SURVEY AND IDENTIFICATION OF PLANT PARASITIC NEMATODES ASSOCIATED WITH SWEET POTATO AND CASSAVA

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ABSTRACT

A survey of plant parasitic nematodes associated with sweet potato and cassava was conducted during the dry and rainy seasons of 1977 in 30 municipalities in two provinces of Leyte, Philippines. A total of 430 and 275 soil samples were gathered from sweet potato and cassava fields, respectively. Thirteen genera and 22 species of nematodes were identified to be associated with sweet potato; 12 genera and 17 species were associated with cassava. *Rotylenchulus, Meloidogyne* **and** *Helicotylenchus* **were the most prevalent and widely distributed genera. Species of** *Meloidogyne* **were identified mainly by the perineal patterns of egg-laying females. Other nematodes were identified by their size, position of the vulva, number of lip annules, and head and tail region of adult females. In both sweet potato and cassava, the population density and distribution of the different nematode genera varied considerably from one locality to another. The differences may be attributed to such factors as soil type, soil moisture and cropping pattern in the area.**

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INTRODUCTION

The two major root crops in the Philippines are sweet potato (*Ipomoea batatas* Poir) and cassava (*Manihot esculenta* Crantz). These root crops have their main bulk of production mostly concentrated in the Visayas, Mindanao and Bicol regions which account for 40, 24 and 17%, respectively, of the total root crops area (BAEcon, 1973). Among the factors which influence the production of sweet potato and cassava is the effect of diseases on these crops.

The association of plant parasitic nematodes with sweet potato and cassava was observed in surveys conducted by many investigators (Brathwaite, 1972, 1974; Martin, 1967). In the Philippines, a list of plant parasitic nematodes found associated with sweet potato and cassava has already been compiled (Castillo and Maranan, 1974). However, the geographical distribution, prevalence and economic importance of these nematodes have not yet been studied. This study presents the population density, occurrence and distribution of plant parasitic nematodes associated with sweet potato and cassava and the genera and species of these nematodes.

MATERIALS AND METHODS

Survey of Plant Parasitic Nematodes. — Survey and collection of soil samples from sweet potato and cassava fields were conducted in 30 municipalities in Leyte and Southern Leyte provinces during the dry season (March to May 1977) and the rainy season (November to December 1977). A survey sheet adopted from Sasser's IMP Field Sheet was used. During the dry season sampling, 10 soil samples were collected at random from a representative area in each sampling municipality. Five composite soil samples were taken during the wet season. Approximately 500 cc soil sample was collected from about the root zone of each plant down to 20 cm deep. The modified sieving-Baermann funnel method was employed in extracting nematodes from all soil samples.

Counting and Identification of Nematodes. — The nematodes were first killed in bulk by plunging the vials in hot water (65°C) for about three min and then fixed in double strength triethanolamine formalin (TAF).

The population density in each soil sample was determined by counting individual nematodes of the same genus. Nematode suspension was placed in a counting dish and counted as they were identified according to genus under the stereomicroscope. Nematodes were identified mainly by means of their distinguishing morphological characters as described in taxonomic keys (Mai, 1964, 1975; Thorne, 1967; Goodey, 1963; Sher, 1961 and Zuckerman, Mai and Rohde, 1971).

In determining the species, whole mounts of adult specimens of each genus previously fixed in TAF were prepared following the procedure used by Goodey (1963). Species of the root-knot nematodes were identified by examining the perineal patterns made from egg-laying females from galled roots collected during the survey. In the case of soil samples without galled roots, susceptible tomato seedlings were planted and perineal patterns were also prepared from those that developed root-knot infection.

RESULTS AND DISCUSSION

The survey conducted in the two provinces of Leyte (Fig. 1) during the dry and the wet seasons of 1977 resulted in a total collection of 430 and 275 soil samples from sweet potato and cassava, respectively. Table 1 presents the different nematode genera and species identified associated with the root crops surveyed. There were 13 genera and 22 species of nematodes identified associated with sweet potato and 12 genera and 17 species with cassava (Fig. 2 and 3).

On Sweet Potato.

The population densities of plant parasitic nematodes found associated with sweet potato during the dry and wet seasons are shown in Tables 2 and 3. High counts of *Rotylenchulus, Meloidogyne, and Helicotylenchus* occurred during the dry season in Leyte with means of 2,090.6, 488.2 and 143.8 per 300 cc soil from 10 samples, respectively. Likewise, the population density of these nematode genera was highest during the wet season in Leyte with means of 4,250.6, 1,158.2 and 73.2 per 300 cc soil from 5 composite soil samples, respectively. Counts from Alejos, Bato; Besoria, Carigara; Mayorga; and Talisayan, Albuera were also relatively high. Generally, the population densities of the different nematode genera in Southern Leyte were lower compared to those in Leyte. The difference in population density of these nematode genera could be attributed to the type of soil in the locality. For example, Mayorga, Carigara, and Dulag, Leyte have sandy loam soil, where nematodes usually thrive best. Similar findings were reported by Rebois and Cairn (1960) who found high nematode populations in light textured soil than in clay soils. Furthermore, clay soils have generally higher pH which could have indirectly affected the population of nematodes. This finding is very evident in this study because the soil type that exists in

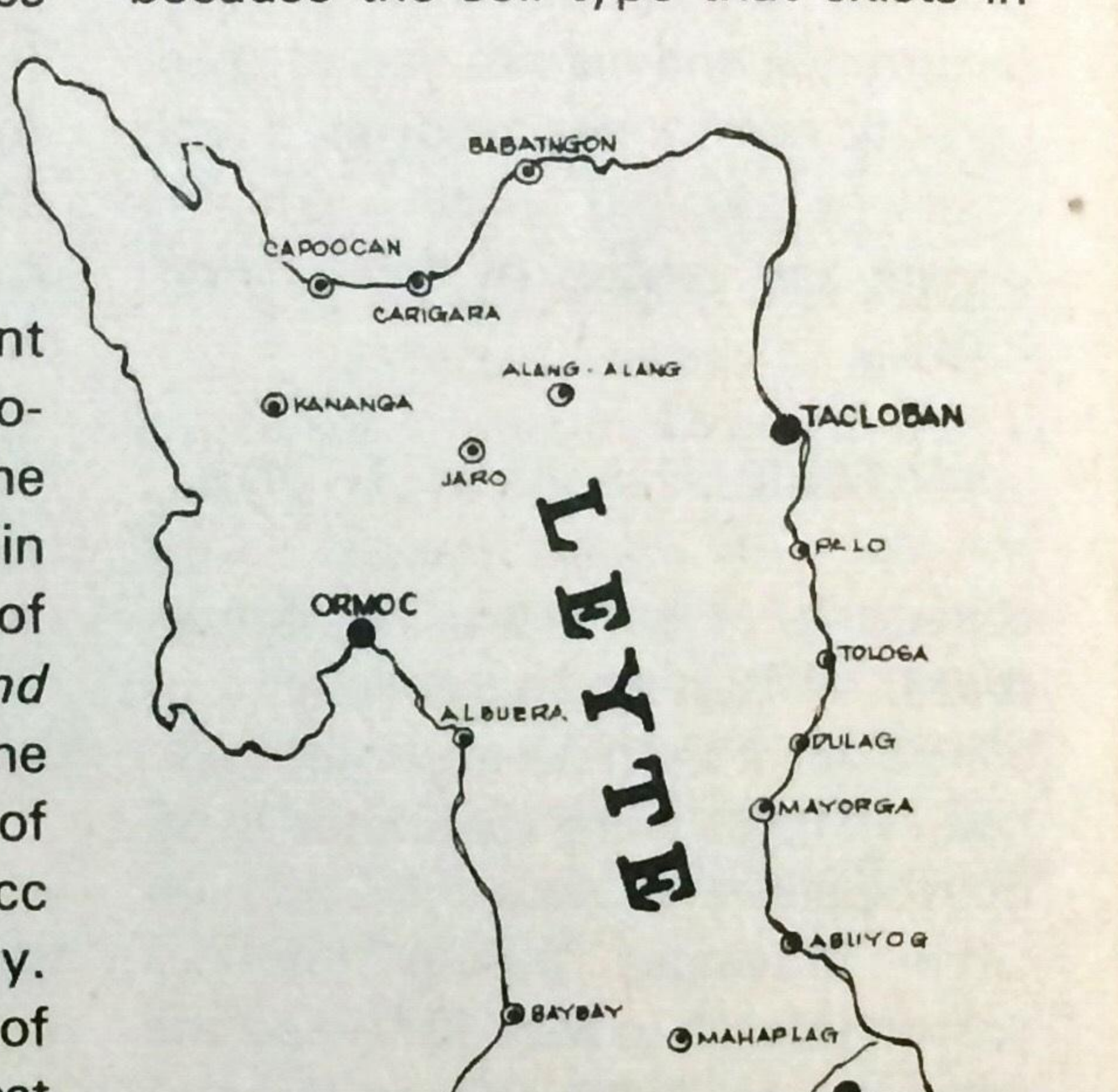

Fig. 1. Map of Leyte island showing the different municipalities surveyed.

Table 1. Nematode genera and species identified associated with sweet potato and cassava in Leyte, Philippines.

Rotylenchulus reniformis Linford and Oliveira, 1940
Meloidogyne incognita (Kofoid and White, 1919) Chitwood, 1949
M. javanica (Treub, 1885) Chitwood, 1949
Helicotylenchus concavus Roman, 1949
H. pseudorobustus (Steiner, 1914) Golden, 1956
H. multicinctus (Cobb, 1893) Golden, 1956
H. dihystera (Cobb, 1893) Sher, 1961
* *H. digonicus* Perry in Perry, Darling and Thorne, 1959
Xiphinema insigne Loos, 1949
* *X. americanum* Cobb, 1913
* *X. elongatum* Schurmans, Stekhoven and Teunissen, 1938
Hemicycliophora gracilis Thorne, 1955
H. penetrans Thorne, 1955
Hoplolaimus seinhorsti Luc, 1958
Pratylenchus zeae Graham, 1951
P. brachyurus (Godfrey, 1929) T. Goodey, 1951
* *P. pratensis* (de Man, 1880) Filipjev, 1936
Tylenchorhynchus martini Fielding, 1956
* *T. dactylurus* Das, 1960
Criconemoides curvatum Raski, 1952
Hemicriconemoides cocophillus (Loos, 1949) Chitwood and Birchfield, 1957
Rotylenchus Filipjev, 1936
Longidorus (Micoletsky, 1922) Thorne and Swanger, 1936
* *Dolichodorus* Cobb, 1914

* Not identified in soil samples from cassava.

Southern Leyte is generally clay, hence, the low population.

The cropping pattern followed in some locality has greatly influenced the population density of nematodes. For example in ViSCA, a very high population of *Rotylenchulus* was observed during the wet season sampling. The area had been planted with sweet potato continuously for one year without any rotation. This confirmed the findings of Nusbaum and Barker (1971) who reported that the frequency of occurrence and densities of most nematodes were influenced by the previous crops. The availability of host plants has an equally important impact on nematode populations (Brodie, *et al.*, 1970; Endo, 1959).

A summary table on the population density, occurrence, and distribution of plant parasitic nematodes on sweet potato is presented in Table 6. Mean population densities of 249.0, 51.7 and 20.3 were observed during the dry season with *Rotylenchulus, Meloi-*

Table 2. Population density of plant parasitic nematodes found associated with sweet potato in different localities in Leyte and Southern Leyte during the dry season.[1]

Locality	Number of nematodes per 300 cc soil[2]					
	Rotylenchulus	*Meloidogyne*	*Helicotylenchus*	*Xiphinema*	*Hemicycliophora*	*Hoplolaimus*
LEYTE						
Abuyog Proper	221.4	4.3	5.4	0.2	0	1.9
Alejos, Bato	623.6	32.1	0.9	0.6	0	0
BPI, Babatngon	0.7	0	0.2	1.3	0	0
Bulacan, Hindang	269.1	0	8.4	0.4	0	0
Caridad, Baybay	399.5	29.4	24.1	0.2	0.2	0
Conalum, Inopacan	370.0	61.6	9.0	0	0	0
Inlatula , Tacloban	57.1	78.7	41.8	8.1	0.2	0
Ipil, Ormoc	516.6	0.7	61.0	0	5.9	0.7
Javier Proper	16.7	94.5	89.1	0.7	18.5	8.6
Kajagnaan, Matalom	12.9	0	0.2	12.2	0	0
Kananga Proper	5.2	2.1	6.7	0	2.3	2.6
Lemon, Capoocan	508.2	91.0	12.0	3.6	0	2.2
Malirong, Palo	5.7	56.1	11.8	2.2	0	0
Mayorga Proper	2090.6	488.2	10.4	0.8	0	1.1
Plaridel, Baybay	8.3	0	1.9	9.6	0	0.2
San Rafael, Dulag	82.6	32.9	143.8	2.7	0.2	0.6
Telegrafo, Tolosa	361.3	80.1	1.4	0.3	6.5	6.4
Tuba, Jaro	47.7	7.7	1.5	0.2	0	0
Uwak, Hilongos	10.9	190.0	1.8	0.2	0	0.8
ViSCA, Baybay	22.6	4.3	14.6	0	0	0.9
SOUTHERN LEYTE						
Himayangan, Liloan	71.8	0	0.1	0.1	0	0.1
Lipanto, St. Bernard	237.0	2.4	37.1	0	0	0.1
Malitbog Proper	70.6	1.2	2.5	0.1	0	0
Nahungid, Libagon	246.9	85.7	15.1	0.3	0	1.0
Panauan, Maasin	214.2	0	16.6	2.6	0	0
Polo, Macrohon	2.2	0.5	9.7	0.2	0	0
TOTAL	**6474.4**	**1343.5**	**527.1**	**46.6**	**33.8**	**26.3**

[1] Mean of 10 soil samples.

[2] Other nematode genera found but with low counts were *Pratylenchus*, *Tylenchorhynchus*, *Longidorus*, *Hemicriconemoides*, *Dolichodorus*, and *Rotylenchus*.

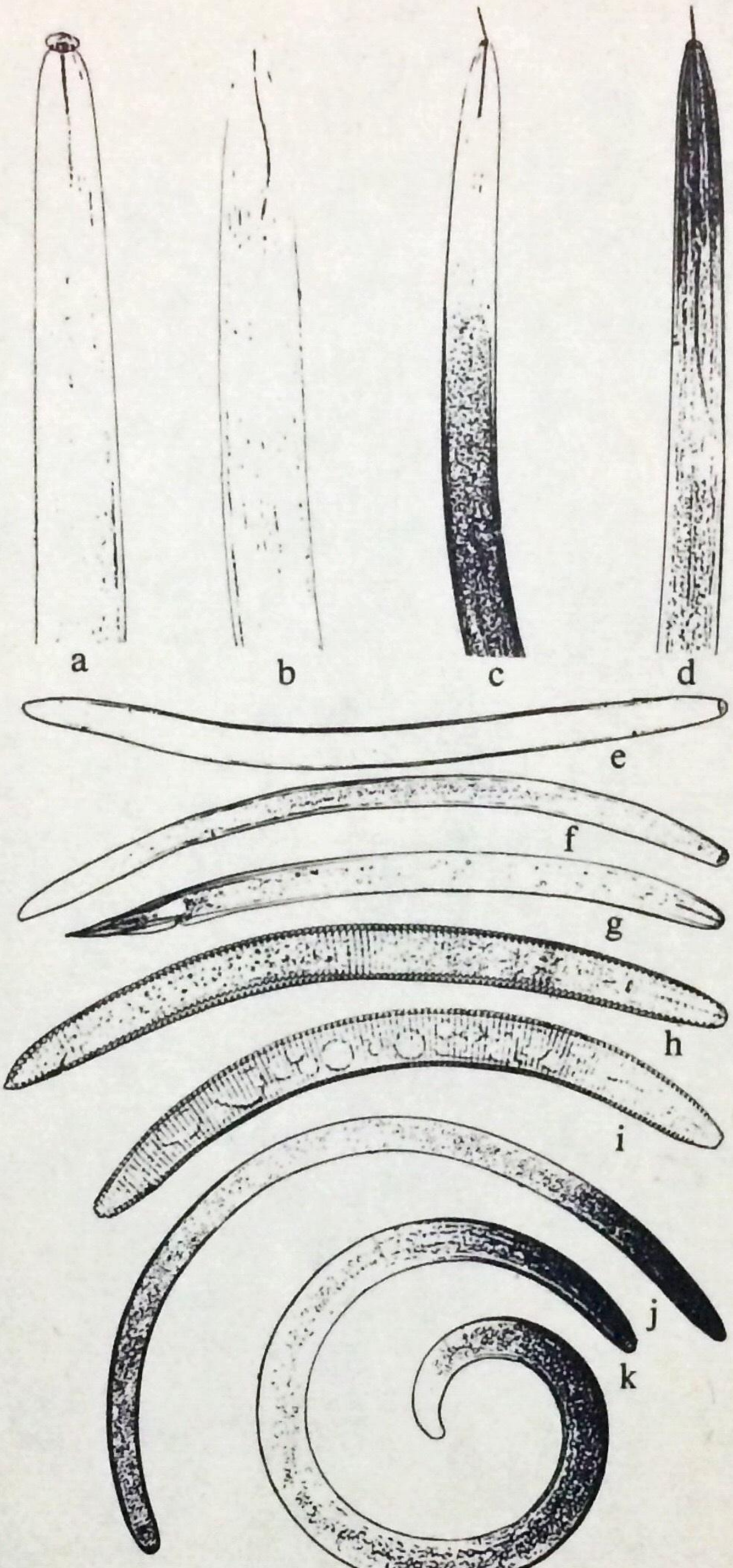

Fig. 2. Photomicrograph of some phytoparasitic nematodes found associated with sweet potato and cassava. Anterior portion of (a) *Dolichodorus* sp., (b) *Longidorus* sp., (c) *Xiphinema ensiculiferum* and (d) *X. insigne;* whole mounts of (e) *Pratylenchus brachyurus*, (f) *P. zeae*, (g) *Hemicycliophora penetrans*, (h) *Hemicriconemoides cocophillus*, (i) *Criconemoides curvatum*, (j) *Hoplolaimus seinhorsti*, and *(k) Helicotylenchus concavus*. (1600 X)

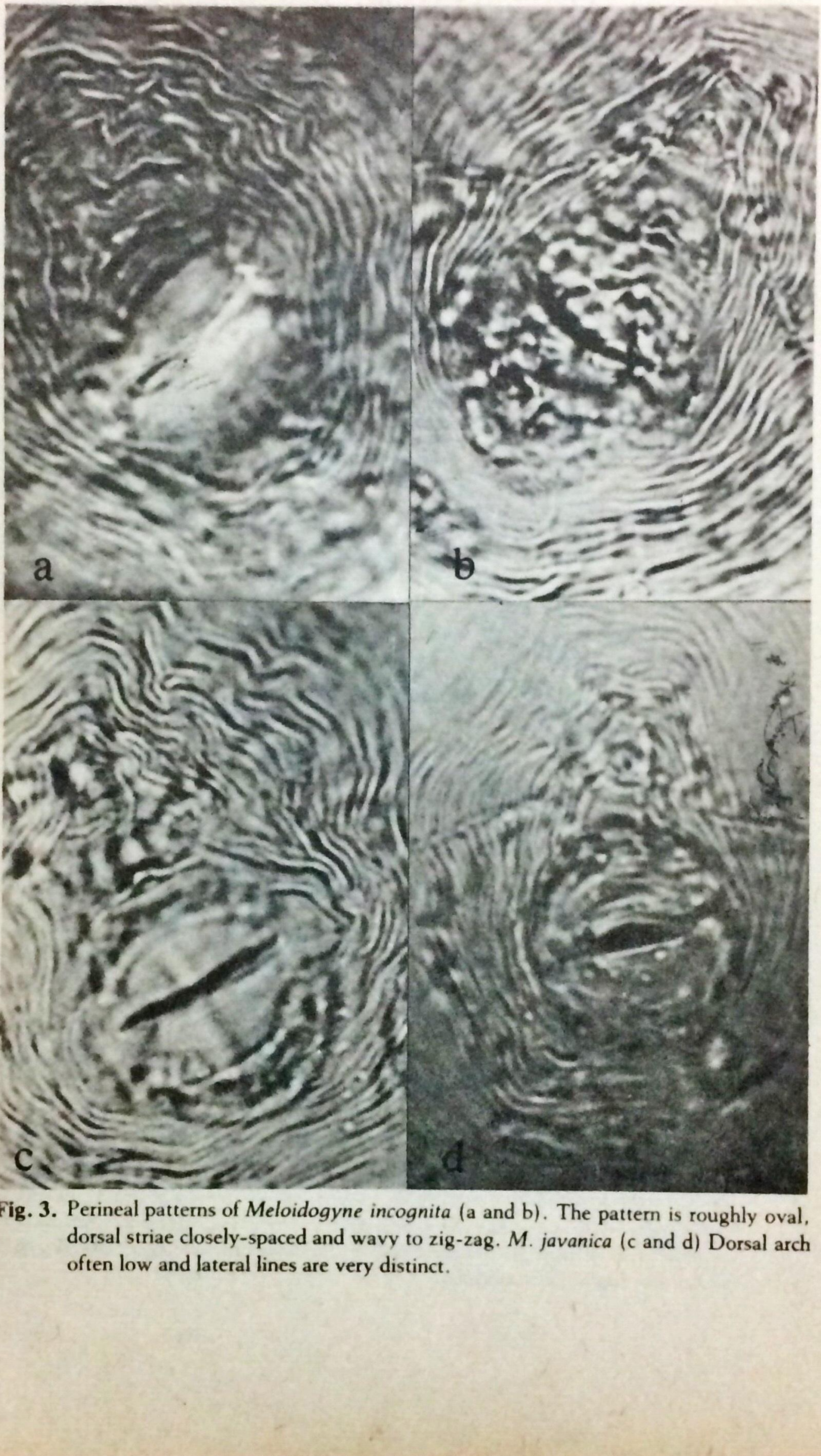

Fig. 3. Perineal patterns of *Meloidogyne incognita* (a and b). The pattern is roughly oval, dorsal striae closely-spaced and wavy to zig-zag. *M. javanica* (c and d) Dorsal arch often low and lateral lines are very distinct.

Table 3. Population density of plant parasitic nematodes found associated with sweet potato in different localities in Leyte and Southern Leyte during the rainy season. [1]

Locality	Number of nematodes per 300 cc soil [2]					
	Rotylenchulus	*Meloidogyne*	*Helicotylenchus*	*Xiphinema*	*Hemicycliophora*	*Hoplolaimus*
LEYTE						
Abuyog Proper	298.0	51.6	19.8	14.0	1.2	1.4
Alejos, Bato	1054.8	6.6	73.2	0	0	0.4
Bago, Bato	158.4	0	0.6	0	0	0.6
Balud, Capoocan	5.6	47.7	15.0	0.2	0.8	2.0
BPI, Babatngon	32.0	0	1.6	2.6	0	2.8
Bulacan, Hindang	303.2	0	52.6	0.8	0	1.0
Besoria, Carigara	1967.2	1158.2	4.8	0.8	11.2	0
Caridad, Baybay	563.0	326.0	27.6	0	1.2	0.4
Cogon, Ormoc	61.2	3.4	11.4	0.8	0.4	0.4
Ipil, Ormoc	905.8	73.6	70.8	6.6	33.8	0
Lingayon, Alang-alang	75.4	0	36.8	6.4	1.6	1.2
Mayorga Proper	2002.6	171.4	72.8	24.0	0	0
Natubgan, Kananga	234.2	0	38.6	15.0	0	0
Plaridel, Baybay	36.4	33.6	25.0	0	0	1.2
Salug, Hilongos	326.0	33.6	48.6	4.6	0	0
San Rafael, Dulag	79.6	0.4	38.8	9.4	0	2.0
Sto. Niño, Jaro	47.2	44.6	3.6	0	0	0
Sto. Niño, Tacloban	243.8	0	7.6	0	33.6	0
Talisayan, Albuera	1205.0	304.4	7.8	3.2	0	0
Telegrafo, Tolosa	388.6	60.8	4.0	0.2	0	7.8
Visares, Capoocan	158.2	0	7.2	0.2	0.6	0
ViSCA, Baybay	4250.6	10.8	8.6	0	4.2	0
SOUTHERN LEYTE						
Bontoc Proper	158.4	0	0.6	0	0	0
Cantamauwak, Malitbog	103.6	0	5.0	0.8	0	0.4
Himayangan, Liloan	132.3	0	12.4	1.4	0	0.6
Himbangan, St. Bernard	378.4	13.8	23.6	41.0	2.4	0.8
Lanao, Maasin	125.2	0	7.2	0	0	0
Lipanto, St. Bernard	266.8	155.0	33.0	1.6	0	0
Libagon Proper	282.0	103.2	45.2	9.4	0	0
Nahungid, Libagon	374.2	149.2	20.8	3.6	0	1.8
Padre Burgos Proper	119.0	0	0.4	0.4	0	10.8
San Jose, Macrohon	105.0	97.8	15.4	0	0	0.6
Sogod Proper	19.8	0	3.8	0.8	0	1.2
Tam-is, Maasin	422.6	245.4	40.4	8.2	0	1.8
TOTAL	16883.0	3088.6	793.6	156.0	91.0	47.6

[1] Mean of 5 composite soil samples.

[2] Other nematode genera found with low counts were *Hemicriconemoides*, *Criconemoides*, *Pratylenchus*, *Longidorus*, *Rotylenchus*, and *Tylenchorhynchus*.

dogyne, and *Helicotylenchus,* respectively. An increase in population was evident during the wet season. Mean population densities of *Rotylenchulus* and *Meloidogyne* increased nearly two-fold. This increase may be attributed to soil moisture and temperature which could have adversely affected the survival of the nematodes. This finding corroborates the report that dry soil conditions reduce population growth by inhibiting the hatching of nematode eggs (Wallace, 1956; Dropkin and Martin, 1957). The improved root growth of the host plants during the wet season may have influenced the increase in population. This would mean abundant food supply, hence, the increase in population.

The most prevalent and widely distributed genera were *Rotylenchulus, Meloidogyne,* and *Helicotylenchus.* A number of these nematode genera were found in feeding position on sweet potato rootlets (Fig. 4). It is evident that these nematodes have a well-established host-parasite relationship with sweet potato. This observation parallels the report of Martin (1960) who found mature females of *R. reniformis* on sweet potato rootlets. Likewise, *Meloidogyne* spp., which were found in the survey, have been reported by several investigators (Martin, 1967; Castillo and Maranan, 1974).

On Cassava.

Tables 4 and 5 present the population densities of major nematode genera found associated with cassava in different localities in Leyte and Southern Leyte. *Meloidogyne* spp. were found highest in Ponong, and Bisoria, Carigara, Leyte with means of 1,485.8 and 1,002.6 per 300 cc soil during the dry and wet seasons, respectively. The population density of *Rotylenchulus* in cassava was found to be low (Fig. 5). This seems to suggest that cassava is not a good host of the nematode although some investigators

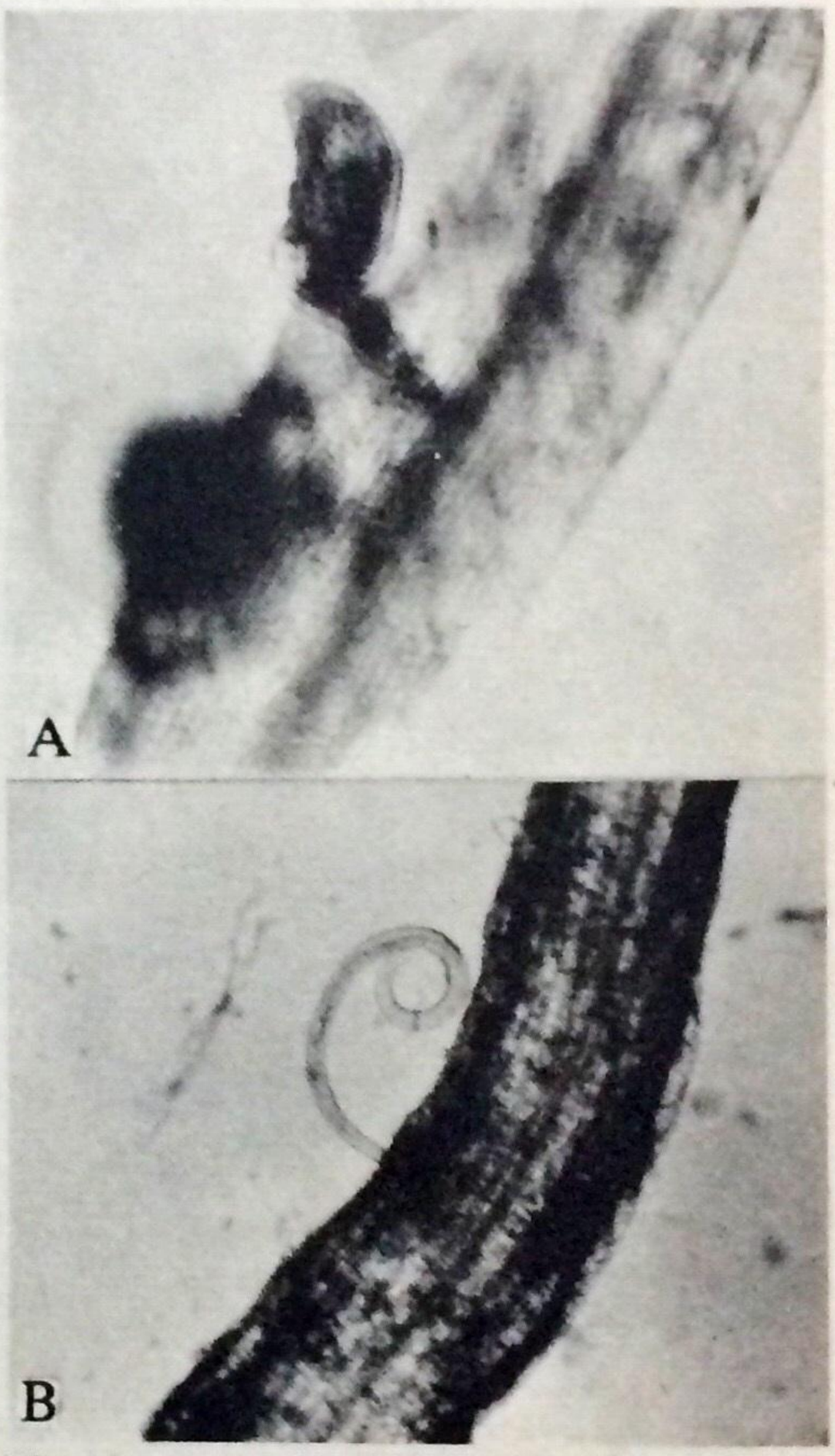

Fig. 4. Adult female *Rotylenchulus reniformis* (A) and *Helicotylenchus pseudorobustus* (B) in feeding position on sweet potato roots.

Table 4. Population density of plant parasitic nematodes found associated with cassava in different localities in Leyte and Southern Leyte during the dry season. [1]

Locality	Number of nematodes per 300 cc soil [2]				
	Meloi-dogyne	*Rotylen-chulus*	*Helicoty-lenchus*	*Hemicy-clio-phora*	*Hoplo-laimus*
LEYTE					
Alejos, Bato	1.2	65.9	19.3	0	0.2
Bil-at, Dulag	11.7	2.5	1.3	0	0
BPI, Babatngon	13.7	3.0	8.2	0	1.6
Bulacan, Hindang	0.7	19.7	54.3	0	0
Lauan, Capoocan	154.7	0.5	5.9	0	2.4
Mahaplag Proper	144.1	3.6	0.6	0	0
Naghalin, Kananga	0.5	5.7	4.7	1.9	0
Ormoc City	194.7	5.4	27.0	54.3	0.6
Pandan, Baybay	0.5	6.0	1.1	0	0
Ponong, Carigara	1485.8	32.8	9.3	0	2.4
Punong, Matalom	0	61.7	2.4	0	0.1
ViSCA, Baybay	0	71.1	20.5	0	0
SOUTHERN LEYTE					
Himayangan, Liloan	0	0.3	0.1	0	0.4
Himbangan, St. Bernard	1.1	3.5	0.1	0	1.1
San Joaquin, Macrohon	0	0.9	0.5	1.2	0.6
San Vicente, Bontoc	5.5	46.1	2.1	0	3.2
Sogod Proper	0.9	1.1	0.2	0	0
TOTAL	2015.1	329.8	206.2	57.4	13.6

[1] Mean of 10 soil samples.

[2] Other nematode genera found but with low counts were *Xiphinema*, *Pratylenchus*, *Tylenchorhynchus*, *Rotylenchus*, and *Criconemoides*.

observed that the nematode species was found feeding on the crop (Castillo and Maranan, 1974).

A summary table on the population density, occurrence, and distribution of nematode genera found associated with the crop is presented in Table 6. *Meloidogyne*, *Rotylenchulus*, and *Helicotylenchus* were the most abundant and widely distributed among the genera with 64.73, 16.26 and 13.27%

Table 5. Population density of plant parasitic nematodes found associated with cassava in different localities in Leyte and Southern Leyte during the rainy season. [1]

Locality	Number of nematodes per 300 cc soil [2]				
	Meloidogyne	*Rotylenchulus*	*Helicotylenchus*	*Pratylenchus*	*Hoplolaimus*
LEYTE					
Alejos, Bato	**248.0**	**83.0**	**69.0**	**30.2**	**0**
Balud, Capoocan	**195.8**	**2.2**	**73.0**	**0**	**1.2**
Besoria, Carigara	**1002.6**	**48.0**	**26.0**	**3.4**	**0**
Bulacan, Hindang	**183.0**	**2.2**	**1.4**	**2.0**	**2.6**
BPI, Babatngon	**34.6**	**8.8**	**7.4**	**0**	**0**
Cabalawan, Tacloban	**50.4**	**50.4**	**1.2**	**0.4**	**0.2**
Cogon, Ormoc	**0**	**31.0**	**8.4**	**4.8**	**0**
Naghalin, Kananga	**86.2**	**45.4**	**5.8**	**0**	**1.2**
Ulutan, Jaro	**128.8**	**34.6**	**22.2**	**1.0**	**0**
Tagbawan, Baybay	**46.4**	**6.0**	**12.2**	**12.0**	**2.8**
Visares, Capoocan	**0**	**2.6**	**5.6**	**0.2**	**3.8**
ViSCA, Baybay	**0**	**5.8**	**11.2**	**0**	**0**
Wangag, Albuera	**32.4**	**18.2**	**103.0**	**0.6**	**6.0**
SOUTHERN LEYTE					
Bontoc Proper	**0.8**	**10.2**	**1.6**	**2.2**	**0**
Liloan Proper	**0**	**17.6**	**2.6**	**1.6**	**1.6**
Lipanto, St. Bernard	**0**	**27.2**	**1.2**	**4.6**	**1.0**
Padre Burgos Proper	**0.4**	**11.8**	**23.2**	**0**	**0.6**
San Joaquin, Macrohon	**0**	**40.6**	**4.4**	**0**	**3.6**
San Roque, Macrohon	**2.8**	**10.2**	**30.8**	**0**	**0**
San Vicente, Bontoc	**10.4**	**51.0**	**3.6**	**0**	**3.4**
Tam-is, Maasin	**0**	**1.2**	**0.4**	**0.4**	**0**
TOTAL	**2022.6**	**508.0**	**414.6**	**63.4**	**28.0**

[1] Mean of 5 composite soil samples.

[2] Other nematode genera found with low counts were *Hemicycliophora*, *Criconemoides*, *Xiphinema*, *Hemicriconemoides*, *Longidorus*, *Rotylenchus*, and *Tylenchorhynchus*.

occurrence, respectively. The other nematode genera were considerably less (below 5%). The nematode genera found in the survey were reported by many investigators to be associated with cassava (Hogger, 1968, 1971; Merney, 1971).

Table 6. Summary table on the population density, occurrence and distribution of plant parasitic nematodes associated with sweet potato and cassava in Leyte and Southern Leyte. [1]

Nematode Genera/Crop	Counts per 300 cc soil		% Occurrence [2]	% Distribution [3]
	Dry	Wet		
SWEET POTATO				
Rotylenchulus	249.01	496.55	79.65	97.64
Meloidogyne	51.67	90.84	14.57	70.58
Helicotylenchus	20.26	23.34	3.74	92.76
Hoplolaimus	1.01	4.58	0.73	47.64
Hemicycliophora	1.30	2.67	0.42	19.41
Xiphinema	1.79	1.40	0.22	34.11
Hemicriconemoides	0.03	1.40	0.22	18.23
Criconemoides	0.29	1.07	0.27	17.64
Pratylenchus	0.89	0.70	0.11	13.52
Longidorus	0.04	0.31	0.05	10.00
Rotylenchus	0.02	0.25	0.04	4.70
Tylenchorhynchus	0.53	0.21	0.03	7.64
Dolichodorus	0.03	0.00	0.01	0.38
CASSAVA				
Meloidogyne	118.53	96.31	64.73	66.66
Rotylenchulus	19.4	24.19	16.26	86.66
Helicotylenchus	12.12	19.74	13.27	80.00
Pratylenchus	0.34	3.02	2.02	28.57
Hoplolaimus	0.80	1.33	0.89	35.23
Hemicycliophora	3.37	1.03	0.69	18.09
Criconemoides	0.15	0.94	0.63	27.61
Xiphinema	0.14	0.91	0.61	19.04
Hemicriconemoides	0.00	0.57	0.38	13.33
Longidorus	0.00	0.35	0.23	5.71
Rotylenchus	0.16	0.30	0.20	4.76
Tylenchorhynchus	0.17	0.05	0.03	5.71

[1] Mean of 430 and 275 soil samples, respectively.
[2] Number of individuals per genus divided by the total number of individuals in all the genera x 100.
[3] Number of soil sample where genus was detected divided by the total number of soil samples x 100.

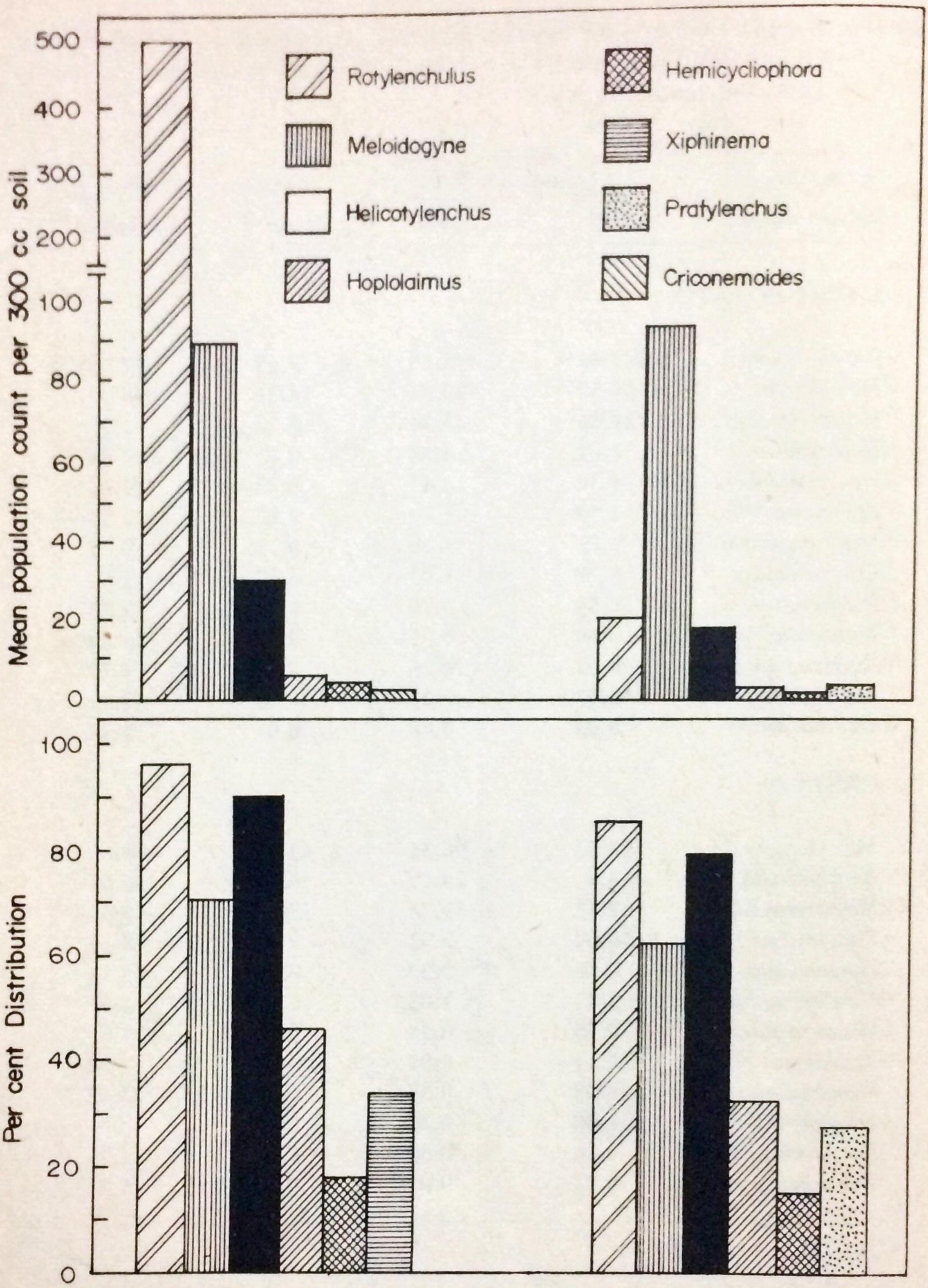

Fig. 5. Mean population counts and percent distribution of major nematode genera found associated with sweet potato and cassava.

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