NEMATODES ASSOCIATED WITH EVERGREENS IN SOUTH CENTRAL KANSAS

by 6408

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INTRODUCTION

With the advent of urban living, and the increasing demand for living plant material around the home environment, the interstate and intrastate shipment of nursery stock has become a thriving business. Consequently, the danger of movement of diseases by rooted nursery stock from one area to another has also increased. One of the least investigated plant pest problems is the potential hazard of movement of nematodes in association with nursery stock. Generally, identification of plant parasitic nematodes in the interstate and intrastate shipment of plant materials involves the readily identifiable endoparasitic genera Meloidogyne Goeldi, Heterodera A. Schmidt and Pratylenchus Filipjev but other important genera are also involved.

Orr (1966), identified nematodes in a survey of one square mile of Kansas native prairie soils. He identified 82 genera and 238 species, with over half of the samples containing 14 genera of nematodes. These genera listed in descending order were: Eudorylaimus Andrassy, Acrobeles Linstow, Helicotylenchus Steiner, Mononchus Bastian, Chiloplacus Thorne, Diphtherophora de Man, Eucephalobus Steiner, Xiphinema Cobb, Mesodorylaimus Andrassy, Plectus Bastian, Tylenchorhynchus Cobb, Pungentus Thorne and Swanger, Mylonchulus (Cobb) Pennak, and Anaplectus deConinck and Shuurmans Stekhoven. He recorded 23 known or suspected plant-parasitic nematode species. Genera recorded most often were Helicotylenchus, Xiphinema, and Tylenchorhynchus. The absence of species in the general group of root-knot or cyst nematodes was noted.

The nematode populations in Kansas nursery fields have not been investigated. Therefore, this study was initiated to 1) survey for nematodes present in evergreen nursery fields by sampling the soil associated with plant roots and identifying to genera all adult nematodes collected, and 2) to correlate the findings with previous surveys in Kansas.

LITERATURE REVIEW

Influence of Temperature on Nematode Survival:

Nematode distribution may be influenced by physical factors such as water, soil structure, soil type, aeration, temperature, and soil moisture content. Temperature appears to be a primary factor with several genera.

The optimum temperature for most free-living nematodes is approximately 30 C. At 40 C nematodes become motionless, and between 40-50 C they die. Lower temperatures are more easily endured.

Barker, Nusbaum, and Nelson (1969) demonstrated that one week of -15 C killed all of the Meloidogyne incognita Goeldi, Belonolaimus longicaudatus Rau, Helicotylenchus dihystera (Cobb) Sher, and Xiphinema americanum Cobb tested. Pratylenchus zeae Graham and Tylenchorhynchus claytoni Steiner were recovered in decreased numbers after one week of exposure to -15 C. They found that the optimum storage temperature for all species studied was 13 C. All species except T. claytoni decreased appreciably in numbers in soil stored at 36 C.

Miller (1968) found that 99% of Pratylenchus penetrans (Cobb) Filipjev and Schuurmans Stekhoven adults and larvae were killed after exposure for 24 hours at -15 C. He also noted that 75-90% of the adults and larvae of Tylenchorhynchus claytoni, Xiphinema americanum, Paratylenchus hamatus Thorne and Allen and Rotylenchus robustus (de Man) Filipjev were killed. All nematodes, in his study, were killed by exposure to -43 C except for Heterodera tabacum Lownsbery and Lownsbery. Miller found that 20% of H. tabacum eggs and encysted larvae were killed at -15 C, and 99% were killed at -43 C for 24 hours. Patel and MacDonald (1968) studied the winter survival of Tylenchorhynchus claytoni in Minnesota. They found that adults are less easily killed by low soil temperatures than larvae.

Taxonomic variations in relation to environal factors within the Xiphinema americanum group were studied by Tarjan (1969). Out of 75 populations, he noted that the European populations, mainly from Mediterranean countries, were distinct from other populations primarily in "a" ratio, vulva position, and tail shape. His data suggest that shorter nematodes with smaller "a" ratios, a wider range of "c" ratios and stylet lengths, and lower vulva percentages are correlated with areas closer to the equator, which have both high precipitation and high temperatures.

Nematodes Associated with Evergreens:

Sutherland (1965) found non-stylet-bearing nematodes to be the most prevalent group in 3 coniferous nurseries in Quebec. The genera in this group included Cephalobus Bastian, Eucephalobus Steiner, Acrobeles Linstow, Rhabditis Dujardin, Acrobeloides (Cobb) Steiner and Buhrer, Plectus, and Wilsonema Cobb. Genera of plant parasitic nematodes included primarily Pratylenchus, Criconemoides Taylor, and Paratylenchus Micoletzky with lesser numbers of Meloidogyne and Trichodorus Cobb.

Ruehle (1968) reported Juniperus virginiana L., was host to Circonemoides sp., Helicotylenchus dihystera, Hemicycliophora sp. de Man, Pratylenchus sp., and Xiphinema americanum. Arizona cypress was host to all of the above except Hemicycliophora sp., and was also noted to be host of Paratylenchus sp. Micoletzky.

Xiphinema americanum was found in 95% of South Dakota shelterbelts sampled by Malek (1968). This species was determined to be associated with Juniperus virginiana, Pinus Banksiana Lamb., and Pinus ponderosa Dougl. Other genera of nematodes recovered in this study, in decreasing order, were Paratylenchus, Tylenchorhynchus, Helicotylenchus Steiner, Hoplolaimus Daday, Pratylenchus,

Trichodorus, Hemicycliphora, and Aorolaimus Sher. Tylenchorhynchus acutus Allen, and Paratylenchus sp. were commonly recovered from the weed-free shelterbelts.

In a New Mexico study, Riffle (1968) reported 33 plant-parasitic species associated with Pinus ponderosa, P. edulis Voss, Juniperus monosperma (Engelm.) Sarg., J. deppeana Stend, and J. scopulorum Sarg. The most widely distributed nematode species were Aphelenchoides sp. Fischer, Xiphinema americanum, and Tylenchus exiguus de Man, with the latter being most frequently found. He determined that all plant-parasitic nematodes combined were more numerous around the roots of junipers than of pines, regardless of stand conditions. He also noted that more nematode species were recovered in non-drought stands than in drought stands. Sutherland (1967), found that Paratylenchus projectus Jenkins, Pratylenchus penetrans, and Tylenchus emarginatus Cobb reproduced better on spruce than on pine. Other good to excellent hosts were tamarack and northern white cedar.

Ruehle (1965, 1966, 1969) conducted host range studies on loblolly, longleaf, pond, pitch, sand, slash, shortleaf, Virginia, and eastern white pine. All nine were hosts to Hoplolaimus galeatus Cobb. Meloidodera floridensis Chitwood, Hannon and Esser was parasitic on all except sand pine. Pratylenchus brachyurus (Godfrey) Filipjev and Shuurmans Stekhoven was parasitic on pond pine and was not tested on pitch pine. He found that Criconemoides xenoplax Raski was not parasitic on eastern white pine, while Helicotylenchus dihystera was not parasitic on Virginia and eastern white pine. Tylenchorhynchus claytoni was parasitic on all pines tested except pitch pine and eastern white pine. The loblolly, longleaf, sand, slash, and shortleaf pines were good hosts for Trichodorus christiei Allen. Ruehle reported that no species of pines tested

were hosts to Meloidogyne arenaria (Neal) Chitwood, M. hapla Chitwood, M. incognita, M. javanica (Treub.) Chitwood, or Pratylenchus zeae. He did note. however, that M. incognita went through several molts in seedling roots of Virginia, pitch, and eastern white pine, but no galls were produced or egg laying females recovered within 70 days after inoculation. Ruehle and Sasser (1962), identified Meloidogyne arenaria on both the loblolly and slash pine. Hoplolaimus coronatus Cobb, Meloidodera floridensis, Helicotylenchus nannus Steiner, and Xiphinema americanum were found associated with stunted loblolly and slash pines. Tylenchorhynchus claytoni, Belonolaimus gracilis Steiner and Trichodorus christiei were not as numerous.

Barker and Griffin (1964) found large populations of Xiphinema americanum around the roots of apparently healthy trees in declining jack pine plantings. They also found large populations of Trichodorus californicus Allen. Helicotylenchus dihystera was prominent in the upper few inches of soil around dead jack pine trees. Low populations of Leptonchus granulosus Cobb, Trichodorus chamberisi, Longidorus elongatus (de Man) Thorne and Swanger, and Tylenchorhynchus sp. were noted associated with jack and red pine. Jenkins (1960) reported Paratylenchus marylandicus Jenkins associated with the roots of Virginia pine.

Sutherland and Adams (1964) reported Tylenchorhynchus claytoni to be parasitic on red, Scotch, shortleaf, white, and Virginia pines; Norway and red spruce; and Japanese and eastern larch. They noted that little or no visible damage was caused by the nematodes to red pine roots on agar culture. Although the organization of the root cap cells was disrupted by the feeding activity of the nematodes.

MATERIALS AND METHODS

Collection:

The metropolitan area of Sedgewick County, Kansas, was chosen for this survey. The topography was smooth to gently rolling in the Arkansas River area, and primarily composed of a sandy loam, well-drained soil.

Twenty-four samples were collected. Each sample was composed of soil and feeder roots to a depth of 10 inches. The 5 to 7 pound samples were placed in polyethylene bags. Each sample was labeled as to the collection site, host plant, general soil type, cultural conditions, and date. Samples that were not processed immediately were stored at 4 C. Sixteen samples were collected November 6-8, 1963, and 8 were collected November 18-20, 1963.

Nineteen samples were taken from around the roots of Gymnosperms growing in clean-cultivated nursery fields, 3 samples were collected from plants grown under balled and burlapped conditions, and 2 samples were collected from plants grown under grass cultivation. The primary genera of plants in this study included: 20 samples of Juniperus sp. (Tourn.) L., 2 samples of Pinus sp. (Tourn.) L., 1 sample of Cupressus sp. L., and 1 sample of Thuja sp. L. (see Table i Appendix for complete listing). Host plants were 2 to 5 years old, and were growing in rows approximately 3 feet apart except for the 3 balled and burlapped samples grown in a heel yard.

Separating, Fixing and Mounting Specimens:

All samples were processed by the Cobb sifting and gravity and the Baermann funnel technique as described in Thorne (1961). Specimens were relaxed in water over an alcohol flame and fixed in FAA containing picric acid for 48 hours. The nematodes were slowly dessicated into anhydrous glycerin and

mounted on Cobb-type slides in anhydrous glycerin.

Taxonomic Keys and Descriptions:

Taxonomic keys to plant, soil and aquatic nematodes compiled by Hopper and Cairns (1959) was used primarily in identification to genus. Monographs of particular groups were also used when available. Thorne (1939) and Thorne and Swanger (1936) were used as references for many genera of Dorylaiminae. Many keys to species with excellent illustrations and descriptions were included in their works. Tylenchorhynchus spp. were found in Allen (1955) and Trichodorus spp. were found in Allen (1957). The key used for Pratylenchus spp. was by Tarjan (1968 unpublished key). The key for Belonolaimus spp. was taken from Rau (1963).

RESULTS

After the 24 soil samples were collected and processed, the nematodes recovered were mounted on permanent slides. Four hundred fifty-two slides were made. They contained 50 genera. Every sample contained several species, ranging from 5 associated with Austrian pine to 27 associated with vonEhron globe juniper. The genera found most frequently are listed in Table 1. Most of the samples had representatives of plant-parasitic, predaceous, and saprophagous nematodes. Some samples contained hundreds of nematodes while other samples contained comparatively few. No attempt was made to estimate total population of any particular genus.

Tylenchida (Filipjev) Thorne:

Most of the known plant-parasitic nematodes are taxonomically placed in Tylenchida. Members of this order were present in 91% of the samples taken. The occurrence of known or suspected plant-parasitic nematodes identified in this study is summarized in Table 2.

The genus Helicotylenchus Steiner was found in 33% of the samples. H. pseudorobustus (Steiner) Golden and Rotylenchus Filipjev were identified from 20%.

The genus Pratylenchus Filipjev comprises over 40 described species, is distributed world-wide, and is parasitic on a wide variety of plants. P. vulnus Allen and Jensen was identified from 4 samples from Pfitzer juniper and 1 sample from Canaerti juniper.

Belonolaimus longicaudatus Rau was in 1 sample associated with Pfitzer juniper. This is the first report of this genus in Kansas.

Paraphelenchus myceliophthorus Goodey and Criconemoides sp. Taylor were

Table 1. Genera of nematodes most frequently found in 24 nursery field collections.

	Genus	% Occurrence		Genus	% Occurrence
1.	Eudorylaimus	100.00	19.	Rotylenchus	20.83
2.	Xiphinema	83.33	20.	Miconchus	16.67
3.	Discolaimus	75.00	21.	Tylenchorhynchus	16.67
4.	Acrobeles	70.83	22.	Ditylenchus	16.67
5.	Rhabditis	70.83	23.	Psilenchus	16.67
6.	Aphelenchus	70.83	24.	Tylenchus	12.50
7.	Mylonchulus	62.50	25.	Nygolaimus	12.50
8.	Chiloplacus	50.00	26.	Alaimus	12.50
9.	Leptonchus	50.00	27.	Aphelenchoides	12.50
10.	Eucephalobus	37.50	28.	Prismatolaimus	12.50
11.	Mononchus	37.50	29.	Axonchium	12.50
12.	Helicotylenchus	33.33	30.	Acrobeloides	8.33
13.	Cephalobus	29.17	31.	Diphtherophora	8.33
14.	Pungentus	29.17	32.	Ironus	8.33
15.	Dorylaimellus	29.17	33.	Isolaimium	8.33
16.	Mesodorylaimus	25.00	34.	Meloidogyne	8.33
17.	Discolaimium	20.83	35.	Plectus	8.33
18.	Pratylenchus	20.83			

Table 2. Known or suspected plant parasitic nematode genera found associated with 4 groups of nursery plants.

Genus	Juniper 20 samples	Pine 2 samples	Arbor vitae 1 sample	Cypress 1 sample	Total
Xiphinema	16[a]	2	1	1	20
Leptonchus	9	1	1	1	12
Helicotylenchus	7	0	0	1	8
Tylenchorhynchus	3	0	1	0	4
Rotylenchus	4	0	0	1	5
Ditylenchus	4	0	0	0	4
Trichodorus	1	0	0	0	1
Psilenchus	3	1	0	0	4
Pratylenchus	5	0	0	0	5
Aphelenchoides	3	0	0	0	3
Meloidogyne	2	0	0	0	2
Tylenchus	3	0	0	0	3
Belonolaimus	1	0	0	0	1
Criconemoides	1	0	0	0	1
Paraphelenchus	1	0	0	0	1

[a]Numbers represent the number of times a genus was found associated with a host.

each found in individual samples. The genus Tylenchus Bastian was found in one-eighth of the samples and were identified from samples associated with Pfitzer juniper.

Ditylenchus sp. was found associated with junipers in 4 samples. An individual male specimen of Meloidogyne sp. Goeldi was found in each of 2 samples collected. Psilenchus hilarulus de Man was found associated with 3 samples from junipers and 1 sample associated with Austrian pine.

Tylenchorhynchus sp. Cobb have a wide distribution and have been reported regularly in surveys of the stylet-bearing nematodes and were identified from 16% of the samples.

The genus Aphelenchoides Fischer is composed of over 80 species. Aphelenchoides sp. was found associated with 3 samples from junipers. The genus Aphelenchus Bastian was found in five-eighths of the samples. A. avenae Bastian was identified from 50% of the samples collected.

Rhabditida (Oerley) Chitwood:

Genera in this order are composed typically of inhabitants of soil and decaying plant tissue. The genera Acrobeles Linstow, Rhabditis Dujardin, and Chiloplacus Thorne were found in at least half of the samples. Acrobeles was observed to be present in 70% of the samples and was the most numerous group identified in this order. Acrobeles complexus Thorne was identified in 13 samples, while A. ciliatus Linstow was only identified in 6 samples. The genus Rhabditis was found in two-thirds of the samples. Rhabditis (Rhabditella) axei (Cobb) Dougherty was identified from one-eighth of the samples. Chiloplacus sp. were found in 50% of the samples. Both Chiloplacus symmetricus (Thorne) Thorne and C. propinquus (de Man) Thorne were identified and C. symmetricus was present in approximately 41% of the samples.

Three-eighths of the samples contained specimens from the genus Eucephalobus. The 3 species identified in order of occurrence were Eucephalobus laevis Thorne, E. oxyuroides (de Man) Steiner, and E. striatus (Bastian) Thorne. The genus Cephalobus Bastian was identified from 7 samples. Twenty percent of the samples contained specimens of C. persegnis Bastian.

There were 2 samples from Canaerti juniper which had specimens identified in the genus Acrobeloides (Cobb), Steiner and Buhrer, (Thorne). The genera Protorhabditis (Osche) Dougherty, Protodiplogasteroides (Ruhm) Paramonov, Pelodera A. Schneider, and Panagrellus Thorne were each identified from individual samples.

Araeolaimida de Coninck and Schuurmans Stekhoven:

This group is composed primarily of bacterial feeders and are among the nematodes classified as free-living. The 3 genera identified from this group were Plectus Bastian, Cylindrolaimus de Man, and Isolaimium Cobb.

Monhysterida (Oerley) Schuurmans Stekhoven and de Coninck:

The food habits are unknown but some genera are believed to be vegetarians (Goodey, 1963). Only the genus Prismatolaimus de Man was found in this survey and was identified from one-eighth of the samples.

Chormadorida (Filipjev) Chitwood:

This order is composed of mainly marine species with some fresh water species present (Goodey, 1963). The genus Achromadora Cobb was identified from one sample.

Enoplida (Baird) Chitwood:

The genera Tripyla Bastian, Tobrilus Andrassy, and Ironus Bastian were

identified from samples in this survey. Species of all 3 genera occur in fresh water or damp soil. Ironus longicaudatus de Man was found in 8% of the samples.

Dorylaimida (de Man) Pearse:

The largest number of genera identified belonged in this order. Every sample had a minimum of 2 genera identified in this group which include saprophagous, predaceous, and plant-parasitic nematodes.

The genus Eudorylaimus Andrassy occurred in all of the samples, and was the most abundant of all genera in this study. E. monohystera (de Man) Andrassy was identified from 33% of the samples and only on Juniperus spp.

The genus Mesodorylaimus Andrassy was found in one-fourth of the samples. M. bastiani (Butschli) Andrassy was the only species identified and was present in 16% of the samples.

Pungentus spp. Thorne and Swanger were identified in over 29% of the samples collected. The 2 species of this genus identified from the samples were P. obscurus Thorne and P. brevidentatus Thorne.

The genus Discolaimus Cobb was found in three-fourths of the collections. The 2 species identified in order of magnitude were Discolaimus texanus Cobb and D. major Thorne. At least one-third of the samples contained D. texanus.

Xiphinema americanum Cobb was found in 83% of the evergreen nursery fields sampled. Axonchium Cobb was identified from 2 samples.

The genus Leptonchus Cobb was found in 50% of the samples. L. granulosus was identified from over 45% of the samples collected. The genus Dorylaimellus Cobb was identified from 29% of the samples. The food habits of this genus are not known. The genus Nygolaimus Cobb, was identified from one-eighth of the samples collected.

The genera Carcharolaimus Thorne, Belondira Thorne, Trichodorus Cobb, and

Prionchulus (Cobb) Wu and Hoeppli were found in 1 sample each. The genus Thornia Meyl was identified from one-sixth of the samples.

The genus Discolaimium Thorne was identified from 20% of the collections. They are all apparently predators of other nematodes. D. latum Thorne was identified from 2 samples, and D. conura was identified from one sample.

Diphtherophora obesus Thorne was identified in 4% of the collections. Their feeding habits are not known. The genus Alaimus de Man, was recorded from one-eighth of the samples.

The genus Mononchus Bastian was found in 37% of all samples collected. M. papillatus Bastian was identified from one-third of the samples. Others identified were M. parvus de Man and M. tunbridgensis Bastian.

The genus Miconchus Andrassy was identified from one-sixth of the samples. They appear to be carnivorus in feeding habits.

Mylonchulus sp. (Cobb) Pennak was identified from 62% of the samples with the species Mylonchulus subsimilis (Cobb) Meyl being identified most frequently. Other species in order of magnitude were M. incurvus Cobb, M. parabrachyurus (Thorne) Andrassy, M. index (Cobb) Andrassy, M. striatus (Thorne) Andrassy, and M. lacustris N. A. Cobb in M. V. Cobb.

In some cases the literature was not sufficient to make positive and accurate identification of specimens to species. This was primarily true for some genera in the Rhabditinae (Orley) Micoletzky. In other instances specimens were either immature or distorted such that identification only to genus could be made.

DISCUSSION AND CONCLUSIONS

Only 7 of the 10 orders of nematodes, as classified by Goodey (1963), were represented in the survey. The 7 were Tylenchida, Rhabditida, Araeolaimida, Monhysterida, Chromadorida, Enoplida, and Dorylaimida. Specimens were not found in the orders Teratocephalida Andrassy, Desmoscolecida (Schepotieff) Schuurmans Stekhoven, or Trichosyringida Ward which include many marine and animal parasitic species.

Members of the orders Tylenchida, Dorylaimida, and Rhabditida were found most often; the orders that contain most of the soil and fresh water forms. The economically important plant-parasitic nematodes are found in the Tylenchida and Dorylaimida which include the stylet-bearing forms.

Each soil sample contained a variety of nematode genera. In many cases, a population of one particular genus was predominent in a specific sample. This was especially true where the genera Xiphinema, Eudorylaimus, Helicotylenchus, or Mylonchulus were present in relatively large numbers.

Two male specimens of Meloidogyne sp. were found in 2 of the samples. This genus is an obligate, sedentary endoparasite in roots. All roots were examined for root-knot nematodes and none were found.

Xiphinema sp. were not found in only 2 samples collected from nursery heel yards, 1 sample from semi-clean cultivation, and 1 sample collected from a clean cultivated nursery field. Xiphinema americanum was identified from samples collected about Pfitzer, Canaerti, Savin, Kalley Pfitzer, Andorra, vonEhron Globe, and Virginia Globe junipers and American arbor vitae, Arizona cypress, and Austrian pine. Orr (1966) identified X. americanum associated with 20 of the 24 native plant species in his survey of true prairie soils of Kansas. This species was called one of the 4 major nematode pests of

Southeastern United States, and was found associated with necrosis and destruction of feeder roots on laurel oak in Florida (Christie, 1952). Malek (1968) found X. americanum in 95% of shelterbelts sampled in South Dakota where it was associated with Juniperus virginiana, Pinus banksiana, and P. ponderosa. X. americanum was observed feeding on the roots of sugar maple seedlings by DiSanzo and Rohde (1969).

Eudorylaimus sp. was found associated with every sample in this study. They were found associated with 26 species of plants from Kansas native prairie soils by Orr (1966).

The genus Trichodorus was associated with only Canaerti juniper. This genus was reported to be associated with Juniperus virginiana, Pinus banksiana, and Pinus ponderosa by Malek (1968) and was identified from about loblolly and slash pines by Ruehle and Sasser (1962). Goodey (1963) stated this nematode was known to cause a considerable amount of damage to a variety of plants.

All members of the *Mononchidae* appear to be carnivorus. They feed on protozoa, nematodes, rotifers, tardigrades, and small oligochaetes. Captured nematodes may commonly be found within the gut contents of this group of nematodes (Goodey, 1963). Several other genera of predaceous nematodes were found including Discolaimus, which was the most frequently occurring predator and was in three-fourths of the samples.

Belonolaimus longicaudatus was identified from Kansas for the first time and was associated with Pfitzer juniper. This genus is a very important parasite in the Southeastern United States on many crops. Ditylenchus sp. has been reported as parasitic on numerous hosts (Goodey, 1963) but was identified as being associated only with juniper hosts in this study. Ruehle (1965, 1966, 1969) identified various species of pine as hosts of numerous genera of nematodes.

Many of the same genera were identified in this study and include Pratylenchus, Criconemoides, Helicotylenchus, Tylenchorhynchus, and Trichodorus. However, the pathogenic potential of the individual species on the host from about which the samples were taken is not known.

Rotylenchus sp. was associated with Canaerti juniper, Pfitzer juniper, and Arizona cypress in this present study. This nematode is known to damage some woody ornamental plants.

The genus Aphelenchus was associated with samples from Pfitzer, Canaerti, Savin, Andorra, and vonEhron globe junipers and arbor vitae and Austrian pine. A. avenae has been found in moderate numbers within the roots of various crops by Hutchinson et al (1961). They were observed feeding on hyphae of Neurospora sitophila (Mont.) Shear and Dodge, by Christie and Arndt (1936). Rhoades and Linford (1959) controlled root rot on corn seedlings caused by Pythium arrhenomanes by adding thousands of A. avenae which invaded only the Pythium lesions.

The genus Aphelenchoides is made up of both plant-parasitic and fungus feeding species and was found in samples from about Pfitzer and Canaerti junipers. Some of them have been known to assume economic importance as a parasite of narcissus bulbs according to Thorne (1961). It was demonstrated to be the causal agent of brown ring symptoms on narcissus by Steiner and Buhrer (1932).

In summary, a broad range of nematodes were found associated with evergreens in south central Kansas. Some species, such as Belonolaimus longicaudatus and Pratylenchus vulnus, are major pests on "woody" ornamental crops in other areas of the United States. Further observations will be necessary to determine if these nematodes were introduced, and, if so, whether they can

survive in Kansas soils and climate. Most of the other genera and species have been found in prior surveys involving native vegetation (Orr, 1966) and their presence in the soil from about evergreens were not considered unusual. However, in view of the pathogenic potential of several of the genera, continued observations and controlled experimental pathogenicity tests would be feasible.

SUMMARY

From 24 soil samples taken from around roots of evergreens growing in Sedgewick County, Kansas, 50 genera of nematodes were identified. Fifteen known or suspected plant-parasitic genera were found. The genus Belonolaimus was identified for the first time in Kansas.

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VITA

Richard D. Charlton, son of Howard Wm. and Helen V. (Ostermeyer) Charlton, was born at Milwaukee, Wisconsin, June 28, 1930. He attended grade school in the city of Milwaukee and graduated from Bryant High School, Bryant, Arkansas in 1949. He attended Arkansas Polytechnic College where he graduated with an A. S. Degree in 1952. He attended the University of Arkansas and graduated with a B. S. Degree in Agriculture in 1954. Following graduation, he served as a processed food inspector for the U.S.D.A., an inspector for the Arkansas State Plant Board, Assistant State Entomologist for the Missouri State Department of Agriculture, Assistant State Entomologist for the Kansas State Board of Agriculture, and as a self-employed entomologist. He attended Kansas State University to study Plant Pathology and Nematology as a part-time student from September 1960 to February 1964. He returned to Kansas State University in June of 1967 as a full time student and graduate teaching assistant.

He was a member of Circle K; Kansas State Entomology Club; Entomological Society of America; Society of Nematologists; and Farm House Fraternity in college.

He was married to Loretta M. Bradford; Texarkana, Arkansas, in 1956 and to this union was born Richard Daniel, Jr., Age 13; and Loretta Marie, age 8.

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APPENDIX

Table i. Hosts from about which samples were taken for nematode analysis.

Sample No.	Scientific Name	Common Name	Type of Cultivation
1	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
2	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
3	Juniperus virginiana canaertii, Senecl.	Canaerti Juniper	Clean
4	Thuja occidentalis, L.	American Arbor Vitae	Clean
5	Juniperus virginiana, L....c. v. 'Blue Haven'	Blue Haven Juniper	Semi-clean
6	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
7	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Grassy
8	Juniperus virginiana canaertii, Senecl.	Canaerti Juniper	Heel Yard
9	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
10	Cuppressus arizonica, Greene	Arizona Cypress	Clean
11	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
12	Pinus nigra, Arnold	Austrian Pine	Heel Yard
13	Juniperus sabina, L.	Savin Juniper	Clean
14	Juniperus horizontalis, Moench...c. v. 'Andorra'	Andorra Juniper	Clean
15	Juniperus virginiana canaertii, Senecl.	Canaerti Juniper	Clean
16	Pinus nigra, Arnold	Austrian Pine	Clean

Table i. (Contd.)

Sample No.	Scientific Name	Common Name	Type of Cultivation
17	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
18	Juniperus sabina, L...c.v. 'vonEhron'	vonEhron Globe Juniper	Clean
19	Juniperus virginiana canaertii, Senecl.	Canaerti Juniper	Clean
20	Juniperus horizontalis, Moench...c. v. 'Andorra'	Andorra Juniper	Clean
21	Juniperus chinensis pfitzeriana, Speath	Pfitzer Juniper	Grassy
22	Juniperus chinensis pfitzeriana, Spaeth	Pfitzer Juniper	Clean
23	Juniperus chinensis, L....c. v. 'Kalley Pfitzer'	Kalley Pfitzer Juniper	Clean
24	Juniperus virginiana, L.	Virginia Globe Juniper	Clean

Table ii. Nematodes found indexed by sample number.

Nematode	Sample Numbers
Achromadora	18[a]
Acrobeles	
A. complexus	1, 4, 5, 6, 7, 8, 11, 13, 16, 17, 19, 21, 22
A. ciliatus	5, 8, 9, 13, 14, 19
Acrobeles sp.	1, 2, 3, 4, 5, 7, 8, 11, 20
Acrobeloides	15, 19
Alaimus	17, 18, 22
Aphelenchoides	1, 9, 15
Aphelenchus	
A. avenae	1, 2, 3, 4, 9, 11, 13, 15, 17, 18, 20, 21
Aphelenchus sp.	1, 7, 11, 14, 16, 17, 18, 21
Axonchium	9, 23
Belondira	19
Belonolaimus	21
Carcharolaimus	5
Cephalobus	
C. persignis	2, 6, 10, 11, 22
Cephalobus sp.	4, 6, 8
Chiloplacus	
C. symmetricus	2, 4, 6, 8, 10, 11, 14, 17, 18, 19
C. propinquus	4, 10, 14, 15, 19
Chiloplacus sp.	2, 3, 5, 14, 19
Criconemoides	8

Table ii. (Contd.)

Nematode	Sample Numbers
Cylindrolaimus	21
Diphtheropora	5, 8
Discolaimium	
D. latum	8, 17
D. conura	9
Discolaimium sp.	2, 6
Discolaimus	
D. major	5, 12, 21
D. texanus	1, 2, 3, 8, 10, 11, 18, 21
Discolaimus sp.	4, 5, 6, 9, 13, 14, 15, 18, 19, 21, 23
Ditylenchus	7, 18, 19, 21
Dorylaimellus striatus	4, 6, 7, 9, 11, 13, 21
Eucephalobus	
E. laevis	4, 13, 20, 21
E. oxyuroides	2, 7, 11
E. striatus	8
Eucephalobus sp.	3, 5, 20
Eudorylaimus	
E. monohystera	5, 9, 17, 18, 19, 20, 23
Eudorylaimus sp. (3)	5, 18, 23
Eudorylaimus sp. (10)	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24
Eudorylaimus sp. (11)	8, 19
Eudorylaimus sp. (12)	4, 6, 8, 11, 13, 19

Table ii. (Contd.)

Nematode	Sample Number
Eudorylaimus sp. (13)	3, 7, 15
Eudorylaimus sp. (14)	1, 2, 14, 17, 18, 19, 21
Eudorylaimus sp. (15)	11, 13, 17, 18
Helicotylenchus	
H. pseudorobustus	8, 11, 15, 23, 24
Helicotylenchus sp.	3, 6, 10, 11, 15
Ironus longicaudatus	5, 6
Isolaimium	8, 9
Leptonchus	
L. granulosus	5, 6, 8, 9, 10, 11, 13, 15, 16, 19, 21
Leptonchus sp.	4, 6, 9, 19, 21
Meloidogyne	7, 11
Mesodorylaimus	
M. bastiani	5, 8, 18, 23
Mesodorylaimus sp.	2, 15, 22, 23
Michonchus	1, 16, 18, 23
Mononchus	
M. papillatus	6, 12, 14, 16, 18, 19, 23, 24
M. parvus	6
M. tunibridgeinsis	18
Mononchus sp.	1, 6, 12, 16, 18
Mylonchulus	
M. incurvus	3, 6, 8, 18

Table ii. (Contd.)

Nematode	Sample Number
M. index	5, 16
M. lacustris	1
M. parabrachyurus	1, 3
M. striatus	1, 5
M. subsimilis	6, 13, 18, 22, 23, 24
Mylonchulus sp.	1, 3, 6, 7, 8, 11, 13, 16, 17, 18, 21, 23
Nygolaimus	
N. vulgaris	9
Nygolaimus sp.	18, 24
Panagrellus	6
Pelodera	1
Plectus	8, 17
Pratylenchus	
P. vulnus	6, 7, 9, 19
Pratylenchus sp.	11
Prionchulus muscorum	12
Prismatolaimus	6, 17, 18
Protodiplogasteroides	11
Protorhabditis	3
Psilenchus	
P. hilarulus	15, 18, 23
Psilenchus sp.	16
Paraphelenchus	15

Table ii. (Contd.)

Nematode	Sample Number
Pungentus	
P. brevidentatus	3, 15, 16, 23
P. obscurus	6, 8, 23
Pungentus sp.	21
Rhabditis, (Rhabditella) axei	3, 12, 15, 20
Rhabditis	1, 3, 4, 5, 6, 7, 8, 9, 11, 13, 15, 16, 19, 20, 21, 22
Rotylenchus	
R. caudaphasmidium	6, 17
R. pumilis	3, 6, 8, 10
Tobrilus	6
Trichodorus	8
Tripyla	18
Tylenchorhynchus	
T. acutus	4, 18, 21
Tylenchorhynchus sp.	3
Tylenchus	13, 17, 22
Xiphinema	
X. americanum	1, 2, 4, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24
Xiphinema sp.	2, 4, 6, 7, 10, 11, 13, 14, 16, 17, 18, 19

[a]The numbers refer to the sample numbers as recorded in Table i.

NEMATODES ASSOCIATED WITH EVERGREENS IN SOUTH CENTRAL KANSAS

by

RICHARD DANIEL CHARLTON

B. S., University of Arkansas, 1954

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

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The purpose of this study was to sample specific evergreen nursery fields in Sedgewick County, Kansas, and identify all the adult nematodes found. The nematodes identified increased the known species in evergreen nursery fields in Kansas and also added to the nematode collection at Kansas State University.

Soil samples were taken and processed, with the nematode specimens found placed onto permanent slides. Cultivated evergreen nursery fields were selected to restrict, to some degree, the host plants for the plant-parasitic nematode species.

Fifty genera were identified in this study. Eudorylaimus Andrassy, Discolaimus Cobb, and Xiphinema Cobb were recorded in at least three-fourths of the samples. Other genera in at least half of the samples included Acrobeles Linstow, Rhabditis Dujardin, Aphelenchus Bastian, Mylonchulus (Cobb) Pennak, Chiloplacus Thorne, and Leptonchus Cobb.

Additional genera in at least one-fifth of the samples included Mesodorylaimus Andrassy, Mononchus Bastian, Helicotylenchus Steiner, Cephalobus Bastian, Pungentus, Thorne and Swanger, Pratylenchus Filipjev, Rotylenchus Filipjev, Eucephalobus Steiner, Discolaimium Thorne and Dorylaimellus Cobb.

Fifteen known or suspected plant-parasitic genera were identified. Xiphinema, Aphelenchus, Helicotylenchus, Pratylenchus, and Rotylenchus were recorded most often.