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Community Composition of Plant-parasitic Nematodes in Native and Cultivated Cerrados of Central Brazil

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Abstract: Communities of plant-parasitic nematodes collected from five different vegetation types (canopy woodland, savannah, gallery forest, cultivated perennial, and annual plants) and soils (yellowish red latosols, dark red latosols, arenosols, acrisols, and gleysols) were studied. Ninety percent of the soil samples collected from savannah contained at least four genera of plant-parasitic nematodes. The highest population densities were recovered from perennial plants and from acrisols. Nematodes from perennial and annual plants formed one cluster, which had a similar flexible-beta distance to that from the gallery forest. The distance in the native savannah and in canopy woodland was very different. Distance values for the soil aspect were similar for arenosols, yellowish, and dark red latosols. The value for acrisols was much larger than for the other soils.

Key words: cerrado, community, ecology, nematode, savannah, soil, vegetation.

Mathematical equations have been used to define nematode communities in native and cultivated ecosystems. Ferris et al. (8) used Preston's resemblance equation for cluster analyses to relate the communities of plant-parasitic nematodes to different soybean fields. The same equation was used to study the nematode habitats in native sites (18) and in some forests (12). Johnson et al. (13) used Giese's ORDCOM computer program to determine ordination of nematode communities in forests.

The Brazilian "cerrado" (savannah-like) occupies about 20% of the country, with 80% of it located in the states of Minas Gerais, Goiás, Mato Grosso, and the Federal District. The cerrado soils are generally characterized by high acidity, aluminum saturation, low fertility, and good drainage. The climate has distinct dry and

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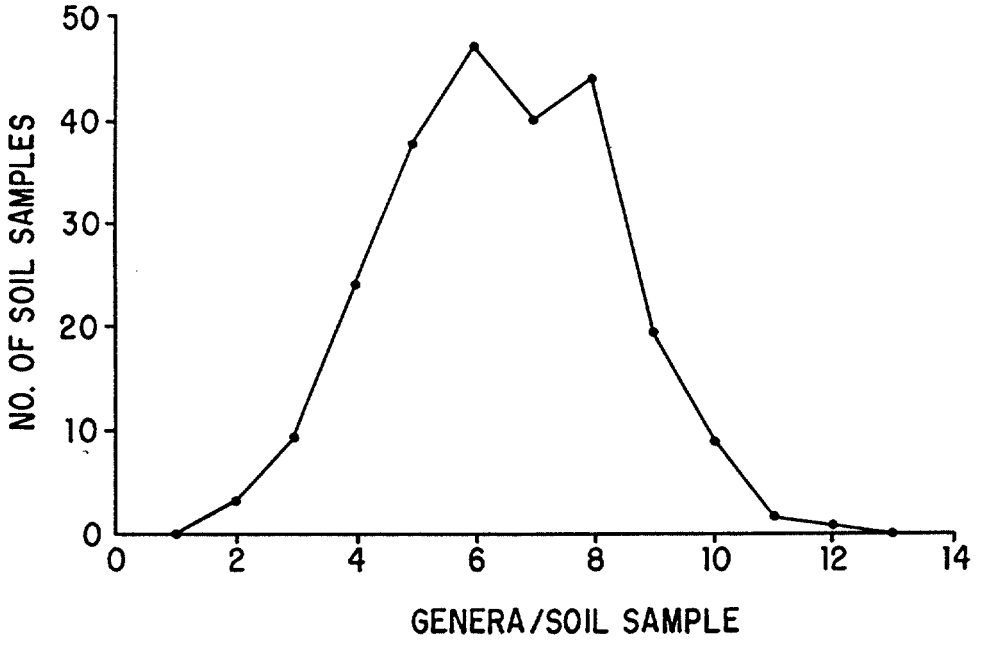

FIG. 1. Distribution of the number of genera per sample in soil collected from cerrado (savannah) vegetation.

rainy seasons, with average temperatures between 20 and 26 C, and annual precipitation between 1,000 and 2,000 mm (1,9). Fabaceae, Poaceae, Asteraceae, Rubiaceae, Arecaceae, and Cyperaceae are the dominant vegetation types in the cerrado (10). With growing exploration of the natural areas, the native plants are being replaced by cultivated plants resulting in homogeneous genotypes.

Studies on the native fauna might give insight to the communities in agricultural soils (18). Recent investigations on nematode fauna in Central Brazil revealed that nematode communities were much more complex in natural than in cultivated ecosystems (4). The present work was to analyze the nematode community structure and size in different kinds of vegetation and soils in the Federal District and adjoining regions of Brazil.

Materials and Methods

The principal native cerrado vegetation in Central Brazil includes "cerradão" (canopy woodland) (10.3%), "cerrado" (savannahs) (80.5%), and gallery forest (marshy palm groves) (5%) (2,5–7). Cerradão are forests with open to closed canopies. The open canopy trees grow to 15–18 m tall, with a dense shrub understory. Cerrado, the most common form of vegetation, consists of widely spaced trees and a ground cover of dense shrubs and grasses. Evergreen gallery forests are composed of

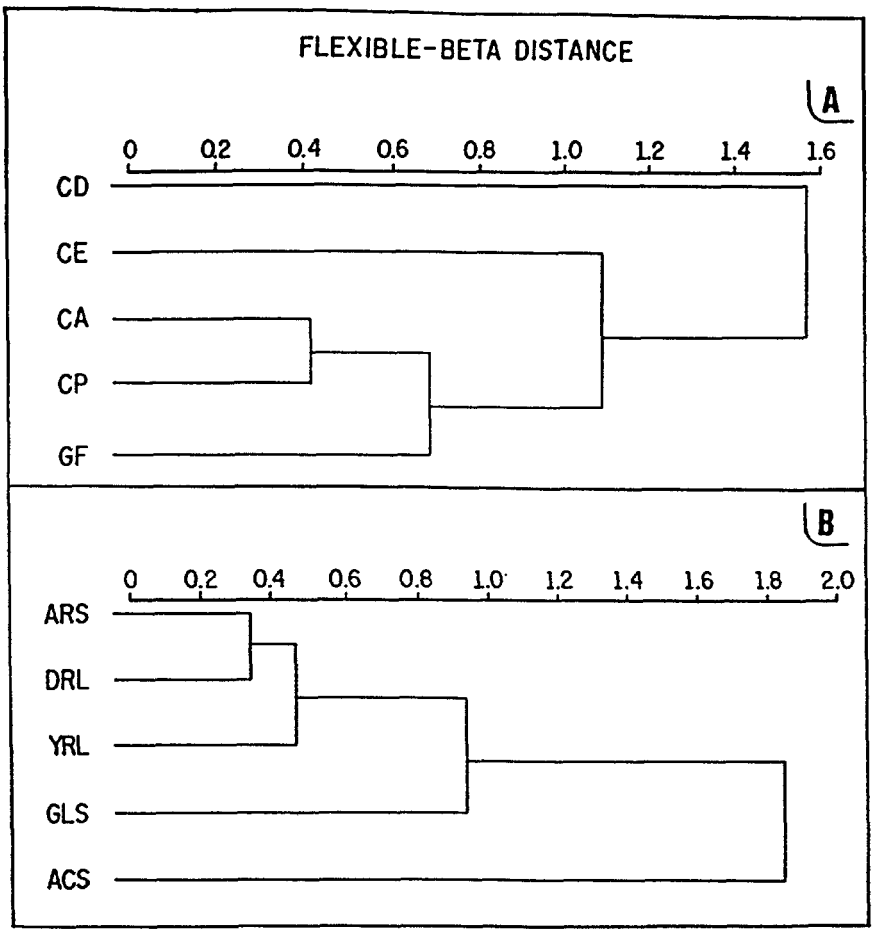

FIG. 2. Dendrogram of plant-parasitic nematodes in five kinds of vegetation (A) CD = cerradão, CE = cerrado, GF = gallery forest, CA = cultivated annual plants, CP = cultivated perennial plants, and soils (B) DRL = dark red latosols, YRL = yellowish red latosols, ARS = arenosols, GLS = gleysols, and ACS = acrisols.

woody plants located in valley bottoms on well-drained or swampy soil, and are adjacent to the cerrado, or wet lands. The plant species richness is greatest in the cerrado, intermediate in the cerradão, and least in the gallery forest. In Central Brazil, the natural vegetation has been replaced by monoculture of perennial (*Eucalyptus,* pine, coffee, and fruit plants) and annual crops (rice, soybean, beans, corn, and vegetables).

The main soils of this region are latosols (46%), arenosols (15%), acrisols (6%), and gleysols (2%) (1,2). The two common latosols are dark red latosols (iron content more than 9%) and yellowish red latosols (less than 9% iron). These soils contain little humus and vary greatly in texture. Textures of arenosols contain more than 80% sand and less than 15% clay. Acrisols have silty surface layer and clay subsoils. They have a high water holding capacity. Gleysols are located in lowlands and river meadows. They are high in black humic matter, contain a large fraction of silt, and are poorly drained.

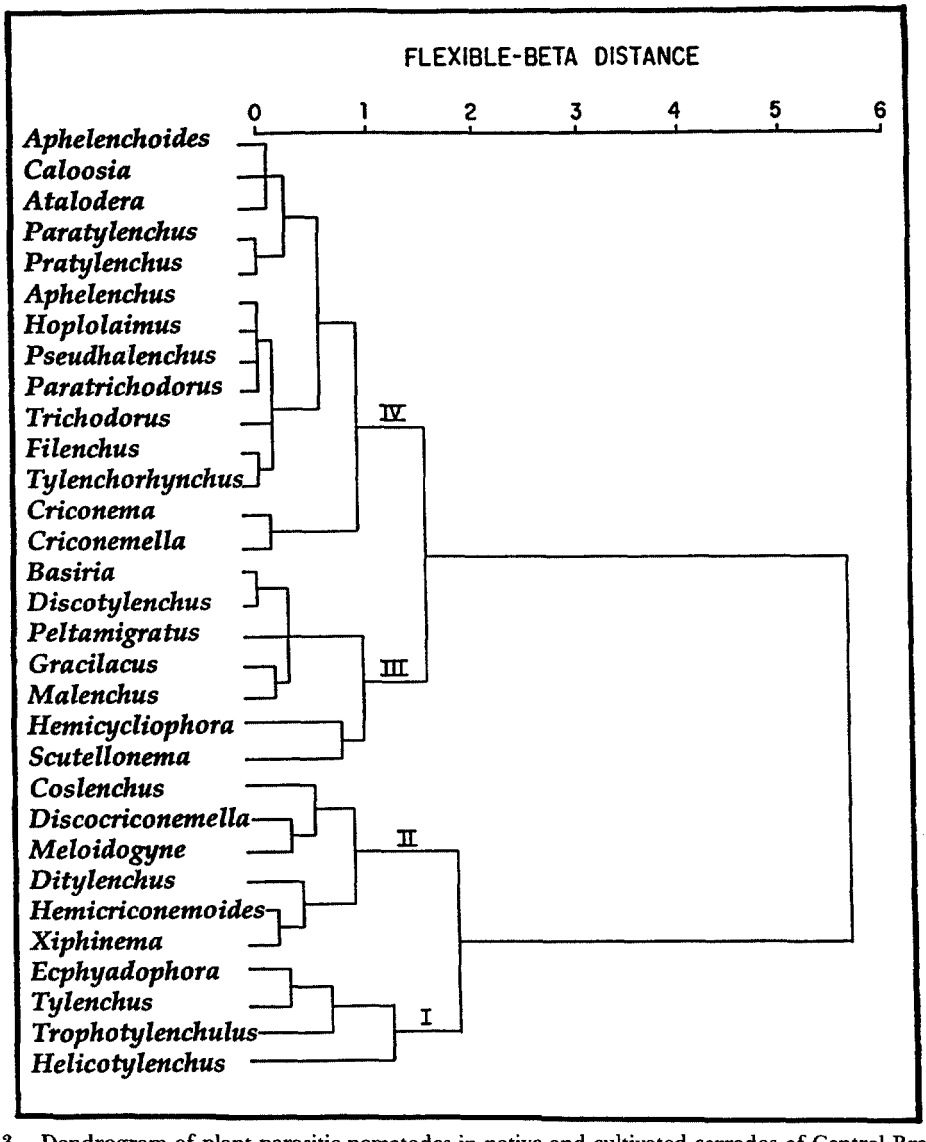

FIG. 3. Dendrogram of plant-parasitic nematodes in native and cultivated cerrados of Central Brazil.

The data used for the analyses described herein were taken from a nematode survey (4) conducted in the Federal District of Brazil and the states of Goiás and Minas Gerais. Plant-parasitic nematodes in this survey were identified to genera according to the reappraisal of Tylenchina (14). Data were composed of actual counts of individuals in 31 genera collected from 297 1-liter soil samples. Vegetation was categorized as cerradão, cerrado, gallery forest, perennial, or annual plants. Soils were grouped into yellowish red latosols, dark red latosols, arenosols, acrisols, or gleysols.

The nematode presence–absence, frequency, and population size were used to construct dendrograms by the Lance and Williams' flexible-beta method (17) using the formula:

$$D_{jm} = (D_{jk} + D_{jl})(1 - b)/2 + D_{kl},$$

where D_{jk}, D_{jl}, and D_{kl} = any distance or dissimilarity measure between clusters and b = the value of the beta (−0.25).

Relative frequency, density, and prominence values (PV) were calculated for each genus (15). Prominence value percentages in each genus (PV in one genus/total PV in one vegetation or soil type × 100) were also calculated. Nematodes were grouped into high (PV% >50), intermediate (PV% = 17.1–50), and low PV% (PV% <17).

Results

Ninety percent of the soil samples collected from the cerrado contained at least four genera of plant-parasitic nematodes (Fig. 1). In the cerrado, the nematode community was dominated by *Helicotylenchus, Meloidogyne, Ecphyadophora, Discocriconemella, Trophotylenchulus,* and *Tylenchus.* The highest average population density (409/liter of soil) in the five vegetation types was found on perennial crops, and the lowest (99/liter of soil) on annual plants. In the five soil types, the largest numbers (721/liter of soil) occurred in ac-

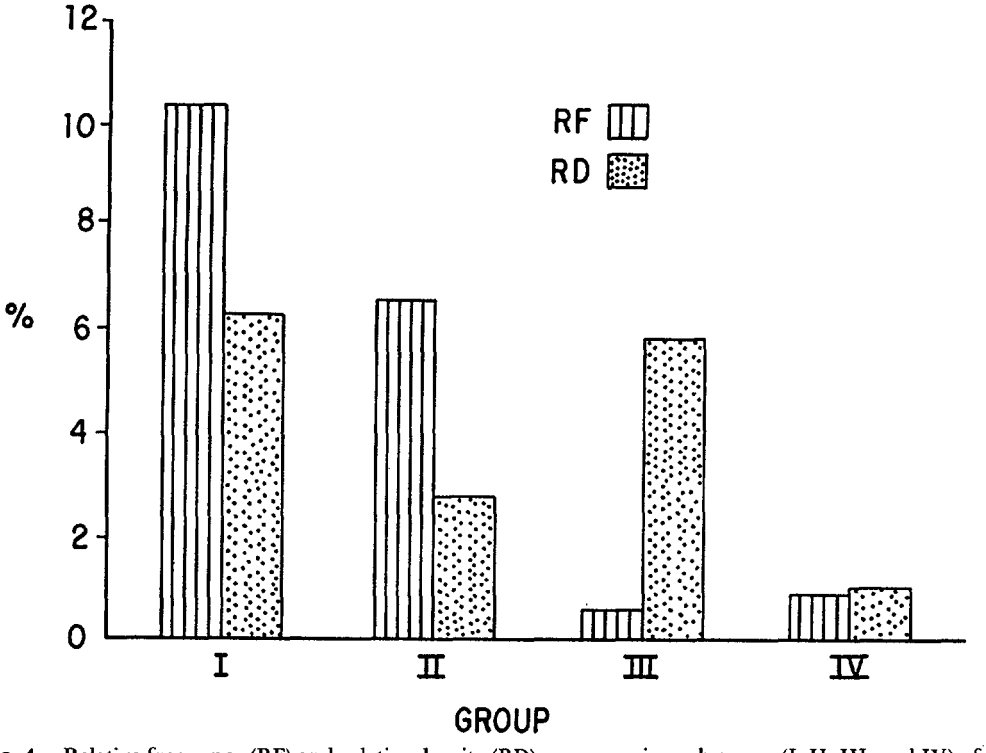

FIG. 4. Relative frequency (RF) and relative density (RD) per genus in each group (I, II, III, and IV) of the dendrogram presented in Fig. 3.

risols, and the numbers (135–272) were not different ($P < 0.05$) among the others.

Plant-parasitic nematodes clustered similarly (at 0.42 of the flexible-beta distance) for cultivated annual and perennial plants, forming one group, which clustered at the next level (0.69) with those from the forest (Fig. 2A). The next clustering occurred at distances of 1.08 and 1.58. The flexible-beta distance was similar in arenosols, yellowish red latosols, and dark red latosols (Fig. 2B). A large distance value was required for the cluster to admit acrisols with the other soils.

Plant-parasitic nematode genera were divisible into four groups in the dendrogram (Fig. 3) based on frequency and density (Fig. 4). The number of genera in the community were as follows: 4 (12.9%) in group I, 6 (19.3%) in group II, 7 (22.6%) in group III, and 14 (45.2%) in group IV.

Based on prominence values, nematodes were allocated to three groups (Tables 1–2). Group I, with a PV% value of 62.2%, contained 16.8% of the total number of genera. Group II contained 26.7% of the genera and had 27.1% of the PV. Most of the genera (56.5%) in group III occurred in low numbers and therefore accounted for only 10.7% of PV.

TABLE 1. Categorization† of plant-parasitic nematodes found in the five different kinds of vegetation and soils in Central Brazil.

	Vegetation‡					Soil‡				
Genus	CD	CE	GF	CA	CP	DRL	YRL	ARS	GLS	ACS
Aphelenchoides	3	3	3	2	2	3	3	–	3	3
Aphelenchus	–	3	–	3	–	3	3	–	–	–
Atalodera	3	3	3	–	3	3	3	3	3	3
Basiria	–	–	2	–	–	–	–	–	2	–
Caloosia	3	3	–	–	–	3	3	1	–	3
Coslenchus	2	2	3	3	3	2	2	2	3	3
Criconema	3	3	3	–	3	2	3	3	3	3
Criconemella	3	3	3	3	3	3	3	3	3	3
Discocriconemella	1	1	3	3	3	1	2	3	3	2
Discotylenchus	–	–	2	–	–	–	–	–	2	–
Ditylenchus	2	3	3	2	3	2	2	3	3	3
Ecphyadophora	2	1	2	2	1	1	2	2	2	2
Filenchus	–	3	3	–	–	3	–	3	–	3
Gracilacus	1	3	–	–	–	3	3	–	–	–
Helicotylenchus	1	1	1	1	1	2	1	1	1	1
Hemicriconemoides	3	2	3	–	–	2	2	3	3	3
Hemicycliphora	1	2	2	–	–	3	1	3	2	–
Hoplolaimus	–	3	–	–	–	3	–	–	–	–
Malenchus	–	2	–	–	3	3	3	–	–	–
Meloidogyne	3	1	2	1	1	1	1	2	2	3
Paratrichodorus	3	3	–	–	–	3	3	–	–	–
Paratylenchus	3	3	3	–	–	3	3	–	–	3
Peltamigratus	–	3	2	–	3	3	3	–	2	2
Pratylenchus	3	3	–	3	–	3	3	3	–	–
Pseudhalenchus	3	3	–	–	–	3	3	–	–	–
Scutellonema	3	3	1	–	–	3	3	–	–	1
Trichodorus	–	–	3	–	–	–	–	–	3	–
Trophotylenchulus	1	1	2	2	2	1	1	1	2	2
Tylenchorhynchus	–	3	–	–	–	3	3	–	–	–
Tylenchus	2	1	2	1	2	1	2	1	2	2
Xiphinema	3	2	2	3	3	2	2	3	2	3
Total genera	22	28	22	13	15	28	26	17	19	19
Total samples	24	224	20	12	16	110	144	12	18	12

† Prominence value percentages grouped into three categories: one (PV% > 50), two (PV% = 17.1–50), and three (PV% < 17). Minus sign (–) indicates the absence of the nematode.

‡ Vegetation: CD = cerradão, CE = cerrado, GF = gallery forest, CA = cultivated annual plants, CP = cultivated perennial plants. Soils: DRL = dark red latosols, YRL = yellowish red latosols, ARS = arenosols, GLS = gleysols, and ACS = acrisols.

TABLE 2. Assignment of plant-parasitic nematode genera to groups based on prominence values (PV) within five vegetation and soil types in Central Brazil.

Vegetation and soil	Group I		Group II		Group III	
	No. of genera (%)	PV (%)	No. of genera (%)	PV (%)	No. of genera (%)	PV (%)
Vegetation†:						
CD	5 (22.7)	56.1	4 (18.2)	26.9	13 (59.1)	17.0
CE	6 (21.4)	67.5	5 (17.9)	19.6	17 (60.7)	12.9
GF	2 (9.1)	59.9	9 (40.9)	34.1	11 (50.0)	6.0
CA	3 (23.1)	62.3	4 (30.8)	23.6	6 (46.0)	14.0
CP	3 (20.0)	74.8	3 (20.0)	17.3	9 (60.0)	7.9
Soil†:						
DRL	5 (17.9)	60.5	6 (21.4)	27.2	17 (60.7)	12.3
YRL	4 (14.8)	55.2	7 (25.9)	30.1	15 (59.3)	14.7
ARS	4 (23.5)	73.1	3 (17.6)	17.1	10 (58.8)	9.8
GLS	1 (5.3)	59.3	9 (47.4)	34.8	9 (47.4)	5.9
ACS	2 (10.5)	52.8	5 (26.3)	40.6	12 (63.2)	6.6
Average	(16.8)	62.2	(26.7)	27.1	(56.5)	10.7

† Vegetation: CD = cerradão, CE = cerrado, GF = gallery forest, CA = cultivated annual plants, CP = cultivated perennial plants. Soils: DRL = dark red latosols, YRL = yellowish red latosols, ARS = arenosols, GLS = gleysols, and ACS = acrisols.

DISCUSSION

Plant diversity is greater in cerrado and cerradão than in gallery forests or in cultivated perennial and annual crops (6,7, 16). This diversity is least in cultivated fields. Nematode generic diversity paralleled that of the vegetation. Nematode abundance was greatest in cultivated perennial plants and is probably related to the large root biomass. In relation to soils, the larger population levels in acrisols than in the other soils are attributed to the better water-holding capacity of the acrisols than that of latosols and arenosols. Gleysols have a high capacity to retain water but have a very low oxygen level (2).

The plant species are similar between cerradão and cerrado, and dissimilar between cerradão and gallery forest (5,6,16). The close clustering within cultivated annual and perennial plants may be due to an absence of the Criconematidae in cultivated soils (4). Nematode communities in arenosols, yellowish red latosols, and dark red latosols formed one close cluster, which was dissimilar to acrisols and gleysols, possibly because of different soil textures. These soils have different drainage patterns and oxygen levels (2).

Nematodes have been grouped into colonizers (rapidly increase in numbers under favorable conditions, but have a short life-cycle) and persisters (low reproductive rate, but have a long life-cycle) (3,15). Bongers' (3) Plant Parasitic Index values from two (colonizers) to five (persisters) parallel the three groups separated by PV in our study. *Meloidogyne* spp. (primarily *M. javanica* and *M. arenaria* in native vegetations) (11, unpubl.) were in group I in cultivated fields and the cerrado, group II in the gallery forest, and group III in the cerradão. It indicates that a nematode that can be a colonizer in a favorable condition can also be a persister in a less favorable one.

It is clear that the diversity of a plant-parasitic nematode community is related to plant species richness. Nematode habitats and population sizes can be influenced by soil drainage and oxygen levels, which are closely correlated with soil texture. This study revealed that less than 25% of the total genera were common in the community of plant-parasitic nematodes.

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