton and potatoes. *Journal of Agricultural Research U.S.D.A.*, 11, 27–33.
Colbran, R.C. (1956) Studies of plant and soil nematodes. 1. Two new species from Queensland. *Queensland Journal of Agricultural Science*, 13, 123–126.
Cook, R., Mizen, K.A., Plowright, R.A. & York, P.A. (1992) Observations on the incidence of plant-parasitic nematodes in grassland in England and Wales. *Grass and Forage Science*, 47, 274–279.
Coomans, A., Vincx, M. & Decraemer, W. (1985) Nematodes from a fresh-water pool on a coral island in the Solomon Islands. *Hydrobiologia*, 123, 265–281.
Corbett, D.C.M. (1973) *Pratylenchus penetrans*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 2, no. 25*. St. Albans, England: Commonwealth Agricultural Bureaux.
Crow, W.T. (2005a) Alternatives to fenamiphos for management of plant-parasitic nematodes on bermudagrass. *Journal of Nematology*, 37, 477–482.
Crow, W.T. (2005b) Plant parasitic nematodes on golf course turf. *Outlooks on Pest Management. February*, 10–15.
Crow, W.T. (2005c) Diagnosis of *Trichodorus obtusus* and *Paratrichodorus minor* on turfgrasses in the Southeastern United States. *Plant Health Progress*; St. Paul: Plant Management Network, 1–7.
Crow, W.T. & Walker, N.R. (2003) Diagnosis of *Peltamigratus christiei*, a plant-parasitic nematode associated with warm-season turfgrasses in the Southern United States. *Plant Health Progress*; St. Paul: Plant Management Network, 1–8.
Crozzoli, R. & Lamberti, F. (2001) Known and new species of *Mesocriconema* Andrássy, 1965 (Nematoda: Criconematidae) from Venezuela. *Russian Journal of Nematology*, 9, 85–105.
D'Errico, F.P., Lamberti, F. & Fiume, F. (1977) The discovery of *Dolichodorus heterocephalus* Cobb in southern Italy. *Nematologia Mediterranea*, 5, 99–101.
Dasgupta, D.R., Raski, D.J. & Van Gundy, S.D. (1969) Revision of the genus *Hemicriconemoides* Chitwood & Birchfield, 1957 (Nematoda: Criconematidae). *Journal of Nematology*, 1, 126–145.
De Grisse, A. & Loof, P.A.A. (1970) Intraspecific variation in some Criconematidae (Nematoda). *Meded. Fak. LandbWet. Gent*, 35, 41–63.
Decraemer, W. (1995) *The family Trichodoridae: Stubby root and virus vector nematodes*. The Netherlands: Kluwer Academic Publishers, 360pp.
Deimi, A.M., Chitambar, J.J. & Maafi, Z.T. (2008) Nematodes associated with flowering ornamental plants in Mahallat, Iran. *Nematologia Mediterranea*, 36, 115–123.
Dickerson, O.J., Willis, W.G., Dainello, F.J. & Pair, J.C. (1972) The sting nematode, *Belonlaimus longicaudatus*, in Kansas. *Plant Disease Reporter*, 56, 957.
Dickson, O.J. (1966) Some observations on *Hypsoperine graminis* in Kansas. *Plant Disease Reporter*, 50, 396–398.
Dobrin, I. & Rosca, I. (1996) *Filenchus cylindricus* and *F. misellus*, new species of nematodes from Romanian fauna. *Revue Roumaine de Biologie. Série de Biologie Animale*, 41, 103–107.
Doucet, M.E. (1980) Description of two new *Peltamigratus* species and of a *Hoplolaimus galeatus* population from Cordoba Province, Argentina. *Nematologica*, 26, 34–46.
Duncan, L.W., Noling, J.W., Inserra, R.N. & Dunn, D. (1996) Spatial patterns of *Belonolaimus* spp. among and within citrus orchards on Florida's central ridge. *Journal of Nematology*, 28, 352–359.
Echeverría, M.M. & Chaves, E.J. (1998) Identification of *Meloidogyne naasi* Franklin, 1965 from Argentina. *Nematologica*, 44, 219–220.
Ediz, S.A. & Dickerson, O.J. (1976) Life cycle, pathogenicity, histopathology, and host range of race 5 of the barley root-knot nematode. *Journal of Nematology*, 8, 228–232.
Elmi, A.A., West, C.P., Kirkpatrick, T.L. & Robbins, R.T. (1990) Acremonium endophyte inhibits root-knot nematodes reproduction in tall fescue. *Arkansas Farm Research*, 39, 3.
Elmiligy, I.A. (1971) Two new species of Tylenchidae, *Basiroides nortoni* n. sp. and *Tylenchus hageneri* n. sp. (Nematoda:

Tylenchida). *Journal of Nematology*, 3, 108–112.
EPPO. (1984) *Xiphinema americanum* Cobb, 1913. / [EPPO data sheets on quarantine organisms. List A2, No.150.]. *Bulletin EPPO*, 14, 67–71.
Erdogus, F.D., Akgul, H.C. & Bayram, S. (2010) Four new records of species for Turkish nematode fauna: *Filenchus cylindricus*, *F. sandneri*, *Lelenchus leptosoma* and *Geocenamus uralensis*. *Pakistan Journal of Nematology*, 28, 241–251.
Erum, Y.I. & Shahina, F. (2010) Taxonomic studies on parasitic and soil nematodes found associated with wheat in Pakistan. *Pakistan Journal of Nematology*, 28, 1–58.
Escuer, M., Lara, M.P. & Bello, A. (1999) Distribution of the Criconematidae in Peninsular Spain and Balearic Islands. *International Journal of Nematology*, 9, 47–67.
Esser, R.P. (1960) Three additional species in the genus *Hemicriconemoides* Chitwood and Birchfield 1957 (Nemata: Tylenchida). *Nematologica*, 5, 64–71.
Fadaei, A.A., Coomans, A. & Ahmad, K. (2003) Three species of the *Xiphinema americanum* lineage (Nematoda: Longidoridae) from Iran. *Nematology*, 5, 453–461.
Feldmesser, J. & Golden, A.M. (1972) Control of nematodes damaging home lawngrasses in two counties in Maryland. *Plant Disease Reporter*, 56, 476–480.
Forer, L.B. & Stouffer, R.F. (1981) *Xiphinema rivesi* associated with tomato ringspot virus-incited diseases in Pennsylvania. *Phytopathology*, 71, 767.
Fourgani, G.M. & Edongali, E.A. (1989) Speciation of root-knot nematode (*Meloidogyne* spp.) associated with crop plants in Libya. *International Nematology Network Newsletter*, 6, 38–39.
Fourie, H., McDonald, A.H. & Loots, G.C. (2001) Plant-parasitic nematodes in field crops in South Africa. 6. Soybean. *Nematology*, 3, 447–454.
Franklin, M.T. (1965) A root-knot nematode, *Meloidogyne naasi* n. sp., on field crops in England and Wales. *Nematologica*, 11, 79–86.
Franklin, M.T. (1973) *Meloidogyne naasi*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 2, no.19*. St. Albans, England: Commonwealth Agricultural Bureaux.
Gazaway, W.S. & Mclean, K.S. (2003) A survey of plant parasitic nematodes associated with cotton in Alabama. *The Journal of Cotton Science*, 7, 1–7.
Giblin-Davis, R.M., Busey, P. & Center, B.J. (1995) Parasitism of *Hoplolaimus galeatus* on diploid and polyploidy St. Augustine grasses. *Journal of Nematology*, 27, 472–477.
Giblin-Davis, R.M., Cisar, J.L., Blitz, F.G. & Williams, K.E. (1992) Host status of different bermudagrasses (*Cynodon* spp.) for the sting nematode, *Belonolaimus longicaudatus*. *Journal of Nematology*, 24, 749–756.
Giblin-Davis, R.M., McDaniel, L.L. & Bilz, F.G. (1990) Isolates of the *Pasteuria penetrans* group from phytoparasitic nematode in bermudagrass turf. *Supplement to Journal of Nematology*, 22, 750–762.
Golden, A.M., Handoo, Z.A. & Wehunt, E.J. (1986) Description of *Dolichodorus cobbi* n. sp. (Nematoda: Dolichodoridae) with morphometrics and lectotype designation of *D. heterocephalus* Cobb, 1914. *Journal of Nematology*, 18, 556–562.
Golden, A.M. (1979) Identification and relationship of the rye grass and oat cyst nematodes. *Nematropica*, 9, 99–100.
Golden, A.M., Maqbool, M.A. & Handoo, Z.A. (1987) Descriptions of two new species of *Tylenchorhynchus* Cobb, 1913 (Nematoda: Tylenchida), with details on morphology and variation of *T. claytoni*. *Jornal of Nematology*, 19, 58–68.
Golden, A.M. & Raski, D.J. (1977) *Cactodera thornei* n. sp. (Nematoda: Heteroderidae) and a review of related species. *Journal of Nematology*, 9, 93–112.
Gomes, C.B., Campos, A.D. & Almeida, M.R.A. (2000) Occurrence of *Mesocriconema xenoplax* and *Meloidogyne javanica* associated with peach tree short life on plum and reduction of phenol oxidizing enzyme activity. *Nematologia Brasileira*, 24, 249–252.
Goswami, S.P., Pathan, M.A., Jiskani, M.M., Wagan, K.H. & Khaskheli, M.I. (2008) Occurrence, population fluctuation and distribution of plant parasitic nematodes in ornamental plants in Sindh. *Pakistan Journal of Agriculture, Agricultural Engineering, Veterinary Sciences*, 24, 33–39.
Grisham, M.P., Dale, J.L. & Riggs, R.D. (1974) *Meloidogyne graminis* and *Meloidogyne* spp. on zoysia; infection, reproduction, disease development, and control. *Phytopathology*, 64, 1485–1489.
Grujicic, G. (1969) Contributions to the study of parasitic nematodes on wheat in Yugoslavia. *Savremena Poljoprivreda*, 17, 531–539.
Gupta, N.K. & Gupta, A.K. (1981) On some plant parasitic nematodes of the genus *Macroposthonia* De Man, 1880 (Medinematidae: Criconematoidea) from India. *Revista Iberica de Parasitologia*, 41, 25–41.
Han H.R., Jeyaprakash, A., Weingartner, D.P. & Dickson, D.W. (2006) Morphological and molecular biological characterization of *Belonolaimus longicaudatus*. *Nematropica*, 36, 37–52.
Handoo, Z.A., Skantar, A.M. & Mulrooney, R.P. (2010) First report of the sting nematode *Belonolaimus longicaudatus* on soybean in Delaware. *Plant Disease*, 94, 133.
Heald, C.M. & Perry, V.G. (1970) Nematodes and other pests. *Turfgrass Science, Agronomy*, (14), 358–369.
Heald, C.M., Starr, J.L. & Robinson, A.F. (1991) Incidence of plant parasitic nematodes in some cotton-growing areas of the Brazos River. *Proceedings - Beltwide Cotton Production Conference*, 1, 189.
Henn, R.A. & Dunn, R.A. (1989) Reproduction of *Hoplolaimus galeatus* and growth of seven St. Augustinegrass (*Stenotaphrum secundatum*) cultivars. *Nematropica*, 19, 81–87.

Heyns, J. (1971) *A guide to the plant and soil nematodes of South Africa*. Cape Town: A.A. Balkema; x+233pp.
Hirata, K. & Yuhara, I. (1986) Plant parasitic nematodes detected from Bonsai trees and Bonsai nurseries. *Research Bulletin of the Plant Protection Service, Japan*, 22, 111–117.
Hixson, A.C, Crow, W.T., McSorley, R. & Trenholm, L.E. (2004) Host status of 'SeaIsle 1' seashore paspalum (*Paspalum vaginatum*) to *Belonolaimus longicaudatus* and *Hoplolaimus galeatus*. *Journal of Nematology*, 36, 493–498.
Holdeman, Q.L. (1955) The present known distribution of the sting nematode, *Belonolaimus gracilis* in the coastal plain of the southeastern United States. *Plant Disease Reporter*, 39, 58.
Holterman, M.H.M., Karssen,G., van den Elsen, S.J.J., Mooijman, P.J.W., Pomp, R., van Megen, H.H.B., Bakker, J. & Helder, H. (2009) Small subunit rDNA-based phylogeny of the Tylenchida sheds light on relationships among some high-impact plant-parasitic nematodes and the evolution of plant feeding. *Phytopathology*, 99, 227–235.
Hooper, D.J. (1977) *Paratrichodorus* (*Nanidorus*) *minor. Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 7, no. 103*. St. Albans, England: Commonwealth Agricultural Bureaux.
Hunt, D.J. (1993) *Aphelenchida, Longidoridae and Tricodoridae: Their Systematics and Bionomics*. CAB International. Wallingford Oxon OX10 8DE. UK. 352 pp.
Hutchinson, M.T., Reed, J.P., Streu, H.T., DiEdwardo, A.A. & Ferris, J.M. (1961) Plant parasitic nematodes of New Jersey. *New Jersey Agricultural Experiment Station Bulletin*, 796.
Inserra, R.N., Vovlas, N. & Brandonisio, A. (1978) Endoparasitic nematodes associated with cereals in Southern Italy. *Nematologia Mediterranea*, 6, 163–174.
Inserra, R., Lamberti, F., Vovlas, N. & Dandria, D. (1975) *Meloidogyne naasi* in southern Italy and Malta. *Nematologia Mediterranea*, 3, 163–166.
Iwaki, M. & Komuro, Y. (1974) Viruses isolated from narcissus (*Narcissus* spp.) in Japan. V. Arabis mosaic virus. *Annals of the Phytopathological Society of Japan*, 40, 344–353.
Jabbari, H. & Niknam, G.R. (2007) Identification of some criconematids from Tabriz area, morphometrical comparison of different populations and their grouping using cluster analysis. *Agricultural Science (Tabriz)*, 17, 143–160.
Jenkins, W.R. (1964) A rapid centrifugal-floatation technique for separating nematodes from soil. *Plant Disease Reporter*, 48, 692.
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.
Jepson S.B. (1987) *Identification of root-knot nematodes.* Wallingford, United Kingdom, CABI, 247pp.
Johnson, A.W. (1970) Pathogenicity and interactions of three nematode species on six bermudagrasses. *Journal of Nematology*, 2, 36–41.
Jordaan, E.M., van den Berg, E. & de Waele, D. (1992) Plant-parasitic nematodes on field crops in South Africa. 5. Wheat. *Fundamental and Applied Nematology*, 15, 531–537.
Jovicic, D. & Grujicic, G. (1986) Root-knot nematodes (*Meloidogyne* spp.) in the SR Serbia. *Zastita bilja*, 37, 31–40.
Karanastasi, E., Handoo, Z.A. & Tzortzakakis, E.A. (2008) First report of *Mesocriconema xenoplax* (Nematoda: Criconematidae) in Greece and first record of *Viburnum* sp. as a possible host for this ring nematode. *Helminthologia*, 45, 103–105.
Karanastasi, E., Neilson, R. & Decraemer, W. (2006) First record of two trichodorid nematode species *Paratrichodorus minor* and *Trichodorus sparsus* (Nematoda: Trichodoridae Thorne 1935) from Greece. *Annals of the Benaki Phytopathological Institute*, 20, 129–133.
Karnkowski, W. (2005) A new species of root-knot nematode on potato. *Ochrona Roślin*, 50, 38–39.
Karssen, G. & Van Hoenselaar, T. (1998) Revision of the genus *Meloidogyne* Göldi, 1892 (Nematoda: Heteroderidae) in Europe. *Nematologica*, 44, 713–788.
Katalan-Gateva, Sh. & Tsoneva, P. (1977) Contribution to the study of the plant nematode fauna in Bulgaria. *Godishnik na Sofiiskiya Universitet "Kliment Okhridski", Biologicheski Fakultet, Kniga 1, Zoologiya*, 71, 49–52.
Kaul, V.K. & Chhabra, H.K. (1988) A new record of *Meloidogyne graminis* on Raya and occurrence of *Meloidogyne* spp. in Ludhiana, Punjab, India. *Journal of Oilseeds Research*, 5, 200–202.
Kepenekci, I. & Ökten, M.E. (2000) New species nematoda fauna of the Türkiye belonging to Tylenchoidea and Hoplolaimoidea (Tylenchida: Nematoda) superfamilies and *Hoplolaimus galeatus* (Cobb, 1913) Thorne. *Bitki Koruma Bülteni*, 40, 1–28.
Khan, A., Shaukat, S.S. & Sayed, M. (2011) Control of nematodes associated with almond using oil-cakes in Balochistan. Pakistan *Journal of Nematology*, 29, 171–177.
Khanna, A.S. & Sharma, N.K. (1988) Pathogenicity of various *Aphelenchoides* species on *Agaricus bisporus*. *Indian Phytopathology*, 41, 472–473.
Kilpatrick, R.A., Gilchrist, L. & Golden, A.M. (1976) Root knot on wheat in Chile. *Plant Disease Reporter*, 60, 135.
Kinloch, R.A. (1971) Florida field crops as hosts of *Helicotylenchus dihystera*. *Nematropica*, 1, 38–39.
Koenning, S.R., Kirkpatrick, T.L., Starr, J.L., Wrather, J.A., Walker, N.R. & Mueller, J.D. (2004) Plant-parasitic nematodes attacking cotton in the United States: old and emerging production challenges. *Plant Disease*, 88, 100–113.
Koenning, S.R. & Barker, K.R. (1998) Survey of *Heterodera glycines* races and other plant-parasitic nematodes on soybean in North Carolina. *Supplement to Journal of Nematology*, 30, 569–576.
Koliopanos, C.N. & Vovlas, N. (1977) Records of some plant parasitic nematodes in Greece with morphometrical descriptions.

Nematologia Mediterranea, 5, 207–215.
Kornobis, S. (2001) Root-knot nematodes, *Meloidogyne* spp. in Poland. *Progress in Plant Protection*, 41, 189–192.
Krall, E., Sturhan, D. & Müür, J. (1999) Cyst nematodes attacking cereals and grasses in Estonia. *Transactions of the Estonian Agricultural University, Agronomy*, 203, 44–48.
Kraus-Schmidt, H. & Lewis, S.A. (1979) Seasonal fluctuations of various nematode populations in cotton fields in South Carolina. *Plant Disease Reporter*, 63, 859–863.
Krusberg, L.R. & Sasser, J.N. (1956) Host-parasitic relationship of the lance nematode on cotton roots. *Phytopathology*, 46, 505–510.
Kuiper, K. (1977) *Introduction and establishment of plant-parasitic nematodes in the New Polder region of Holland, in particular of Trichodorus teres*. Thesis, Wageningen School of Agriculture. Mededelingen Landbouwhogeschool 77–4, 140 pp.
Kulinich, O.A., Tyuldyukov, P.V. & Kozyreva, N.I. (2003) Phytoparasitic quarantine nematodes. *Zashchita i Karantin Rastenii*, 7, 24–27.
Lamberti, F. & Dandria, D. (1979) Plant parasitic nematodes in the Maltese islands and the problems they cause. *Phytopathologia Mediterranea*, 18, 71–76.
Lamberti, F., Luca, F.de, Molinari, S., Duncan, L.W., Agostinelli, A., Coiro, M.I., Dunn, D. & Radicci, V. (2002) *Xiphinema chambersi* and *Xiphinema naturale* sp. n., two monodelphic longidorids (Nematoda, Dorylaimida) from Florida. *Nematologia Mediterranea*, 30, 3–10.
Lamberti, F., Molinari, S., Moens, M. & Brown, D.J.F. (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.
Lee, Y.B. & Han, S.C. (1976) The nematode genus *Xiphinema* (Dorylaimida: Longidoridae) from Korea. *Korean Journal of Plant Protection*, 15, 17–21.
Lewis, S.A., Drye, C.E., Saunders, J.A., Shipe, E.R. & Halbrendt, J.M. (1993) Plant-parasite nematodes on soybean in South Carolina. *Supplement to Journal of Nematology*, 25, 890–894.
Li, X., Guo, K., Zhang, Y., Yan, X. & Zheng, J. (2010) First report of the stubby root nematode, *Paratrichodorus minor*, in Mainland China. *Plant Disease*, 94, 376.
Lima, M.B. (1965) Study on species of the genus Xiphinema and other nematodes. London: University of London, 163.
Loof, P.A.A. (1968) Taxonomy of *Hemicycliophora* species from west and central Europe (Nematoda: Criconematoidea). *Meded. Landbouwhogeschool Wageningen*, 68, 1–43.
Loof, P.A.A. (1974a) *Macroposthonia curvata*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 4, no. 58*. St. Albans, England: Commonwealth Agricultural Bureaux.
Loof, P.A.A. (1974b) *Tylenchorhynchus claytoni*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 3, no. 39*. St. Albans, England: Commonwealth Agricultural Bureaux.
Loof, P.A.A. & Barooti, S. (1991) New records of species of Criconematidae from Iran with description of *Criconemoides decipiens* sp. n. (Nematoda: Tylenchida). *Nematologia Mediterranea*, 19, 83–95.
Loof, P.A.A., Wouts, W.M. & Yeates, G.W. (1997) Criconematidae (Nematoda: Tylenchida) from the New Zealand region: genera *Mesocriconema*, *Criconema*, *Discocriconemell*a, and *Hemicriconemoides*. *New Zealand Journal of Zoology*, 24, 123–151.
Loof, P.A.A. (1984) *Hemicycliophora* species from Iran (Nematoda: Criconematoidea). *Nematologica*, 30, 22–41.
Luc, M. (1959) Nouveaux Criconematidae de la zone intertropicale (Nematoda: Tylenchida). *Nematologica*, 4, 16–22.
Luc, M. (1970) Contribution l'étude du genre Criconemoides Taylor, 1936 (Nematoda: Criconematidae). *Cahiers ORSTOM, Série Biologie*, 11, 60–131.
Luc, M., Coomans, A., Loof, P.A.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.
Lucas, L.T., Barker, K.R. & Blake, C.T. (1978) Seasonal changes in nematode densities on bentgrass golf greens in North Carolina. *Plant Disease Reporter*, 62, 373–376.
Lucas, L.T. (1982) Population dynamics of *Belonolaimus longicaudatus* and *Criconemella ornata* and growth response of bermudagrass and overseeded grasses on golf greens following treatment with nematicides. *Journal of Nematology*, 14, 358–363.
Lucas, L.T., Blake, C.T. & Barker, K.R. (1974) Nematodes associated with bentgrass and bermudagrass golf greens in North Carolina. *Plant Disease Reporter*, 58, 822–824.
Maas, P.W.T. & Brinkman, H. (1977) Life cycle and pathogenicity of a grass cyst nematode, *Heterodera mani*, on perennial ryegrass in the Netherlands. *Mededelingen van de Faculteit Landbouwwetenschappen Rijksuniversiteit Gent*, 42, 1541–1548.
Maas, P.W.T. & Maenhout, C.A.A.A. (1978) The grass root-knot nematode (*Meloidogyne naasi*) on sugar beet. *Gewasbescherming*, 9, 159–166.
Maqbool, M.A. (1980) Occurrence of eight cyst nematodes on some agricultural crops in Pakistan. *Karachi University Journal of Science*, 8, 103–108.
Martin, B. (1997) Interactions between herbicide use and turfgrass diseases. *Proceedings of the fifty-first annual meeting of the*

Northeastern Weed Science Society, Newport, RI, USA, 6–9 January 1997, 177–180.
Martin, S.B., Mueller, J.D., Saunders, J.A. & Jones, W.I. (1994) A survey of South Carolina cotton fields for plant parasitic nematodes. *Plant Disease*, 78, 717–719.
Mathews, H.J.P. (1971) Two new species of cyst nematode, *Heterodera* mani n. sp. and *H. iri* n. sp., from Northern Ireland. *Nematologica*, 17, 553–565.
McGawley, E.C., Winchell, K.L. & Berggren, G.T. (1984) Possible involvement of *Hoplolaimus galeatus* in a disease complex of 'centennial' soybean. *Phytopathology*, 74, 831.
McGuire, J.M. (1964) Efficiency of *Xiphinema americanum* as a vector of tobacco ringspot virus. *Phytopathology*, 54, 799–801.
McKenry, M.V. & Anwar, S.A. (2006) Nematode and grape rootstock interactions including an improved understanding of tolerance. *Journal of Nematology*, 38, 312–318.
Michell, R.E. (1972) Comparative studies on the developmental rate, reproductive potential, pathogenicity, host range, and morphology of five geographical isolates of *Meloidogyne naasi*. *Dissertation Abstracts International*, 33B, 11.
Michell, R.E., Malek, R.B., Taylor, D.P. & Edwards, D.I. (1973) Races of the barley root-knot nematode, *Meloidogyne naasi*. III. Reproduction and pathogenicity on creeping bentgrass. *Journal of Nematology*, 5, 47–49.
Mitkowski, N.A. (2007) First report of *Subanguina radicicola*, the root-gall nematode infecting *Poa annua* putting greens in Washington State. *Plant Disease*, 91, 905.
Moghaddam, E.M. & Kheiri, A. (1995) Some plant parasitic nematode fauna of sugar beet fields in Mashhad region. *Iranian Journal of Plant Pathology*, 31, 24–26.
Mojtahedi, H. & Santo, G.S. (1999) Ecology of *Paratrichodorus allius* and its relationship to the corky ring-spot disease of potato in the Pacific Northwest. *American Journal of Potato Research*, 76, 273–280.
Mowat, D.J. (1974) The host range and pathogenicity of some nematodes occurring in grassland in Northern Ireland. *Record of Agricultural Research*, 22, 51–58.
Mundo-Ocampo, M.J., Becker, J.O. & Baldwin, J. (1994) Occurrence of *Belonolaimus longicaudatus* on bermudagrass in the Coachella Valley. *Plant Disease*, 78, 529.
Murray, J.J., Poole, T.E. & Ostazeski, S.A. (1986) Techniques for determining reproduction of *Meloidogyne graminis* on zoysiagrass and bermudagrass. *Plant Disease*, 70, 559–560.
Myers, R.F. (1979) The sting nematode, *Belonolaimus longicaudatus*, from New Jersey. *Plant Disease Reporter*, 63, 756–757.
Nambiar, L., Quader, M. & Nobbs, J.M. (2008) First record of *Hoplolaimus galeatus* in Australia. *Australasian Plant Disease Notes*, 3, 145–146.
Nico, A.I., Rapoport, H.F., Jiménez-Díaz, R.M. & Castillo, P. (2002) Incidence and population density of plant-parasitic nematodes associated with olive planting stocks at nurseries in Southern Spain. *Plant Disease*, 86, 1075–1079.
Niles, R.K., Yoder, K.S. & Elliott, A.P. (1985) The effect of nematicide treatment on nematodes associated with non-bearing apple, 1981–1982. *Fungicide and Nematicide Tests*, 40, 93–94.
Norton, D.C., Donald, P., Kimpinski, J., Myers, R., Noel, G., Noffsinger, E.M., Robbins, R.T., Schmitt, D.P., Sosa-Moss, C. & Vrain, T.C. (1984) *Distribution of plant-parasitic nematode species in North America.* Society of Nematologists. 19pp.
Norton, D.C., Dunlap, D. & Williams, D.D. (1982) Plant-parasitic nematodes in Iowa: Longidoridae and Trichodoriadae. *Proceedings of the Iowa Academy of Science*, 89, 15–19.
Norton, D.C. & Hinz, P. (1976) Relationships of *Hoplolaimus galeatus* and *Pratylenchus hexincisus* to reduction of corn yields in sandy soils in Iowa. *Plant Disease Reporter*, 60, 197–200.
Norton, D.C. & Hoffmann, J.K. (1974) Distribution of selected plant parasitic nematodes relative to vegetation and edaphic factors. *Journal of Nematology*, 6, 81–86.
Nyczepir, A.P. (2011) Host suitability of an endophyte-friendly tall fescue grass to *Mesocriconema xenoplax* and *Pratylenchus vulnus*. *Nematropica*, 41, 45–51.
Nyczepir, A.P. & Esmenjaud, D. (2008) Nematodes. In*:* Layne, D. R.& Bassi, D. (eds), *The peach: botany, production and uses*. Wallingford: CABI, pp. 505–535.
Nyczepir, A.P., Bertrand, P.F., Miller, R.W. & Motsinger, R.E. (1985) Incidence of *Criconemella* spp. and peach orchard histories in short life and non-short life sites in Georgia and South Carolina. *Plant Disease*, 69, 874–877.
Okie, W.R., Reighard, G.L. & Nyczepir, A.P. (2009) Importance of scion cultivar in peach tree short life. *Journal of American Pomological Society*, 63, 58–63.
Olsen, L.G. (1983) Nematode control in concord grapes in Michigan, 1983. *Fungicide and Nematicide Tests*, 39, 91–92.
Orton Williams, K.J. (1972) *Macroposthonia xenoplax*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 1, no. 12*. St. Albans, England: Commonwealth Agricultural Bureaux.
Orton Williams, K.J. (1973a) *Hoplolaimus galeatus*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 2, no. 24*. St. Albans, England: Commonwealth Agricultural Bureaux.
Orton Williams, K.J. (1973b) *Macroposthonia sphaerocephala*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 2, no. 28*. St. Albans, England: Commonwealth Agricultural Bureaux.
Orton Williams, K.J. (1974a) *Belonolaimus longicaudatus*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 3, no. 40*. St. Albans, England: Commonwealth Agricultural Bureaux.
Orton Williams, K.J. (1974b) *Dolichodorus heterocephalus*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 4, no. 56*. St. Albans, England: Commonwealth Agricultural Bureaux.

Paracer, S.M. (1968) The biology and pathogenicity of the awl nematode, *Dolichodorus heterocephalus*. *Nematologica*, 13, 517–524.
Peng, D.L. & Vovlas, N. (1994) Occurrence of the cyst-forming nematode *Cactodera thornei* in China. *Nematologia Mediterranea*, 22, 75–78.
Perry, V.G. (1953) The awl nematode, *Dolichodorus heterocephalus*, a devastating plant parasite. *Proceedings of Helminthological Society of Washington*, 20, 21–27.
Person-Dedryver, F., Gueye, P.S. & Boulch, M.F. (1987) Grasses as hosts of *Meloidogyne naasi* Franklin: II. Study of nematode populations and their effects on yield of three varieties. *Nematologica*, 33, 72–82.
Pinochet, J. & Raski, D.J. (1975) Four new species of the genus *Hemicriconemoides* (Nematoda: Criconematidae). *Journal of Nematology*, 7, 263–270.
Ponchillia, P.E. (1975) Plant-parasitic nematodes associated with burley tobacco in Tennessee. *Plant Disease Reporter*, 59, 219–220.
Raski, D.J. (1952) On the morphology of *Criconemoides* Taylor 1936, with descriptions of six new species. *Proceedings of Helminthological Society of Washington*, 19, 85–99.
Raski, D.J. (1975) Revision of the genus *Paratylenchus* Micoletzky, 1922 and descriptions of new species. Part I of 3 parts. *Journal of Nematology*, 7, 21–22.
Raski, D.J. & Geraert, E. (1987) Review of the genus *Filenchus* Andrássy, 1954 and descriptions of six new species (Nematoda: Tylenchidae). *Nematologica*, 32, 265–311.
Rau, J.G. (1958) A new species of sting nematode. *Proceedings of the Helminthological Society of Washington*, 25, 95–98.
Rhoades, H.L. (1975) Pathogenicity and control of the sting nematode, *Belonolaimus longicaudatus*, on carrot. *Plant Disease Reporter*, 59, 1021–1024.
Rhoades, H.L. (1986) The sting nematode, *Belonolaimus longicaudatus*, a serious pest of corn in Florida. *Nematology Circular, Division of Plant Industry, Florida Department of Agriculture and Consumer Service*, (131), 2pp.
Riggs, R.D. (1961) Sting nematode in Arkansas. *Plant Disease Reporter*, 45, 392.
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., Riggs, R.D. & Von Steen, D. (1987) Results of annual phytoparasitic nematode surveys of Arkansas soybean fields, 1978–1986. *Annals of Applied Nematology*, 1, 50–55.
Robbins, R.T. & Barker, K.R. (1973) Comparisons of host range and reproduction among populations of *Belonolaimus longicaudatus* from North Carolina and Georgia. *Plant Disease Reporter*, 57, 750–754.
Rodriguez-Kabana, R. & Thurlow, D.L. (1980) Effect of *Hoplolaimus galeatus* and other nematodes on yield of selected soybean cultivars. *Nematropica*, 10, 130–138.
Russell, C.C. & Sturgeon, R.V. (1969) Occurrence of *Belonolaimus longicaudatus* and *Ditylenchus dipsaci* in Oklahoma. *Phytopathology*, 59, 118.
Sammons, B. & Barnett, O.W. (1987) Tobacco ringspot virus from squash grown in South Carolina and transmission of the virus through seed of smooth pigweed. *Plant Disease*, 71, 530–532.
Schneider, W. (1925) Freilebende Süsswassernematoden aus ostholsteinischen Seen. Nebst Bemerkungen über die Nematodenfauna des Mad- und Schaalsees. *Archiv für Hydrobiologie* 15, 536–584.
Seth, A. & Sharma, N.K. (1986) Five new species of genus *Aphelenchoides* (Nematoda: Aphelenchida) infesting mushroom in northern India. *Indian Journal of Nematology*, 16, 205–215.
Sher, S.A. (1963) Revision of the Hoplolaimidae (Nematoda). Il. *Hoplolaimus* Daday, 1905 and *Aorolaimus* n. gen. *Nematologica*, 9, 267–295.
Sher, S.A. (1966) Revision of the *Hoplolaiminae* (Nematoda). VI. *Helicotylenchus* Steiner, 1945. *Nematologica*, 12, 1–56.
Sheridan, J.E. & Grbavac, N. (1979) Cereal root-knot nematode, *Meloidogyne naasi* Franklin, on barley in New Zealand. *Australasian Plant Pathology*, 8, 53–54.
Shishda, Y. (1983) Studies on nematodes parasitic on woody plants. 2. Genus *Xiphinema* Cobb, 1913. *Japanese Journal of Nematology*, 12, 1–14.
Siddiqi, M.R. (1972) On the genus *Helicotylenchus* Steiner, 1945 (Nematoda: Tylenchida), with descriptions of nine new specics. *Nematologica*, 18, 74–91.
Siddiqi, M.R. (1961) Studies on species of Criconematidae (Nematoda: Tylenchida) from India. *Proceedings of Helminthological Society of Washington*, 28, 19–34.
Siddiqi, M.R. (1972) *Helicotylenchus dihystera*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 1, no. 9*. St. Albans, England: Commonwealth Agricultural Bureaux.
Siddiqi, M.R. (1974a) *Hemicriconemoides chitwoodi*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 3, no. 41*. St. Albans, England: Commonwealth Agricultural Bureaux.
Siddiqi, M.R. (1974b) *Scutellonema brachyurum*. *Commonwealth Institute of Helminthology Descriptions of Plant-Parasitic Nematodes, set 4, no. 54*. St. Albans, England: Commonwealth Agricultural Bureaux.
Siddiqi, M.R. (2000) *Tylenchida: parasites of plants and insects*. 2nd edition. CAB International. Wallingford Oxon OX10 8DE. UK, 833 pp.
Siddiqui, Z.A. & Khan, M.W. (1986) Nematodes causing damage to wheat crops in Libya. *International Nematology Network Newsletter*, 3, 23.

Sikora, E.J., Guertal, E.A. & Bowen, K.L. (2001) Plant-parasitic nematodes associated with hybrid bermudagrass and creeping bentgrass putting greens in Alabama. *Nematropica*, 31, 301–305.
Sikora, R.A., Taylor, D.P., Malek, R.B. & Edwards, D.I. (1972) Interaction of *Meloidogyne naasi*, *Pratylenchus penetrans*, and *Tylenchorhynchus agri* on creeping bentgrass. *Journal of Nematology*, 4, 162–165.
Simard, L., Bélair, G., Powers T., Tremblay, N. & Dionne, J. (2008) Incidence and population density of plant-parasitic nematodes on golf courses in Ontario and Québec, Canada. *Journal of Nematology*, 40, 241–251.
Singh, N.D. (1973) Preliminary report of plant parasitic nematodes associated with important crops in Trinidad. *Nematropica*, 3, 56–61.
Sledge, E.B. (1962) Preliminary report on a *Meloidogyne* sp. parasite of grass in Florida. *Plant Disease Reporter*, 46, 52–54.
Sledge, E.B. & Golden, A.M. (1964) *Hypsoperine graminis* (Nematode: Heteroderidae), a new genus and species of plant parasitic nematode. *Proceedings of Helminthological Society of Washington*, 31, 83–88.
Smolik, J.D. & Malek, R.B. (1972) *Tylenchorhynchus nudus* and other nematodes associated with Kentucky bluegrass turf in South Dakota. *Plant Disease Reporter*, 56, 898–900.
Southard, C.J. (1967) The pseudo-root-knot nematode of bermuda grass in Tennessee. *Plant Disease Reporter*, 51, 455.
Southey, J.F. (1970) *Laboratory methods for work with plant and soil nematodes*. London, UK: Her Majesty's Stationery Office, 148 pp.
Spaull, A.M. & Mewton, P.G. (1982) Numbers of root-ectoparasitic nematodes under some forage crops. *Nematologica*, 28, 450–452.
Steiner, G. (1937) *Tylenchorhynchus claytoni* n. sp., an apparently rare nemic parasite of the tobacco plant. *Proceedings of Helminthological Society of Washington*, 4, 33–34.
Stirling, G.R. (1976) Distribution of plant parasitic nematodes in South Australian vineyards. *Australian Journal of Experimental Agriculture and Animal Husbandry*, 16, 588–591.
Sturhan, D. (1973) Meloidogyne naasi - a new parasite of cereals in Germany. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes*, 25, 102–103.
Sturhan, D. (1976a) First records of five *Heterodera* species in the Federal Republic of Germany. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes*, 28, 167–169.
Sturhan, D. (1976b) Outdoor occurrence of *Meloidogyne* species in Western Germany. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes*, 28, 113–117.
Sturhan, D. (2006) Cyst-forming nematodes and related Heteroderidae in Germany. *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft*, 404, 18–30.
Sumner, D.R. (1967) Nematodes in bluegrass. *Plant Disease Reporter*, 51, 457–460.
Sutherland, J.R. (1977) Corky root disease of Douglas-Fir seedlings: pathogenicity of the nematode *Xiphinema bakeri* alone and in combination with the fungus *Cylindrocarpon destructans*. *Canadian Journal of Forest Research*, 7, 41–46.
Tarjan, A.C. (1964a) Plant-parastici nematodes in the United Arab Republic. *FAO Plant Protection Bulletin*, 12, 1–8.
Tarjan, A.C. (1964b) Rejuvenation of nematized centipede-grass turf with chemical drenches. *Proceedings of the Florida State Horticultural Society*, 77, 456–461.
Tarjan, A.C. (1974) The dagger nematodes (*Xiphinema*, Cobb) of Florida. *Proceedings of the Soil and Crop Science Society of Florida*, 33, 92–95.
Tarjan, A.C. & Frederick, J.J. (1981) Reaction of nematode-infected centipedegrass turf to pesticidal and non-pesticidal treatments. *Proceedings of the Florida State Horticultural Society*, 94, 225–227.
Tarjan, A.C. & Jimenez, M.F. (1973) Debilitation of cacao in Costa Rica by plant nematodes. *Nematropica*, 3, 25–28.
Taylor, A.L. (1936) The genera and species of the Criconematinae, a sub-family of the Anguillulinidae (Nematoda). *Transactions of the American Microscopical Society*, 55, 391–421.
Thomas, E. (1981) Occurrence of *Meloidogyne naasi* in the northern part of the Rhineland. *Nachrichtenblatt des Deutschen Pflanzenschutzdienstes*, 33, 20–21.
Thorne, G. (1955) Fifteen new species of the genus *Hemicycliophora* with an emended description of *H. typica* de Man (Tylenchida, Criconematidae). *Proceedings of Helminthological Society of Washington*, 22, 1–16.
Thorne, G. & Malek, R.B. (1968) *Nematodes of the Northern Great Plains. Part I. Tylenchida (Nemata: Secernentea)*. South Dakota Agricultural Experiment Station Technical Bulletin 13, 111pp.
Timm, R.W. (1965) *A preliminary survey of the plant parasitic nematodes of Thailand and Philippines*. *In:* Report for the South-East Asia Treaty Organization Secretariat-General. Bangkok, Thailand: Thai Sambhand Printing Press, 71 pp.
Todd, T.C. & Tisserat, N.A. (1990) Occurrence, spatial distribution, and pathogenicity of some phytoparasitic nematodes on creeping bentgrass putting greens in Kansas. *Plant Disease*, 74, 660–663.
Toida, Y. (1983) Criconematidae (Nematoda: Tylenchida) from soil around roots of mulberry in warm climate regions of Japan, with descriptions of two new species. *Japanese Journal of Nematology*, 13, 14–19.
Torres, G.R.de C., Medeiros, H.A.de, Sales Júnior, R. & Moura, R.M.de. (2007) Occurrence of *Hoplolaimus galeatus* associated to banana rhizosphere in the Brazil. *Caatinga*, 20, 113–117.
Troll, J. & Rohde, R.A. (1966) Pathogenicity of *Pratylenchus penetrans* and *Tylenchorhynchus claytoni* on turfgrasses. *Phytopathology*, 56, 995–998.
Troll, J. & Tarjan, A.C. (1954) Widespread appearance of plant parasitic nematodes on golf greens in Rhode Island. *Plant Disease Reporter*, 38, 342–344.

Valocka, B. & Sabova, M. (1978) Nematodes of cereal crops: species new for the fauna of Czechoslovakia. *Biologia, Bratislava, B, Zoologia* 3, 33, 686–688.
Van den Berg, E. (1980) Studies on some Criconematoidea (Nematoda) from South Africa with a description of *Ogma rhombosquamatum* (Mehta & Raski, 1971) Andrassy, 1979. *Phytophylactica*, 12, 15–23.
Van den Berg, E. (1981) Further studies on the genus *Hemicycliophora* de Man, 1921 in South Africa (Nematoda: Hemicycliophoroidea) with a description of a new species. *Phytophylactica*, 13, 181–194.
Van den Berg, E. (1987) *Hemicycliophora* species from the Cape Province with a key to the South African species (Hemicycliophoridae: Nematoda). *Phytophylactica*, 19, 303–307.
Vandenbossche, B., Viaene, N., Sutter, N.de, Maes, M., Karssen, G. & Bert, W. (2011) Diversity and incidence of plant-parasitic nematodes in Belgian turf grass. *Nematology*, 13, 245–256.
Venter, C., Waele, D.de & Eeden, C.F.van. (1992) Plant-parasitic nematodes on field crops in South Africa. 4. Groundnut. *Fundamental and Applied Nematology*, 15, 7–14.
Vovlas, N., Inserra, R.N. & Esser, R.P. (1991) *Mesocriconema ornicauda* n. sp. and *Ogma floridense* n. sp. (Nematoda: Criconematidae) from two Florida habitats. *Journal of Nematology*, 23, 48–57.
Waele, D.de & Cohn, E. (1992) Trichodoridae from Israel, with a description of *Trichodorus minzi* n. sp. *Fundamental and Applied Nematology*, 15, 201–207.
Waele, D.de & Jordaan, E.M. (1988a) Plant-parasitic nematodes on field crops in South Africa. 1. Maize. *Revue de Nématologie*, 11, 65–74.
Waele, D.de & Jordaan, E.M. (1988b) Plant-parasitic nematodes on field crops in South Africa. 2. Sorghum. *Revue de Nématologie*, 11, 203–211.
Waele, D.de, McDonald, A.H., Jordaan, E.M., Orion, D., Van den Berg, E. & Loots, G.C. (1998) Plant-parasitic nematodes associated with maize and pearl millet in Namibia. *African Plant Protection*, 4, 113–117.
Wallace, H.R. (1971) The influence of the density of nematode populations on plants. *Nematologica*, 17, 154–166.
Wallace, M.K. & MacDonald, D.H. (1979) Plant-parasitic nematodes in Minnesota apple orchards. *Plant Disease Reporter*, 63, 1063–1067.
Walters, S.A., Bond, J.P., Russell, J.B., Taylor, B.H. & Handoo, Z.A. (2008) Incidence and influence of plant-parasitic nematodes in southern Illinois peach orchards. *Nematropica*, 38, 63–74.
Wang, K.H. & Hooks, C.R.R. (2009) Plant-parasitic nematodes and their associated natural enemies within banana (*Musa* spp.) plantings in Hawaii. *Nematropica*, 39, 57–73.
Wang, R.X. (1993) The identification of nematodes on fruit trees in Shaanxi Province. *Acta Agriculturae Boreali-Occidentalia Sinica*, 2, 81–86.
Williams, A.S. & Lauhglin, C.W. (1968) Occurrence of *Hypsoperine graminis* in Virginia and additions to the host range. *Plant Disease Reporter*, 52, 162–163.
Williams, T.D. (1961) *Xiphinema bakeri* n. sp. (Nematoda: Longidorinae) from the Fraser River Valley, British Columbia, Canada. *Canadian Journal of Zoology*, 39, 407–412.
Wrather, J.A., Niblack, T.L. & Milam, M.R. (1992) Survey of plant-parasitic nematodes in Missouri cotton fields. *Journal of Nematology*, 24, 779–782.
Xie, H. & Feng, Z.X. (1996) Identification of the species of genus *Paratrichodorus* Siddiqi, 1974 (Nemata: Trichodoridae) from Hong Kong. *Journal of South China Agricultural University*, 17, 70–73.
Xie, Z.C., L, W.C., Yang, Q., Cheng, J. & Zhang, S.S. (2007) Eight species of nematodes parasitized at the roots of rice. *Journal of Fujian Agriculture and Forestry University (Natural Science Edition)*, 36, 20–24.
Ye, W.M. (1996) Applying Microsoft Works spreadsheet in statistics for morphometric data of nematode identification. *Afro-Asian Journal of Nematology*, 6, 203–211.
Ye, W.M. & Robbins, R.T. (2000) Morphology of four species of *Hemicriconemoides* (Nematoda: Criconematidae) in the USA with the synonymy of *H. annulatus*. *International Journal of Nematology*, 10, 101–111.
Ye, W.M. & Robbins, R.T. (2003) *Longidorus grandis* sp. nov. and *L. paralongicaudatus* sp. nov. (Nematoda: Longidoridae), two parthenogenetic species from Arkansas. *Journal of Nematology*, 35, 375–387.
Ye, W.M. & Robbins, R.T. (2010) Morphology and taxonomy of *Xiphinema* (Nematoda: Longidoridae) occurring in Arkansas. *Acta Agriculturae Universitatis Jiangxiensis*, 32, 928–945.
Ye, W.M., Zeng, Y.S., Tredway, L., Martin S. & Martin. M. 2012. Plant-parasitic nematodes in Carolina turfgrass. *Carolina Green*. March/April: 26–28. http://spectrumcreativegraphics.com/carolinasgreen_marapr12/
Yokoo, T. (1970) Soil nematological notes. II. *Agricultural bulletin, faculty of agriculture. Saga University*, 29, 15–28.
Yu, Q., Badiss, A., Zhang, Z.D. & Ye, W.M. (2010) First report and morphological, molecular characterization of *Xiphinema chambersi* Thorne, 1939 (Nematoda, Longidoridae) in Canada. *Zookeys*, 49, 13–22.
Zeidan, A.B. & Geraert, E. (1991) The genera *Filenchus* Andrássy, 1954, Sakia Khan, 1964, Boleodorus Thorne, 1941 and Basiria Siddiqi, 1959 (Nemata: Tylenchida) from Sudan. *Nematologica*, 37, 185–212.
Zeng, Y.S., Ye, W.M., Tredway, L., Martin, S. & Martin, M. (2012) Description of *Hemicaloosia graminis* n. sp. (Nematoda: Caloosiidae) associated with turfgrasses in North and South Carolina, USA. *Journal of Nematology*, 44, 134–141.
Zhuo, K., Hu, M.X., Wang, H.H., Tang, Z.L., Shao, X.Y. & Liao, J.L. (2011) Identification of *Meloidogyne graminis* on golf greens. *Acta Prataculturae Sinica*, 20, 253–256.