DISTRIBUTION OF PLANT-PARASITIC NEMATODES IN FIELD CROP SOILS OF SOUTHWESTERN AND CENTRAL ONTARIO

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Abstract

Pratylenchus, Paratylenchus, Helicotylenchus, Tylenchorhynchus, Meloidogyne and Heterodera are widely distributed throughout Southwestern and Central Ontario. The first three genera occur more frequently than the last three. Xiphinema and Criconemoides also occur infrequently in field crop soils. Pratylenchus neglectus is a cereal and forage parasite whereas P. penetrans is a fruit and tobacco parasite. Pleloidogyne hapla, Heterodera trifolii, Helicotylenchus digonicus, and Helicotylenchus canadiensis are chiefly forage parasites. Heterodera avenae, H. schachtii, and P. penetrans were probably introduced into the province. The distribution of H. avenae and H. trifolii is related to watersheds.

Introduction

Previous studies of the distribution of plant parasitic nematodes in Ontario were usually part of a research program concentrating on a single crop grown in a relatively limited area. Celery, strawberry, tobacco, wheat, and peach are grown primarily in a few southern counties near Lake Erie and Lake Ontario. The root-rot and replant problems of these crops (3, 9, 10, 16, 17) are caused by only two congeneric species of nematodes. Consequently, research emphasized the distribution of these nematodes in the locales where the host crops were grown. Likewise a number of other surveys (7, 12, 13, 14, 19, 22) were similarly oriented toward single nematode species or involved intensive sampling for nematodes on a specific host in a fairly restricted area. While such distribution studies were essential to the research program of which they were a part, still the helminth fauna of much of the agricultural land of Ontario remained unknown. This paper complements our present knowledge of the general distribution of genera and species of plant-parasitic nematodes in Ontario and demonstrates some influences of host crop on the frequency of occurrence and abundance of certain species.

Methods

Using highway and soil association maps, a sampling route was established which permitted the uniform sampling of the major agricultural areas of Southwestern and Central Ontario. Southwestern Ontario refers to Southern and Western Ontario as designated by the Ontario Agricultural Statistics Publication 20 (1). In Central Ontario (1) the sampling route included only Durham, Ontario, Victoria, and York counties. Automobile odometer readings relative to selected reference points, usually towns, were used to locate sampling sites every 5 miles along the route. Minor deviations from the 5-mile interval occurred only for the lack of a crop or the presence of non-arable land. The sampling was accomplished with field trips in June, July, and August, 1967.

Ten cores of soil 2.5 x 20 *cm* were taken with a probe through the root systems of randomly selected plants in a field at each sampling site. These cores were bulked in a 1-kg sample. The samples were stored immediately in portable Styrofoam coolers with refrigerant packs and later stored in the laboratory at 4.5 C until processed, usually within a week. Location, crop, condition of crop, soil type, soil moisture, and soil temperature were noted at each sampling site.

In the laboratory, two 50-g soil portions were removed from each 1-kg sample after thorough mixing. From one 50-g portion, migratory nematodes were extracted for 1 week by the Oostenbrink direct cotton-wool filter method (18). The other 50-g portion was air-dried and cysts were extracted by the Fenwick can method (4).

Migratory plant-parasitic nematodes were identified to genus and counted at 50X magnification in a water suspension. These nematodes were then killed by adding an equal

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volume of boiling water and nreserved in 4% formalin. To prepare slides for species identification, the fixed nematodes were transferred to lactophenol for 2 weeks and mounted in the same medium. Cysts were oreserved in 2% formalin and later identified at the Entomology Research Institute, Agriculture Canada, Ottawa.

The locations at which the various qenera and species of the major plant-parasitic nematodes occurred on the authors' field trips were plotted on maps of Southwestern Ontario. Points off the highways were from the authors' unpublished records and were plotted only to clarify the pattern of distribution of certain species. Where sufficient nematodes were present to permit species identification, the species were named on the maps; otherwise, "sp." was used to indicate the presence of the genus at a sampling location. At some locations two or more species of a genus were found. Also at some locations several crops or mixtures of crow were sampled. For example, barley and oats occurred as mono-specific stands at some locations and as mixed qrain crops at others. Where such a mixed grain crop occurred, it was designated "b,o" on the maps. Thus, a sample designated "m, pe/b, o,w" would indicate species "m" and "pe" on a mixed grain crop (barley "b" and oats "o") in one field and on wheat "w" in another field.

Results and discussion

Plant-parasitic nematodes were extracted from 291 survey soil samples, mostly from corn (Zea mays L.) (76 samples), foraqe [usually alfalfa (Medicago sativa L.) or red clover (Trifolium pratense L.) plus timothy (Phleum nratense L.), bromeqrass (Bromus inermis Leyss.), or orchardqrass (Dactylis glomerata L.)] (39), winter wheat (Triticum aestivum L.) (37), barley (Hordeum vulgare L.) (5), oats (Avena sativa L.) (60), and mixed grains (barley & oats, 48). The remaining 26 survey samples (9%of the total number) were from beets (Beta vulqaris L.), carrots (Daucus carota L.), celery (Apium graveolens L.), potatoes (Solanum tuberosum L.), peas (Pisum sativum L.), rutabaqas (Brassica napobrassica [L.] Mill.), rye (Secale cereale L.), soybeans (Glycine max. [L.] Mers.), tobacco (Nicotiana tabacum L.), and tree- and small-fruits. Eight genera of plant-parasitic nematodes were commonly encountered in the samples.

In assessinq orevalence of plant-parasitic nematodes, we used two different measures of occurrence: frequency, i.e. the percentage of samples containing a qiven genus or species of nematode regardless of the number of nematodes in each sample; and abundance, i.e. the numbers of a given genus or species in an infested sample.

Lesion nematodes, Pratylenchus spp., were present in 95% of the samples; sniral nematodes, Helicotylenchus spp., in 72%; pin nematodes, Paratylenchus spp., in 65%; stunt nematodes, Tylenchorhynchus spp., in 32%; root-knot nematodes, Meloidogyne spn., in 16%; cyst nematodes, Heterodera spp., in 16%; dagger nematodes, Xiphinema spp., in 11%; and ring nematodes, Criconemoider spp., in 4%.

Five species of Pratylenchus were identified from the survey samples. Of these, P. thornei Sher & Allen was found twice and P. pratensis (de Man) Filipjev once, both species on corn; consequently these species are considered to be infrequent or rark in Ontario (Fig. 1). P. crenatun Loof and P. penetrans (Cobb) Chitwood & Oteifa were more frequently encountered. occurring sporadically on cereal qrains and foraqe, and in the case of P. penetrans, on tree- and small-fruits and tobacco. P. neqlectus (Rensch) Chitwood & Oteifa was the most frequent lesion nematode species in corn, foraqe, wheat, barley, oats, and mixed grains soils, representing 55-60% of the lesion nematodes identified from these crops. Lesion nematodes were more abundant on corn (average 2400/kg of soil), foraqe (1900/kg), wheat (1500/kg), oats (1500/kg), mixed qrains (1300/kg) and barley (1200/kg) and less so on the other crops (800/kg). As P. neqlectus was the lesion nematode most frequently found, it is apparently a cereal and foraqe parasite, and probably indigenous to Ontario. It is rarely found in fruit-qrowinq areas (10, 17, 19), where P. penetrans seems to occur more frequently; also P. penetrans is more prevalent in tobacco areas (9, 12).

The only species of the pin nematode, Paratylenchus, identified was P. projectus Jenkins. This nematode was also wide-spread in Ontario (Fig. 2) althouqh it was less frequent in our survey samples than the lesion nematodes. The pin nematode occurred in 88%of mixed grain, 85%of forage, 82%of oats, and 80%of barley samples, but in only 49% of wheat and 36%of corn samples. It was most abundant in foraqe samples (760/kg of soil), less abundant in wheat (640/kg), mixed grain (600/kg), oats (520/kg), and barley (500/kg), and least abundant in corn (320/kg). Tne frequent occurrence and abundance of the pin nematode in foraqe samples and those of cereal grains (mixed grains, oats, barley) often underseeded to forage may be a reflection of host preference; Townshend (20) has observed that timothy, a common forage component, is a favorable host for this nematode.

The spiral nematodes, Helicotylenchus spp., had a wide distribution (Fig. 3), mostly in the Western and Central regions from Sarnia to Hamilton north to Georgian Bay and Lake Simco. Three species of spiral

nematodes, H. digonicus Perry, H. canadensis Waseem and H. pseudorobustus (Steiner) Golden, were identified. Spiral nematodes occurred frequently in barley samples (100%), mixed grains (94%), oats (87%), forage (80%), and corn (65%) samples and least often in wheat (38%). They were most abundant in forage (1900/kg of soil), followed by mixed grains (1400/kg), corn (1300/kg), oats (820/kg), wheat (780/kg), and barley (480/kg). As with the pin nematode, the number of spiral nematodes in forage soil may be a reflection of host preference, as Townshend (20) also found alfalfa to be a favorable host for H. digonicus.

Stunt nematodes, Tylenchorhynchus spn., were widely distributed in the province (Fig. 4) in geographic terms. However, this genus was not found freauently as only 32% of samples contained it, nor was it especially abundant. The highest averaqe number was under wheat (540/kg) and the least under oats (160/kg). Two species, T. claytoni Steiner and T. nudus Allen were identified.

The northern root-knot nematode, Meloidogyne hapla Chitwood, was broadly distributed (Fig. 5) but infrequently encountered; the highest frequency of occurrence was in forage (33%), and slightly less in mixed grains (21%) and oats (18%). The frequency of occurrence in forage might have been higher than 33% had a bioassay been used in conjunction with the other detection methods. In a subsequent survey, the authors found that use of celery as the host in a bioassay doubled the number of fields identified as containinq root-knot nematode (Townshend, Willis, Potter, and Santerre, Can. Plant Dis Surv., in press). As grasses and cereals are not known to be hosts (5), the occurrence of this nematode in oat and mixed grain samples probably is a result of parasitizing the underseeded foraqe lequmes. In corn and wheat, the root-knot nematode may be parasitizing weeds (21).

The cyst nematodes, Heterodera spp., were found throughout the sampled area (Fig. 6). Three suecies, H. avenae Wollenweber, H. schachtii Schmidt- and H. trifolii Goffart were identified. The oat-cyst nematode, H. avenae, and clover-cyst nematode, H. trifolii, were mainly found in the Trent, Grand, Maitland, Thames, and Welland River watersheds, often within a half-mile of a creek or river. H. avenae was probably introduced into Ontario, as it has not been found in the northeastern (8), north central (11) or northern great plains (15) regions of the United States, while H. trifolii is widespread in these areas. H. avenae was present in 25% of oats, 23% of mixed grains, and 20% of barley soil samples but only 8% of wheat samples. The nematode was most abundant in oats (520 larvae/kg of soil) and least in wheat (100/kg). Althouqh this nematode can not reproduce on corn (6), 7% of corn soil samples contained the nematode. Because of the limited host range of H. avenae, these infestations were probably the result of previous cropping to a host cereal grain.

H. trifolii was found in 21% of forage soil samples, at an average of 220 larvae/kg of soil. The sugarbeet-cyst nematode, H. schachtii, was distributed in the province with a hiqh correlation to host crop distribution (Fig. 6), as it was found mainly on rhubarb (Rheum rhaponticum L.) north and west of Toronto. This nematode mav well have been introduced into former sugarbeet-qrowinq areas (2) and later spread on rhubarb roots to the Toronto area as the winter rhubarb forcing industry expanded (22).

The dagger nematode, Xiphinema americanum Cobb, was most frequent in wheat (19%) and corn (18%) soil samples, less freauent in oats (10%) and forage (10%) and infreauent in mixed grains. The greatest abundance of this nematode was in forage, with an average of 140/kg of soil.

The ring nematodes, Criconemoides spp., occurred sporadically in 4% of the cereal and foraqe soil samples. Numbers of these nematodes were insufficient to permit species identification.

Our observations have shown that, in qeneral, those species havinq a broad host ranqe, such as the lesion nematodes, were widesnread and frequentlv encountered, showing little relation to host distribution. Conversely, species having a fairly narrow host range, such as Heterodera avenae, were restricted to fields where the host crops were being grown and consequently were less frequently found. One exception to this generalization might be the sniral nematodes, Helicotylenchus spp., which have a fairly broad host range, yet were infrequent in wheat soils in Southern Ontario but frequent in foraqe and cereals underseeded to forage in Western and Central Ontario. Another exception could be the pin nematode, Paratylenchus projectus, where host preference again seemed to influence the distribution of a nematode havinq a fairly broad host range. It can also be noted from the mans that several genera and species of nematodes might occur at a single sampling site. Consequently the interactions of these genera and species with one another and with their resnective preferred hosts become an imnortant aspect of research into cron loss assessment and cultural control of nematodes by crop rotation or host resistance.

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Mulvey, Entomology Research Institute. Agriculture Canada, Ottawa, for Paratylenchus and Heterodera species, respectively.

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Figures 1-6. Distribution in Southwestern and Central Ontario of 1) Pratylenchus, 2) *Paratylenchus*, 3) *Helicotylenchus*, 4) Tylenchorhynchus, 5) *Meloidogyne*, and 6) *Heterodera*.
Note: On all maps sampling sites are designated as: nematode species/host crop(s).

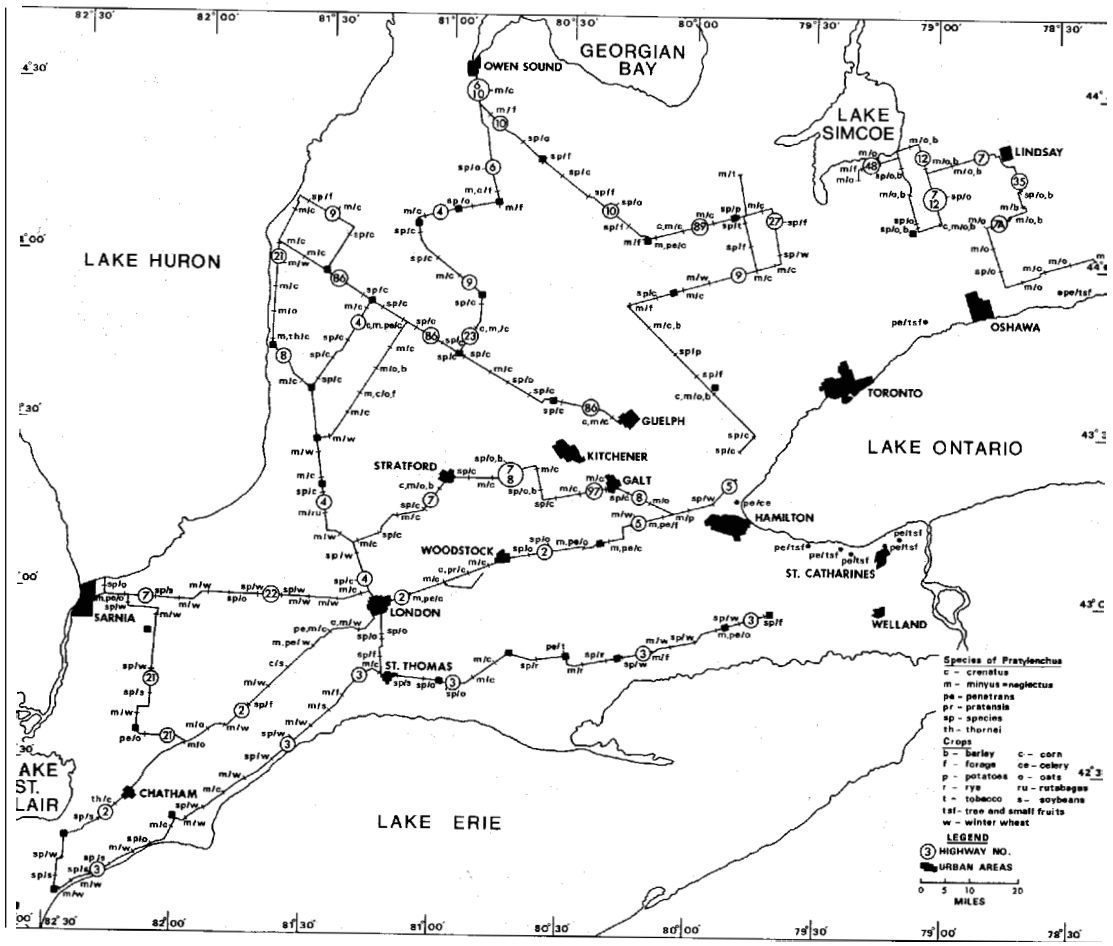

Figure 1 – *Pratylenchus*

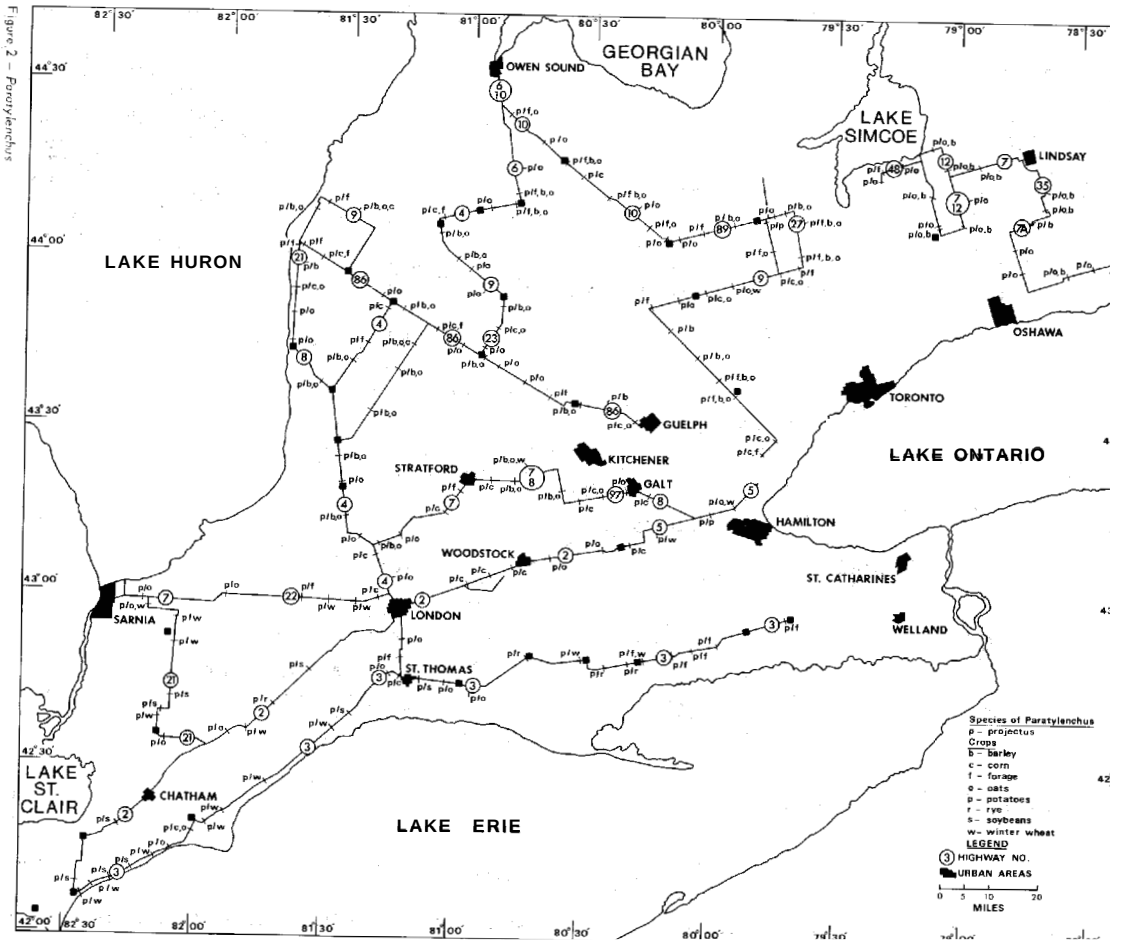

Figure 2 – *Paratylenchus*

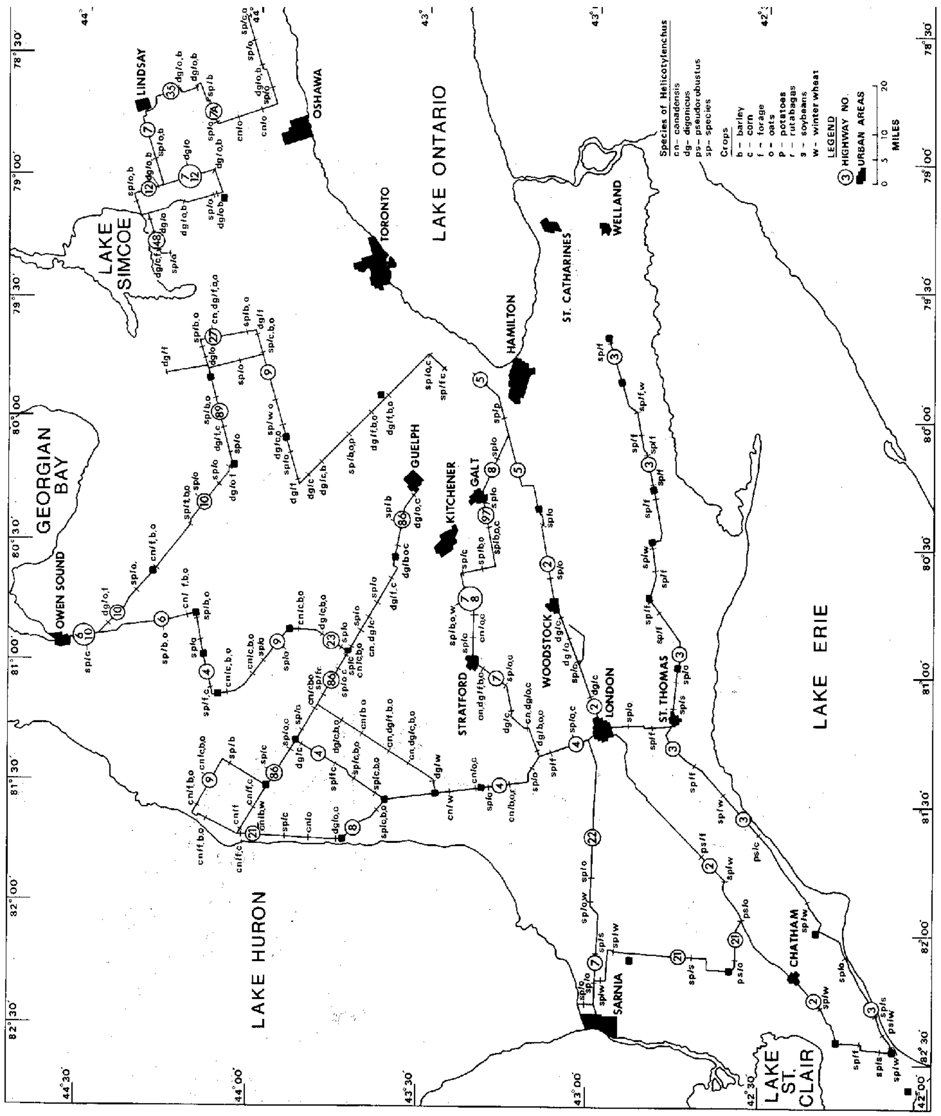

Figure 3 – *Helicotylenchus*

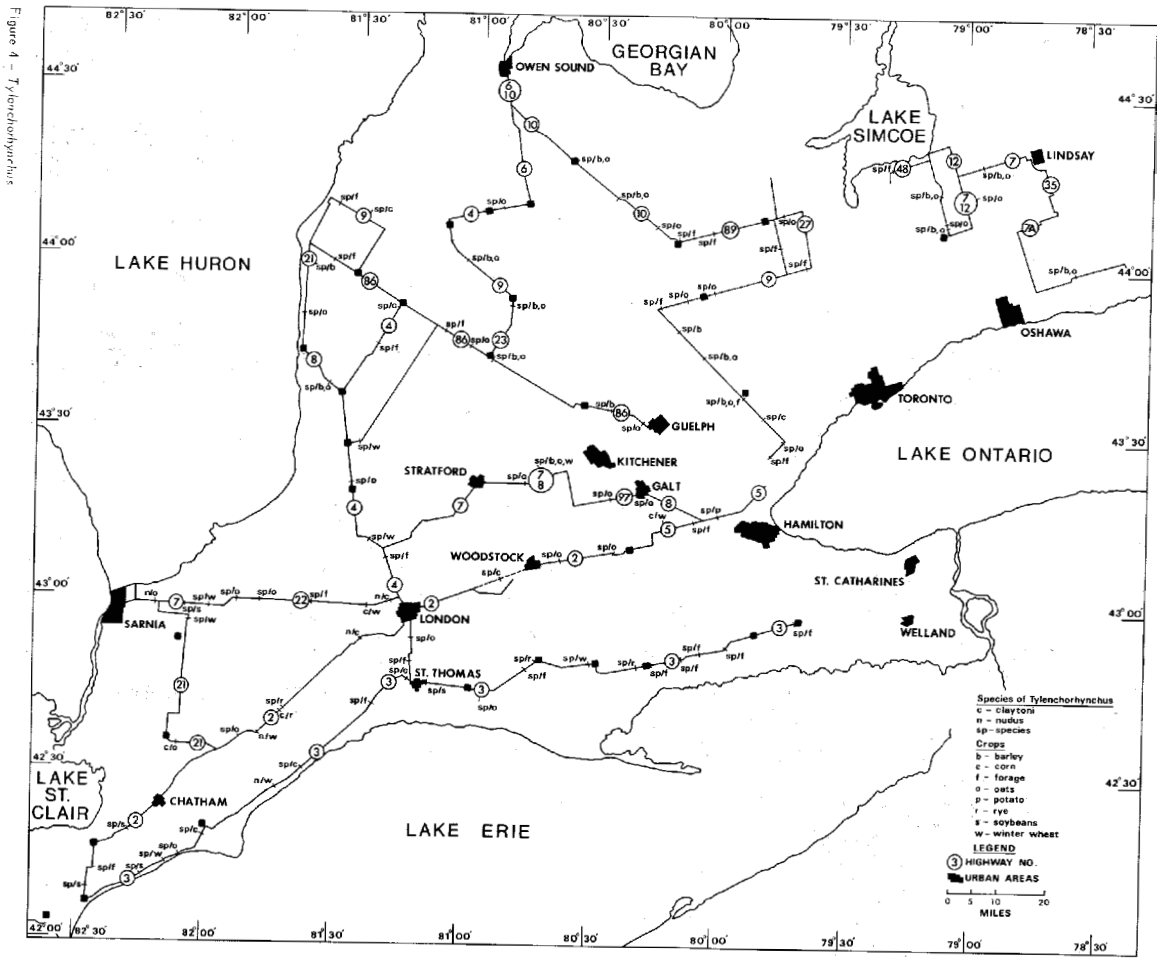

Figure 4 – *Tylenchorhynchus*

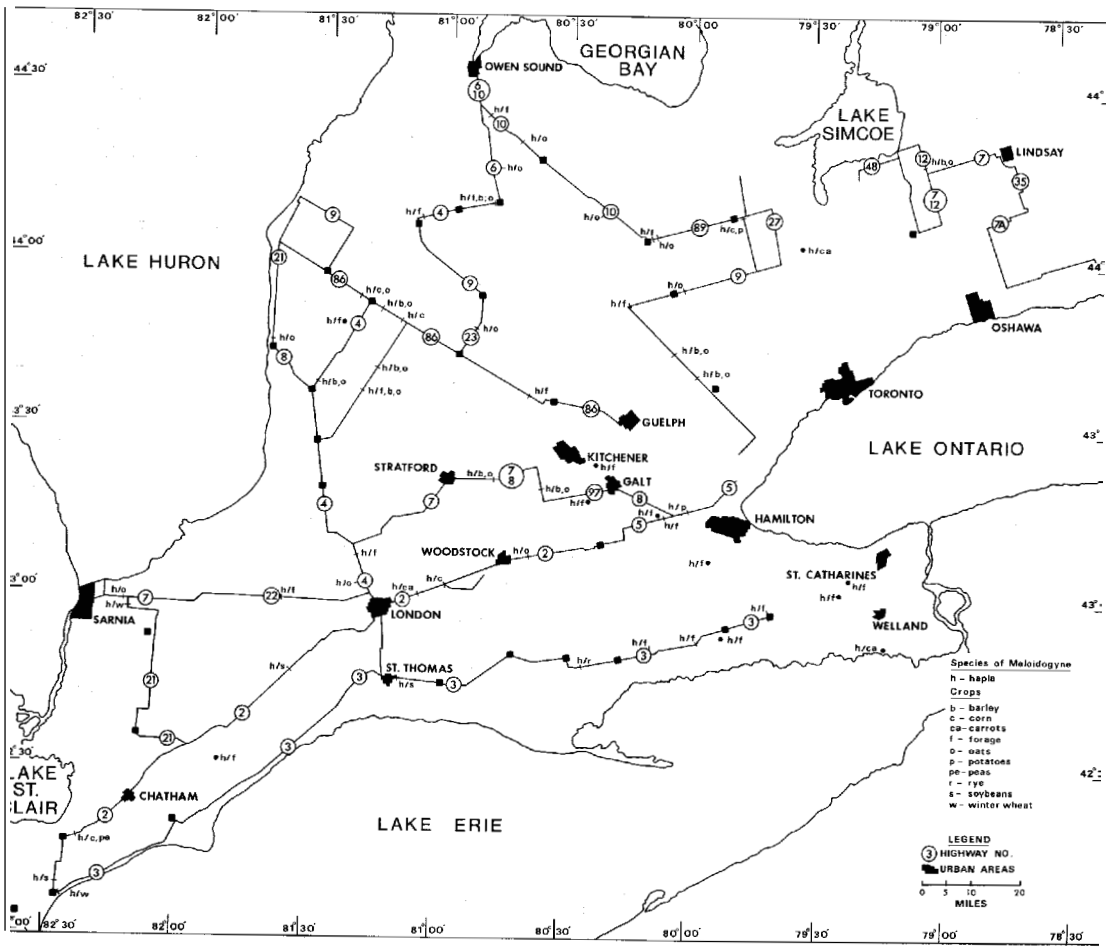
GEORGIAN BAY
OWEN SOUND
LAKE SIMCOE
LINDSAY
LAKE HURON
OSHAWA
TORONTO
GUELPH
KITCHENER
GALT
STRATFORD
LAKE ONTARIO
HAMILTON
WOODSTOCK
ST. CATHARINES
WELLAND
SARNIA
LONDON
ST. THOMAS
CHATHAM
LAKE ST. CLAIR
LAKE ERIE
Species of Meloidogyne
h - hapla
Crops
b - barley
c - corn
ca - carrots
f - forage
o - oats
p - potatoes
pe - peas
r - rye
s - soybeans
w - winter wheat
LEGEND
HIGHWAY NO.
URBAN AREAS
MILES

Fig. 5

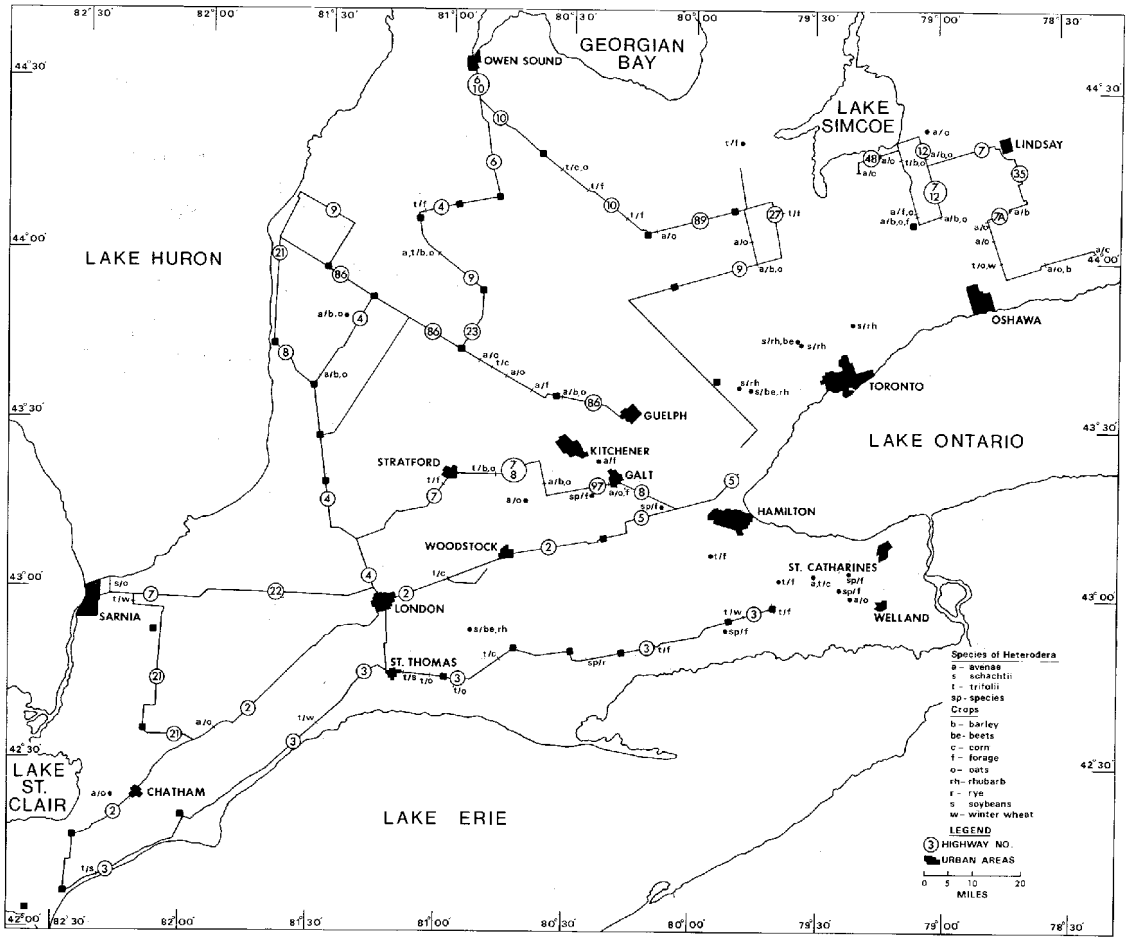

Figure 6 – *Heterodera*