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Nematodes Associated with Plants in Iowa[1]

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Abstract. During a preliminary survey of plant parasitic nematodes in Iowa, 55 species, mostly in the Tylenchoidea, were identified. Except for *Longidorus, Xiphinema,* and *Trichodorus,* the Dorylaimoidea were not considered. Most samples were taken in forage legume fields and woodlands. The seven genera encountered most frequently were the following, as expressed in percentage of total samples (1,308): *Tylenchus* (56), *Helicotylenchus* (40), *Xiphinema* (36), *Aphelenchus* (31), *Tylenchorhynchus* (20), *Paratylenchus* (14), and *Pratylenchus* (13). *Helicotylenchus microlobus* and *Xiphinema americanum* were among the most common and widespread plant parastic nematodes found. While *H. microlobus* occurred most frequently in cultivated fields, *H. platyurus* was mainly a woodland inhabitant. Although processing procedures were not directed toward recovery of root knot and cyst nematodes, evidence indicates that *Meloidogyne hapla, Heterodera trifolii,* and *H. weissi* are common in Iowa.

Stylet-bearing nematodes suspected or proved to be plant parasitic are little known in Iowa, but, as in other states where recent investigations have been made, this fauna appears to be rich and varied. Hansen (1) reported *Hemicycliophora similus* Thorne, 1955; *H. weissi* Steiner, 1949; *Hoplolaimus tylenchiformis* Daday, 1905; *Tylenchus exiguus* de Man, 1876; and many Dorylaimoidea including *Xiphinema americanum* Cobb, 1913, as occurring in Iowa. Perry *et al.* (2) reported *Helicotylenchus microlobus* Perry, 1959 in eastern Iowa. In addition to some of the above, Castaner (3) reported *Pratylenchus hexincisus* Taylor and Jenkins, 1957, on corn in Iowa.

A preliminary survey for plant parasitic nematodes in Iowa was initiated in 1959. Emphasis was on the Tylenchoidea, which contains most of the recognized plant parasites. Few Aphelenchoidea and Dorylaimoidea were considered. Even with the Tylenchoidea, many species were probably overlooked, due either to insufficient examination or to identification only to genus.

MATERIALS AND METHODS

About 500 cc soil samples were taken from the root zone of plants. Where obvious plant decline was evident, more samples were taken than where the plants appeared healthy. Most samples were processed within a few days of sampling by a

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modification of the Christie and Perry (4) technique. The Seinhorst (5) elutriator method was used in the early work. All 99 Iowa counties were represented in the samplings. Representative specimens are deposited in the nematode collection at the Department of Botany and Plant Pathology, Iowa State University, Ames, Iowa.

Table 1. Number of samples taken from around plant groups

Forage legumes		*Beta vulgaris* L.	25
Lotus corniculatus L.	5	*Glycine max* L.	36
Medicago sativa L.	325	*Zea mays L.*	100
Melilotus alba Dear.	1	Marshes and stream banks	59
Melilotus officinalis Lam.	48	Fruits	23
Trifolium hybridum L.	8	Ornamentals	164
Trifolium pratense L.	60	Vegetables	16
Trifolium repens L.	20	Grasses—turf, pasture	106
Trifolium procumbens L.		1Trees and woodland	254
Trifolium sp.	13	Miscellaneous	30
Other field crops			
Avena sativa L.	14	Total	1308

Table 2. Relative frequency of nematode genera in 1308 soil samples

Nematode genus	Percent of total samples[1]	Nematode genus	Percent of total samples[1]
Aorolaimus	T	*Longidorus*	1
Aphelenchoides	3	*Meloidogyne*	3
Aphelenchus	31	*Paratylenchus*	14
Boleodorus	1	*Pratylenchus*	13
Criconema	T	*Psilenchus*	3
Criconemoides	2	*Rotylenchus*	T
Helicotylenchus	40	*Scutellonema*	1
Hemicycliophora	6	*Trichodorus*	2
Heterodera	3	*Tylenchorhynchus*	20
Hirschmaniella	3	*Tylenchus*	56
Hoplolaimus	7	*Xiphinema*	36

[1] T = Trace

Results

Data are recorded for 1,308 soil samples. The numbers of samples were listed according to the plants around which soil was taken (Table 1). The frequencies of nematode genera recovered were also listed (Table 2).

Only named species are discussed. Several apparently undescribed species were found, including members of the genera *Aorolaimus, Criconema, Criconemoides, Hemicycliophora, Hirschmanniella,* and *Longidorus.*

Longidorinae

Longidorus.

Small numbers of *Longidorus* spp. were collected sporadically from woodland habitats.

Xiphinema.

Xiphinema americanum was one of the most frequently found plant parasitic nematodes in Iowa. It was associated with 66 different plant species and was found in 40 per cent of the

soil samples from around alfalfa plants and in 80 per cent of samples from around sweet clover. Abundance varied considerably, but, in samples from some fields and woodlands, recoveries were more than 2,000 per 250 cc of soil. The species is widely distributed in the state.

Xiphinema chambersi Thorne, 1939, is a common inhabitant of woodlands and along streams. This species was usually found in small numbers. It was found only once in a cultivated field, which was adjacent to a woods in Muscatine County.

TRICHORINAE

Trichodorus spp. were found in 2 per cent of the samples. All were from woodland soils. The only species identified was *T. christiei* Allen, 1957.

TYLENCHINAE

Tylenchus.

Tylenchus was recorded in 56 per cent of the samples. In general, species were not identified in this ubiquitous genus. *Tylenchus davainei* Bastian, 1865, *T. exiguus* and *T. filiformis* Butschli, 1873, were found commonly in samples from alfalfa, corn, and soybean fields. *T. costatus* de Man, 1921, was found frequently in soil from forage legume fields and from woodlands.

Psilenchus.

The only species identified was *P. hilarulus* de Man, 1921. It is a common and widespread inhabitant of cultivated fields and woodlands and especially along river banks.

Tylenchorhynchus.

Of the several species found, *Tylenchorhynchus acutus* Allen, 1955, *T. martini* Fielding, 1956, and *T. nudus* Allen, 1955, appear to be the most common. *T. acutus* occurred around corn, oats, and forage legumes in the western and, to a lesser extent, in the southern part of the state. It was not found in northeastern Iowa or in woodlands. Iowa specimens usually have up to 24 annules on the tail as compared with the 17 observed by Allen (6) on Utah and Colorado specimens. *T. martini* was associated with cultivated and non-cultivated plants in scattered locations throughout the state. Many specimens differ from those described by Fielding (7) in that the tail is not always clavate and the number of annules on the tail vary from 17 to 26. Timm (8) reported that the tail shape of *T. martini* from East Pakistan was variable but never clavate. *T. nudus* appears to be the most common member of the genus around corn and other field crops in the northeast section of the state. It was found less frequently in other areas of Iowa but was still common. It is also found in woodlands. *Tylenchorhynchus acti* Hopper, 1959, was once found associated with *Begonia* in the greenhouse. *T. agri,* V.

Ferris, 1963, was found associated with sweetclover in Hamilton County. *T. brevicaudatus* Hopper, 1959, was associated with *Pinus strobus* L. and herbaceous plants in White Pine Hollow State Park. *T. leptus* Allen, 1955, was associated with golf turf in Hamilton County and in the Yellow River Forest Reserve and White Pine Hollow State Park. *T. maximus* Allen, 1955, was found in pastures in Worth County. *Equisetum fluviatile* L. was found in Allamakee County, around various plants at Pike's Peak State Park, and around several greenhouse plants. *T. silvaticus* V. Ferris, 1963, was found in one sample from the Donnellson unit of Shimek State Forest.

HOPLOLAIMINAE

Hoplolaimus.

Hoplolaimus galeatus (Cobb, 1913) Thorne, 1935, was the only species found. It was associated with a wide range of plants in cultivated and non-cultivated habitats. It was common in forage legume fields, but numbers were generally low. Highest numbers were obtained in woodlands.

Rotylenchus.

The only species of this genus found was *R. pumilus* (Perry, 1959) Sher, 1961. It occurred in Pammel Woods, Ames.

Helicotylenchus.

Two species of this genus are very common in Iowa. *H. microlobus* was associated with 55 different plants in several different habitats including cultivated and non-cultivated fields, grasslands, woodlands, and stream banks. It was much more common in cultivated fields than woodlands, however. It occurred in about 50 per cent of the corn and forage legume samples.

The predominant spiral nematode of woodlands was *Helicotylenchus platyurus* Perry, 1959. The specimens agree well with the original description, There is some variation in the shape of the tail, although it is always bluntly rounded. This species appears to be very common around woodland trees in all parts of Iowa and has been associated occasionally with turf.

Helicotylenchus digonicus Perry, 1959, was found occasionally in woodlands. Specimens tentatively identified as *H. dihystera* (Cobb, 1893) Sher, 1961, were found infrequently in cultivated fields and in the Hayden Prairie.

SCUTELLONEMA

Scutellenema brachyurum (Steiner, 1938) Andrassy, 1958, was collected on several occasions around *Zamia, Saintpaulia, Coleus, Nerium,* and *Begonia* in greenhouses or around potted plants.

PRATYLENCHINAE

Pratylenchus.

Pratylenchus hexincisus and *P. penetrans* (Cobb, 1917) Filipjev and Schuurmans Stekhoven, 1941, appear to be the two most widely distributed members of this genus in Iowa. Both were found occasionally in forage legume fields and in 6 per cent of the corn samples. *P. minyus* Sher and Allen, 1953, and *P. scribneri* Steiner, 1943, have been associated with corn and soybeans, the former nematode being more abundant.

Pratylenchus convallariae Seinhorst, 1959, was found twice. Some individuals resemble P. *pratensis* (de Man, 1880) Filipjev, 1936, because of the more rounded tail and more elongated spermatheca. *P. coffeae* (Zimmerman, 1898) Filipjev and Schuurmans Stekhoven, 1941, was found once in *Fragaria* in southwestern Iowa and once in *Narcissus.*

NEOTYLENCHINAE

Boleodorus.

Boleodorus thylactus Thorne, 1941, was the only species of the Neotylenchinae identified. It was found most frequently in cultivated fields, especially forage legumes.

HETERODERINAE

Heterodera

Since cysts were generally not collected during the soil processing, the low figure given in Table 2 is no reliable indication of their abundance. Where special attempts were made to collect cysts, they were found in most samples. *H. trifolii* (Goffart, 1932) Oostenbrink, 1949, was obtained in several instances from central and eastern Iowa in association with *Trifolium. H. weissi* Steiner, 1949, known only on *Polygonum,* was found in all regions of the state. Records supplied by A. H. Hagge of the Plant Pest Control Division. U. S. D. A., indicate that these two species are common in Iowa.

Meloidogyne.

Meloidogyne hapla Chitwood, 1949, has been found scattered throughout Iowa in alfalfa, carrots in the Mason City area, soybeans and other crops near Muscatine, ornamentals in southwestern Iowa, and in many home gardens. It is probably more widely distributed than recognized. Members of the *Meloidogyne incognita* group have been found on several occasions in greenhouses and potted plants.

CRICONEMATINAE

Members of the Criconematinae were almost invariably found in woodlands and other moist habitats. They were found in cultivated fields only twice. Populations were generally low except for *Hemicycliophora similis.*

Criconema.

Two species were identified. *C. fimbriatum* Cobb, in Taylor, 1936, was associated with *Populus grandidentata* Michx. along the Mississippi River bluffs in Clayton County. *C. octangulare* (Cobb, 1914) Taylor, 1936, was associated with *Tilia ameicana* L. in Pammel Woods, Ames.

Criconemoides.

Criconemoides macrodorum Taylor, 1936, was found in woodlands at Ledges State Park and the Donnellson unit of Shimek State Forest. *C. curvatum* Raski, 1952, was found in Pammel Woods, Ames, and in a golf green in Hamilton County. *C. ornatum* Raski, 1958, occurred in woodlands in Lee County. *C. xenoplax* Raski, 1952, was found at Ledges State Park, in a woodland near Keokuk, and in a blue spruce nursery near Shenandoah.

Hemicycliophora.

Members of this genus were found in 18 per cent of the samples from woodlands including river banks. The species most commonly found was *H. similis.* It occurs in all regions of the state, sometimes in large numbers. Specimens which resemble this species, except for a more forward position of the excretory pore, have been found several times. At present, these are not being included in *H. similis.* Juveniles which appear to be *H. gigas* Thorne, 1955, have been found in the Donnellson unit of Shimek State Forest and in Stephens State Forest. *H. uniformis* Thorne, 1955, was found in Wild Cat Den State Park and in a corn field near Muscatine. *H. vidua* Raski, 1958, was found in Woodman Hollow State Park and in the Donnellson unit of Shimek State Forest.

PARATYLENCHINAE

Paratylenchus.

In contrast to other Criconematidae found, members of this genus were more frequent in cultivated fields than in woodlands. The most common species found was *Paratylenchus projectus* Jenkins, 1956, which was associated with many field crops and trees. *P. aculentus* Brown, 1959, was associated with alfalfa in Pottawattamie County. *P. audriellus* Brown, 1959, was found in woodlands at Pilot Knob, Waubonsie, Maquoketa, and White Pine Hollow state parks as well as at Shimek and Yellow River state forests. *P. curvitatus* van der Linke, 1938, was associated with alfalfa in Story County. *P. elachistus* Steiner, 1949, was found around *Morus* in Pammel Woods, Ames. *P. microdorus* Andrassy, 1959, was associated with corn and soybeans in northwestern Iowa and with *Pinus strobus* in White Pine Hollow State Park If *P. brevihastus* Wu, 1962, (9) is accepted as a

valid species, then *P. microdorus* from Iowa would fit more closely into that species. *P. nanus* Cobb, 1923, was associated with grasses in the Hayden Prairie, with white clover and grass in Jones County, and with yellow tuft of turf in Webster City. High populations were found in the latter instance. *P. tenuicaudatus* Wu, 1961, was found around *Prunus* sp. at Pike's Peak State Park.

Aphelenchoidea

Little attention was given this group. *Aphelenchus avenae* Bastian, 1865, is very common. *Aphelenchoides parietinus* (Bastian, 1865) Steiner, 1932, was collected on several occasions. *Aphelenchoides ritzemabosi* (Schwartz, 1911) Steiner and Buhrer, 1932, was found damaging chrysanthemums out-of-doors in Polk, Story, and Woodbury counties.

Discussion

The results reported here are an attempt to document occurrence of the nematodes which may be of economic importance in Iowa as well as to examine further the diversity of this fauna. Association of nematodes with plants, or even parasitism, does not imply pathogenicity to the plant. It merely indicates that determination of the nature of the association or parasitism is desirable. The pathogenicity of some nematodes, such as *Meloidogyne* (root knot) on various crops, *Aphelenchoides ritzamabosi* on chrysanthemums, and *Pratylenchus* on several crops has been well demonstrated. Although less is known of its behavior in the field, the pathogenicity of *Heterodera trifolii* on clover is easily demonstrated in the greenhouse. Acumulated evidence indicates that *Xiphinema americanum* probably is an important pathogen. The pathogenicity of many other nematode species, either in the greenhouse or in the field, is recorded in the literature. The report presented here is one step toward the evaluation of their importance in Iowa.

Although most, if not all, of the nematode species recorded here are plant parasitic, the associations with stated plants may or may not have meaning. Attempts were made to sample soil from around specific plants. However, since emphasis was placed on forage legumes and woodlands, both of which largely constitute mixed plantings, there was the possibility that the soil sampled comprised portions of mixed root systems.

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A Quantitative Method for the Study of Pollen and Spores in Bog Sediments[1]

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Abstract. A filtration method involving a membrane filter for the collection and subsequent microscopic examination of weighed, treated samples is presented. The filter and the sample collected upon it are both mounted for microscopic examination. The filter permits sufficient light passage for identification of spores and pollen upon its surface. This method permits a more accurate transfer of weighed samples from centrifuge tubes to microscope slides.

Before a palynological study of peat or other similar sediments can be made, the material must be treated in such a way as to remove the extraneous material and still preserve the pollen and spores. Brown (1) reviews several methods for this. The method used depends partly on the material to be studied and partly upon individual preferences. After the pollen and spores have been identified at a number of levels through a peat bed or lake bottom, a profile is developed and conclusions are drawn concerning the history of past vegetation and the environment which supported it. Variations in the proportions of pollen and spores at various levels are considered indicative of variations in the actual flora surrounding the lake or bog.

There are a number of difficulties in interpreting a pollen profile, but the one of greatest concern here is that some plants are known to produce much more pollen than others. As a result of this, it has been shown that some plants are over repre-

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