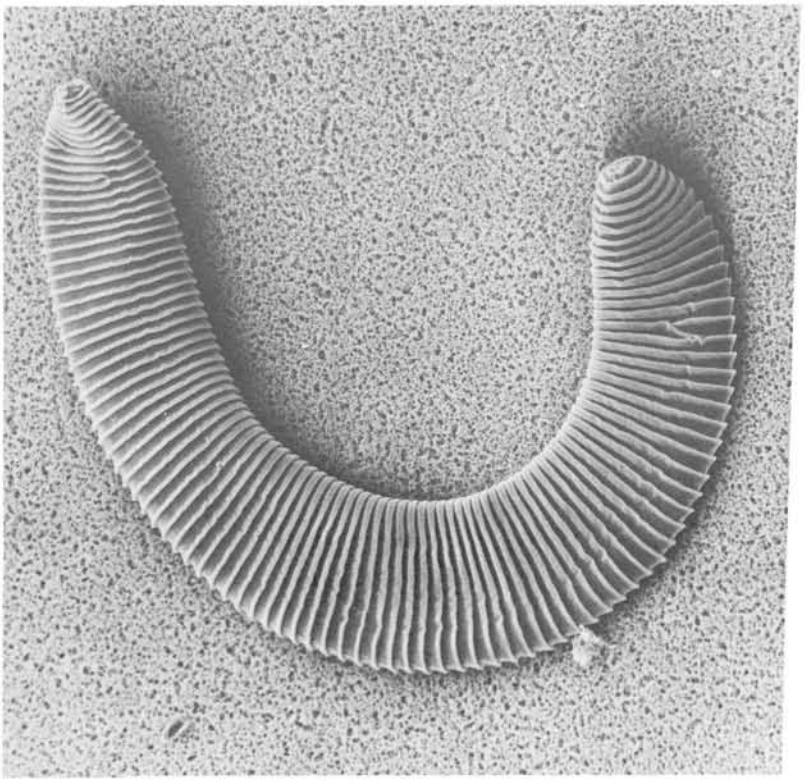
BULLETIN 768 MARCH, 1977

NEMATODES IN CONNECTICUT LAWNS AND GARDENS



Scanning electron micrograph of ring nematode

P. M. MILLER

CONNECTICUT AGRICULTURAL EXPERIMENT STATION NEW HAVEN

Figure 1. *Pratylenchus penetrans — root lesion nematode.*

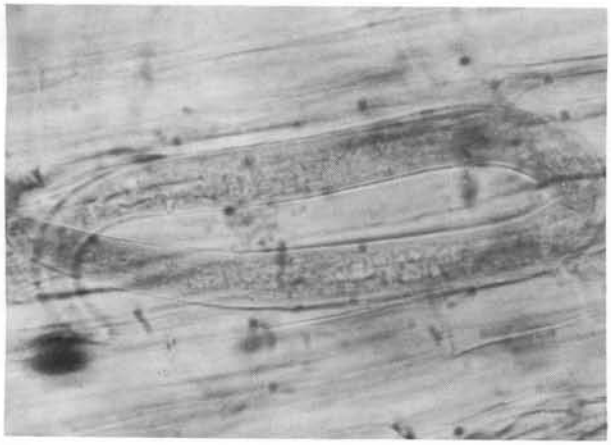


Figure 2. *Root lesion nematode inside a tomato root.*

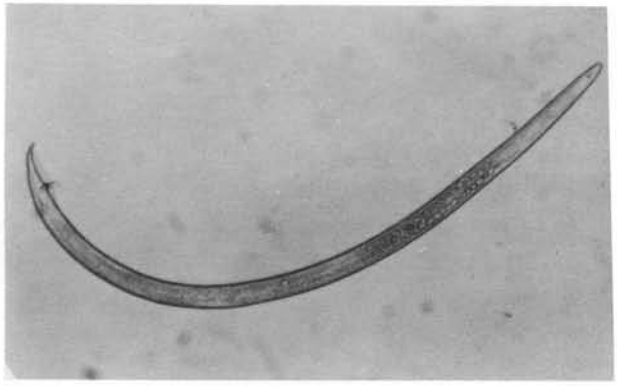


Figure 3a. *Tylenchorhynchus dubius — grass stylet nematode.*

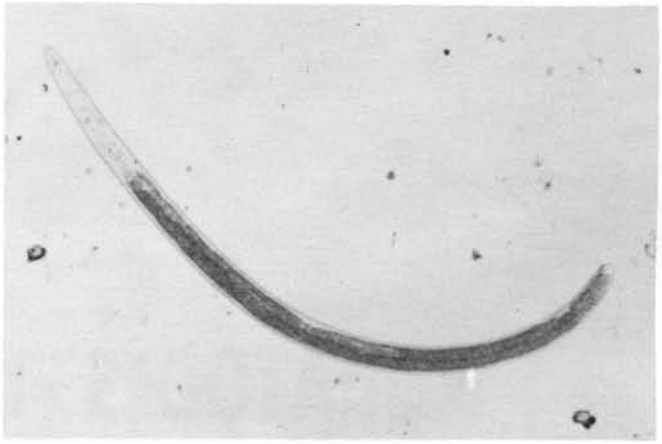


Figure 3b. *T. claytoni — tobacco stylet nematode.*

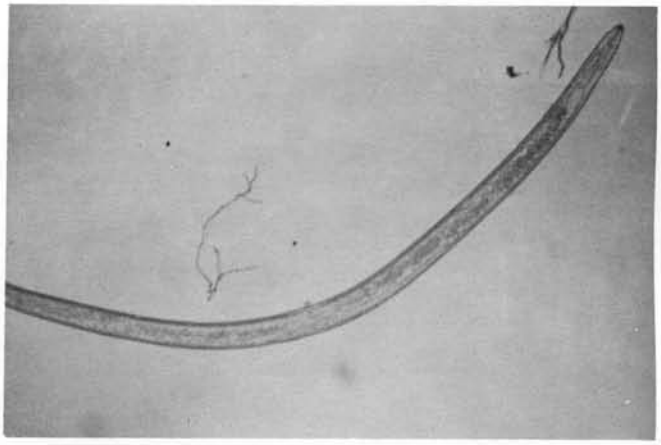


Figure 4. *Hoplolaimus tylenchiformis — lance nematode.*

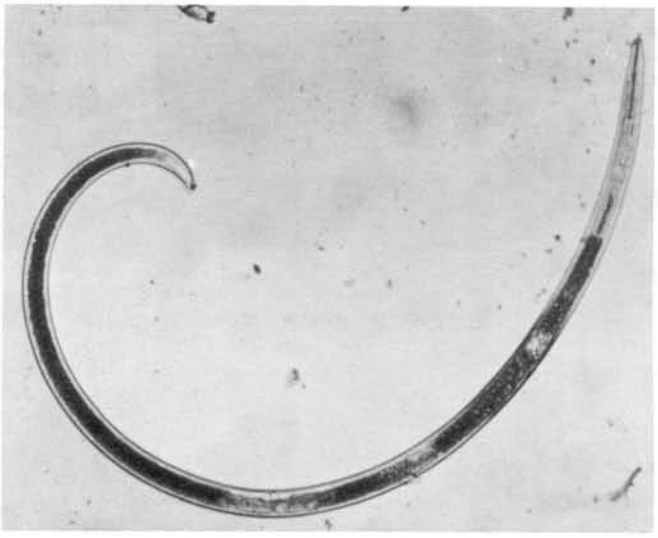


Figure 5. *Xiphinema americanum — dagger nematode.*

NEMATODES IN CONNECTICUT LAWNS AND GARDENS

P. M. MILLER

Many homeowners are changing portions of their lawns into gardens to grow vegetables for the kitchen table. Among the problems which might arise from this conversion is that plant parasitic nematodes usually found on the grass will attack vegetables in the garden. Nematodes are microscopic worms that attack roots.

Information on nematodes in grass and gardens is incomplete, and practical methods of controlling nematodes in home gardens are needed. Although some information is available on nematodes in vegetable fields (5, 7, 14), information is needed on whether nematodes found on turf in Connecticut are injurious to vegetables.

MATERIALS AND METHODS

Grass samples were taken in April on the Station lawn, at Lockwood Farm seven miles away, and on four home lawns. Most home lawns are mixtures of grasses, but usually contain either a bluegrass, a fescue or a ryegrass. Since there are different varieties of each in these mixtures, results of a previous survey of nematode populations around grasses growing in a turf nursery are also included. Four 5 oz. soil samples were taken to a depth of 3 inches, where previous tests have shown that most nematodes live. The nematodes were removed from soil by the sugar flotation method (8). Soil with stylet and ring nematodes and soil in which these nematodes had been killed were placed in large styrofoam cups. Corn (two varieties, Butter and Sugar or Golden Beauty), Sparkler radishes, Golden Acre cabbage and Tendergreen beans, also used in the outdoor garden, were each planted in four cups holding 250 g of soil. After 6 weeks apparent differences in growth due to nematode control were rated.

Next, a survey was taken of nematodes in gardens. Soil was taken from gardens 1 or 2 years out of turf and from older gardens. Most soil was taken from around vegetables, but some was taken from around flowers and a few lawn areas near the garden. Up to three samples were taken for each vegetable in each garden. Over 250 samples were collected from 43 different plants in 25 gardens. Most came from within 30 miles of New Haven and were either from a fine sandy loam or a silt loam, but one garden had a muck soil and another garden had a very fine sandy loam. Three gardens were mulched.

Since addition of organic matter to soil has reduced plant parasitic nematode populations (1, 2, 3, 4, 5, 6) we tested the value of easily available organic matter sources for nematode control in gardens. Soil containing stylet, ring, lance, lesion, and dagger nematodes was mixed with an equal volume of sand (for a reason explained later), then this mixture was mixed with either 5 g of leaf mold or 0.5 g of bluegrass clippings (3 weeks old) per kg of soil (equal to 5 tons and 0.5 t/acre or 222 or 22 lbs/1000 sq. ft. respectively).

Since Miller and Ahrens (10, 11) and others (15, 16) found that marigolds and other plants reduced plant parasitic nematode populations, soil infested with these nematodes was mixed with an equal volume of soil in which marigolds had grown for 12 weeks. As peppers had reduced stylet nematode numbers, nematode-infested soil was mixed with an equal volume of pepper soil. The fertilizer, urea, has been found to be toxic to nematodes (19), and it was mixed with infested soil at the rate of 200 mg/kg of soil

Table 1. Parasitic nematode populations around several turf grasses and in different bluegrass sods. Number of nematodes/100g soil.

		Stylet	Ring	Dagger	Pin	Lance	Lesion
Lockwood Farm							
Native Grass		7	0	15	0	0	0
Merion bluegrass		35	16	0	16	2	2
Kentucky bluegrass		21	0	21	0	0	0
Creeping red fescue		23	0	151	0	0	1
Chewing fescue		8	0	91	0	0	0
Manhattan ryegrass		7	0	12	1	3	2
Norlea ryegrass		38	1	113	0	29	5
Meyers zoysia		15	3	43	2	16	1
Bluegrass 15 years old		128	88	13			
Bluegrass 12 years old		10				2	20
Bluegrass at Station							
Location	A	450	88			13	
	B	142	88	4	48		
	C	40	8				
	D	4	12	4	2		
	E	450	250		14		
Lawns not on Station grounds							
Bluegrass	H	120	200		42		
Bluegrass	R	56	88		42		
Fescue	M	40	42		56		
Fescue	R	25	17		45	20	

(200 lb/acre or 4.5 lb/1000 sq. ft.). The bean soil, pepper soil, marigold soil, and nematode-infested soil were mixed with an equal volume of sand to keep the nematode populations equal to those soils where two soils were mixed. Each mixture was put into four styrofoam cups holding 350 g each and put in the greenhouse on September 14. One hundred g of soil were removed from each cup after 3 and 6 weeks; nematodes were floated from the soil and live nematodes were counted.

RESULTS

Grass Nursery, 1973. Six different plant parasitic nematodes were found in the grass nursery in 1973 (Table 1): lesion nematodes, grass stylet nematodes, dagger nematodes, lance nematodes, ring nematodes and pin nematodes. Different varieties and types of grasses supported different mixtures of nematodes. A mixture of native grasses and Manhattan ryegrass had low populations of all nematodes. Merion bluegrass had moderate populations of dagger, stylet and lance nematodes. Chewings fescue had high populations of dagger nematodes. Creeping red fescue had very high populations of dagger nematodes and moderate populations of grass stylet nematodes. Ring, lesion and pin nematode populations were uniformly low. Norlea ryegrass and Meyers zoysia supported the most lance nematodes.

Bluegrass test areas. In 1975 two of three bluegrass plots at the farm were heavily infested with stylet and ring nematodes and a few dagger nematodes, but the third area had few stylet and dagger nematodes. The age of these plots varied from 6 to 12 years.

Lawn areas. Nematode populations in the Station lawn also varied widely. There was over a 100-fold variation (from 4 to 450) in grass stylet nematode populations and over a 30-fold variation (from 8 to 250) in ring nematode populations. Lance and dagger nematode populations were low and erratic. Pin nematodes were found in only two areas. In samples from four home lawns, stylet and ring nematode populations were high on two bluegrass lawns and low on two fescue lawns. The fescue lawns had high populations of dagger nematodes and moderate populations

Table 2. Increasing growth and yields of beans, tomatoes and peppers by controlling grass stylet, ring and lesion nematodes with a nematicide in a former bluegrass turf and by use of a black plastic mulch.

Nematicide	+/ or —black plastic mulch	Weight of 12 bean plants on July 10 lb.	kg	Ave. yield on 9/15 per bean plot after replanting July 10 lb.	kg	Wt. tomato fruit per plant 9/28 lb.	kg	Ave. # of fruit per pepper plant 8/21 & 9/15
None	—	3[1]	1.4	4.5	2.0	2.8	1.3	19
	+	8	3.7	5.75	2.6	4.5	2.0	23
Phenamphos	—	8	3.7	4.75	2.2	4.2	1.8	20
4.9 Kg/A	+	13	5.8	10.5	4.8	5.9	2.8	21

1/ Average of two plots. Other plots destroyed by rabbits.

2/ Average from four plants from four plots.

of lesion nematodes. Thus stylet and ring nematodes apparently prefer bluegrass lawns and dagger nematodes apparently prefer fescue lawns.

Mulching and control with nematicides. Either controlling stylet and ring nematodes or mulching more than doubled the weight of bean plants and increased tomato yields 50 to 60% (Table 2). Mulching plus nematode control increased yields still more. Nothing increased yields of peppers. In September neither mulching nor nematode control alone influenced bean yields but mulching plus nematode control doubled yields as compared to non-mulched, untreated plots.

Growth of radishes increased 42% in soil treated with phenamiphos. Growth of one corn variety, Butter and Sugar, increased 45% but growth of another corn variety, Golden Beauty, increased 8%. Growth of the bean, variety Tendergreen, increased 21% and growth of a cabbage, variety Golden Acre, increased 3%.

Populations in Gardens. Many different nematodes were found in gardens (Table 3). Newer gardens tended to have more nematodes than older gardens. Nematodes were found on over 40 plants. Stylet nematodes were the most common, occurring in 37 of 48 crops. Lesion nematodes were found on 25 crops. High populations of dagger nematodes were found in two samples of soil from squash in a new garden and in turf, but were scarce in established gardens. Spiral nematodes were common in some turf but scarce in gardens. Ring nematodes were common in newer gardens around pepper, squash, cucumber, bean and chives, but were scarce in older gardens. They were abundant around roots of lettuce in older gardens and

Table 3. Plant parasitic nematodes found in survey of new and old gardens, showing the number and types of nematodes in 100g of soil. The number in parentheses is the number of samples.

	LESION		STYLET		DAGGER		SPIRAL		RING		LANCE		PIN	
PLANT[1]	New	Old	New	Old	New	Old	New	Old	New	Old	New	Old	New	Old
Tomato	4(2)	11(2)	25(3)	6(3)	20(1)	0(2)		4(1)	19(4)	9(7)		0(2)		0(3)
Yellow tomato		0(1)		0(1)		0(1)		0(1)		0(1)		0(1)		0(1)
Corn	12(2)	2(2)	10(2)	58(2)	12(1)									
Pepper	6(2)	2(9)	7(3)	4(7)		4(8)			48(3)	0(6)	10(1)	4(7)	20(1)	0(6)
Eggplant	24(1)	4(1)	20(1)	20(1)	16(1)									
Hot peppers			20(1)											
Potatoes		4(2)		11(3)		0(1)		0(1)		21(2)		0(1)		0(1)
Beans	8(1)	8(1)	22(2)	25(9)					27(2)	11(6)		54(6)		
Yellow wax										6(1)				
String beans	4(1)	0(1)	28(1)	0(1)		0(1)		0(1)		0(1)		0(1)		0(1)
Lima beans		4(1)		8(1)										
Soybeans			32(1)											
Squash	6(1)		30(1)	30(3)	142(2)				37(2)	12(1)				
Cucumber		5(6)	16(1)	1(3)		0(2)		0(2)	36(1)	0(2)		10(5)		24(6)
Pumpkin		4(1)												
Muskmelon			9(2)											
Broccoli	32(1)		9(2)	6(2)										
Cabbage		3(3)	12(1)	0(2)		0(2)		0(2)		1(3)		16(3)		0(2)
Cauliflower			8(1)											
Kale		12(1)		8(1)										
Carrots	0(1)	12(1)	4(2)	20(1)		0(3)		0(1)	6(1)	0(1)		12(3)		0(1)
Lettuce	20(1)	36(1)	12(2)	14(1)						114(1)				
Chives	20(1)	11(2)	56(1)						28(1)					
Onion				10(2)								16(1)		
Turnips			4(1)							24(1)				
Rhubarb	20(1)	48(1)												
Parsley			63(1)											
Asparagus	12(1)	4(1)		4(1)										
Strawberries	8(1)		6(2)						4(1)					
Lawn area around gardens	13(2)		37(10)		54(4)			55(3)			175(7)	23(4)	23(4)	

[1]Plants with no or very low counts of all nematodes not included.

in lawns. Lance nematode populations were usually low or nonexistent in newer gardens but were found in older gardens. Grass had more lance nematodes than any plant except beans and some were found around roots of cabbage, carrots and onions. Cucumber and turf had moderate pin nematode populations. Rhubarb and strawberries had very low pin nematode populations but these nematodes were very scarce or not found in other soil samples.

Organic matter and other substances. Organic matter, urea and nematoxic compounds from plant roots reduced nematode populations within 6 weeks (Table 4). Grass clippings were by far the most effective soil additive. They reduced lesion, stylet, and ring nematode populations by 95% and lance nematode populations by 85%. Leaf mold reduced these four nematodes by approximately 70%. Marigold soil reduced populations of stylet and ring nematodes approximately 80%, lesion nematodes 65% and lance nematodes 50%. Pepper root exudate suppressed stylet and ring nematodes approximately 70 to 75% and lesion nematodes 54%. Pepper soil had no influence on lance nematode populations. Urea reduced stylet, ring and lesion nematode populations approximately 55% and reduced lance nematode populations 43%.

Marigolds growing in the greenhouse reduced populations of grass stylet nematode 32%, tobacco stylet nematode 5%, lance nematode 72%, lesion nematode 75%, and tobacco cyst nematode 15%. Dagger nematodes did not persist on either marigold or tomato.

DISCUSSION

There was a wide variation in nematode populations among the turf samples, within different varieties of the same grass and in closely spaced areas containing the same grass. Often grass had high populations of plant parasitic nematodes but appeared uninjured. Grass may not show injury until roots are unable to supply the needed water during dry weather. The Station lawn was growing well in 1975 until a dry spell combined with high temperatures killed the grass in sunny areas. Grass in shaded areas showed no injury. High populations of stylet, ring and lance nematodes were found in soil around the grass roots in both sunny and shaded areas.

Although nematodes may not appear to injure fast-growing roots, they may cause severe injury to some vegetables in a garden made from the turf area. The ring nematode and stylet nematode have not been reported frequently in vegetable fields. In field and greenhouse tests both stunted plant growth without producing visible root symptoms. The grass stylet nematode and the tobacco stylet nematode were the most common nematodes in home gardens. Yet we do not know how injurious they, alone or with ring nematodes, are to most vegetables. The tobacco stylet nematode reduces height of tobacco only 5 to 10% (unpublished data). It reduces growth of Pennlawn fescue 15% and annual ryegrass 25% but does not reduce growth of bluegrass (unpublished data). Dagger nematodes like fescues, which are the major components of shady grass seed mixtures. Bluegrass also may have some lesion nematodes around its roots. Lesion nematodes attack many vegetables and flowers, injuring some of them severely.

High populations of plant parasitic nematodes were carried over into the gardens made from the turf, but some nematodes did not persist more than 1 or 2 years. New gardens had higher populations than old gardens. Ring and dagger nematodes were scarce in old gardens. It may be that ring and dagger nematodes have a limited host range and are unable to persist with the rotation of vegetables normally planted. Per-

Table 4. Biological control of nematodes with leaf mold, grass clippings and other soil additives 3 and 6 weeks later. Type of nematode and No./5 oz. of soil.

Additive	Stylet		Ring		Lesion		Lance		Dagger	
	3 wks	6 wks	3 wks	6 wks	3 wks	6 wks	3 wks	6 wks	3 wks	6 wks
None	92[1]	82	82	87	38	28	45	28	24	18
Marigold soil	19	12	36	18	19	10	14	14	14	10
Pepper soil	26	32	32	20	20	12	18	26	10	8
Bean soil	56	62	60	68	32	24	44	42	21	18
Leaf mold/10T	36	28	25	30	18	9	10	8	9	7
Grass clippings/1 T	15	4	7	4	4	2	5	4	6	5
Diluted bean soil	15	28	60	56	20	14	8	8	3	0
Diluted pepper soil	15	16	8	22	4	3	18	22	0	0
Diluted marigold soil[2]	0	0	0	0	0	0	0	0	0	0
Urea 200 lb/acre	36	36	28	31	15	12	6	16	4	2

[1] Average number of 4 samples.

[2] Marigolds planted originally in sterile soil.

haps they are less able to withstand winter conditions in the absence of host roots in a garden whereas they have host roots in a turf area during the winter. Still, ring nematodes resisted freezing in recent laboratory tests.

Control of plant parasitic nematodes in a garden poses problems. Chemical control is difficult because toxic nematicides cannot be purchased by the homeowner. Therefore biological control methods must be used. We and others (1, 2, 3, 4, 5) found organic matter helps keep parasitic nematode populations low. Grass clippings and leaf mold reduced lesion, stylet, ring and lance nematode populations in this study. We have found that a grass clipping mulch kept lesion nematode populations low (unpublished data). However, grass clippings may injure a garden if taken from a lawn recently treated with a herbicide.

Marigolds reduced plant parasitic nematode populations as in previous tests (10). In this work the lesion nematode was controlled for 3 years, but tobacco stylet nematode was controlled for only 1 year. Soil in which marigolds had grown for 4 months reduced ring, stylet, lesion and lance nematode populations in greenhouse tests.

For most efficient control of nematodes, marigolds may be grown in a different location each year. Then nematode-sensitive crops can be planted where marigolds grew the previous season.

Small amounts of nematode-free soil can be obtained by placing soil in a freezer. We found that 48 hours exposure to -10°C (14°F) killed all stylet, ring, lesion, lance, dagger, pin, spiral and rootknot larvae in soil (unpublished data). These include all nematodes usually found in gardens.

SUMMARY

New gardens are more likely to have nematode problems than old gardens. Even in old gardens individual crops may have nematode injury. Methods which reduce nematode injury in gardens include planting of marigolds and addition of organic matter to soil, particularly grass clippings. Rotation of crops in a garden probably would help keep populations at a lower level. Freezing can be used to provide nematode-free soil in small amounts.

LITERATURE CITED

1. Duddington, C. L., F. G. W. Jones, and F. Moriarity. 1956. The effect of predacious fungi and organic matter upon the soil population of a beet eelworm *Heterodera schachtii*. Nematologica *1*:344-348
2. Hutchinson, M. T., J. P. Reed and D. Pramer. 1960. Observations on the effects of decaying organic matter on nematode populations. Plant Dis. Reptr. *44*:400-401.
3. Johnson, L. F. 1959 Effect of the addition of organic amendments to soil on root knot of tomatoes. Plant Dis. Reptr. *43*:1059-1962.
4. Linford, M. B., F Yap, and J. M. Oliveira. 1938. Reduction of soil populations of the root-knot nematodes during decomposition of organic matter. Soil Science *45*:122-140.
5. Mai, W. F., H. W. Crittenden, and W. R. Jenkins. 1963. Distribution of stylet-bearing nematodes in the Northeastern United States. N. J. Agr. Exp. Sta. Bull. 795.
6. Mankau, R. 1962. The effects of some organic amendments on a soil nematode population and associated natural enemies. Nematologica *7*:65-73.
7. Marks, F., J. L. Townshend, J. W. Potter, T. H. A. Olthof, and H. A. Cornelise. 1971. Plant-parasitic nematode genera associated with crops in Ontario in 1970. Can. Plant Dis. Jour. *51*:127-128.
8. Miller, P. M. 1957. A method for the quick separation of nematodes from soil samples. Plant Dis. Reptr. *41*:194.
9. Miller, P. M. 1968. The susceptibility of parasitic nematodes to subfreezing temperatures. Plant Dis. Reptr. *53*:191-193.
10. Miller, P. M., and J. F. Ahrens. 1969. Influence of growing marigolds, weeds, two cover crops and fumigation on subsequent populations of plant parasitic nematodes and plant growth. Plant Dis. Reptr *53*:642-646.
11. Miller, P. M. and J. F. Ahrens. 1969. Marigolds — a biological control of meadow nematodes in gardens. Conn. Agr. Expt. Sta. Bull. 701.
12. Miller, P. M. and J. L. McIntyre. 1975 *Tylenchorhynchus claytoni* feeding on tobacco roots inhibits entry of *Pratylenchus penetrans*. (Abst.) J. of Nem. *7*:327.
13. Miller, P. M. and P. E. Waggoner. 1963. Interaction of mulch, pesticides and fungi in the control of soil-borne nematodes. Plant and Soil. *18*:45-52.
14. Olthof, H. A. and J. W. Potter. 1973. The relationship between population densities of *Pratylenchus penetrans* and crop losses in summer-maturing vegetables in Ontario. Phytopathology *63*:577-582.
15. Oostenbrink, M. 1960. *Tagetes patula* L. als voorurucht van enkels land-en tuinbouwgenwassen op sand-en dalgronce. Meded. Landbhogeschool Hogesch Gent. *24*: 1065-1075.
16. Oostenbrink, M., K. Kuiper, and J. J. s'Jacob. 1957. *Tagetes* als feindplanzon von Pratlylenchus Arten. Nematologica. Suppl. *2*:424-433.
17. Waggoner, P. E., P. M. Miller and H. C. DeRoo. 1960. Plastic mulching, principles and benefits. Conn. Agr. Expt. Sta. Bull. 634.
18. Taylor, A. L. and W. Q. Loegering. 1953. Nematodes associated with root lesions of abaca. Turrialba *3*:NS:8-13.
19. Walker, J. T., C. H. Specht, and S. Mavrodineau. 1967. Reduction of lesion nematode populations in soybean and soil-amended soils. Plant Dis. Reptr. *51*:1021-1025.
20. Watson, J. R. 1944. Mulches to control root-knot. Proc. Florida Acad. Sci. *7*:151-153.

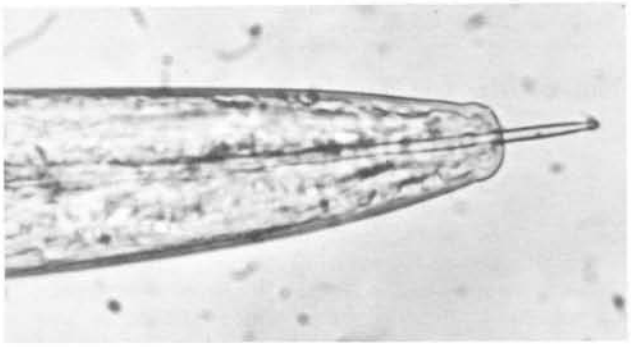


Figure 6. *Xiphinema americanum — dagger nematode stylet or feeding tube.*

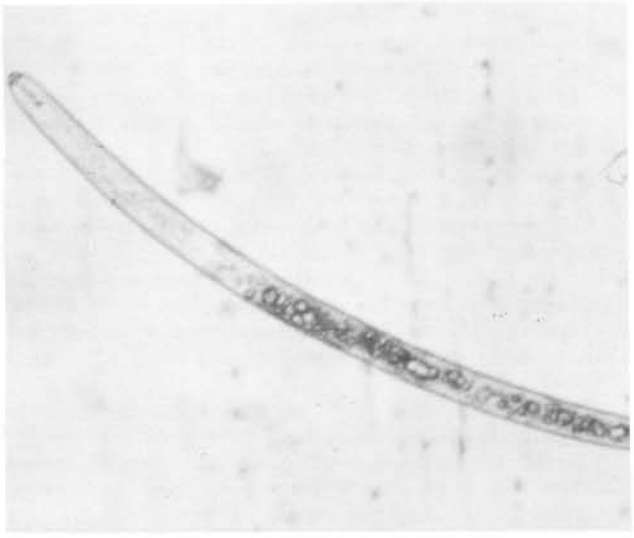


Figure 7. *Heterodera tabacum — tobacco cyst nematode.*

Figure 8. *Paratylenchus hamatus — pin nematode.*

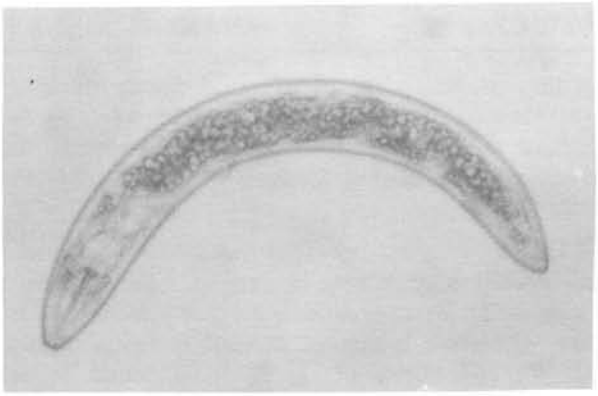


Figure 9. *Crionemoides xenoplax — ring nematode.*

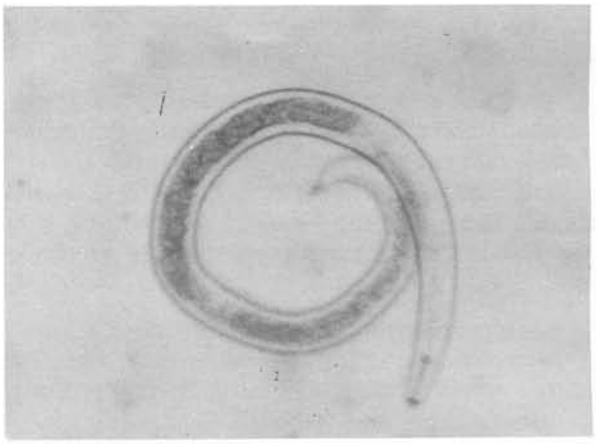


Figure 10. *Helicotylenchus sp. — spiral nematode.*

(Figures 1 through 9 are from Ektachrome photomicrographs taken by Saul Rich, Figure 10 was taken by the author).