Community Analyses of Plant-Parasitic Nematodes in the Kalsow Prairie, Iowa[1]

DON C. NORTON and DONALD P. SCHMITT[2]

Abstract: Twenty-one species of plant-parasitic nematodes were recovered from 15 sites in the Kalsow Prairie, Iowa. Nematode communities were analyzed by prominence and importance values of the nematode species and also by diversity and concentration of dominance. The use of numbers and biomass were compared in indices of diversity and concentration of dominance. *Tylenchorhynchus maximus* ranked first in mean density/site, prominence value, and importance value, although it was not found as frequently as many other nematodes. *Xiphinema americanum* and *T. maximus* were among the dominant nematodes in 11 of 15 sites when biomass was used in the concentration-of-dominance index, but they were dominant in only five sites when numbers were used. *Key Words: Tylenchorhynchus maximus, Xiphinema americanum,* prominence value, importance value, diversity, similarity.

The Kalsow Prairie, Section 36, Bellville Township, T-90N, R-32W, Pochahontas County, Iowa, is a mesic tall-grass prairie, with small relief, comprising 64.6 ha in the Clarion-Nicolett-Webster soil association. The prairie has never been cultivated, although the northwestern 12.1 ha was grazed before 1940. The tract is burned occasionally to preserve the prairie aspect.

Early reports of nematodes in native prairies in the U.S.A. consisted mainly of

Received for publication 5 July 1977.

[1] Journal Paper No. J-8884 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa 50011. Project 2119.

[2] Department of Botany and Plant Pathology, Iowa State University, Ames. Present address of junior author: Department of Plant Pathology, North Carolina State University, Raleigh. The many helpful suggestions by Dr. David Glenn-Lewin are gratefully acknowledged.

faunistic lists (5, 6, 16). More recently, interest has increased in community analysis and population change (9, 10, 13). The factors associated with nematode abundance that seem to be the most important are topography and vegetation (10). Data of Schmitt (8) were analyzed by different methods to compare community patterns of plant-parasitic nematodes, and the results are reported here.

MATERIALS AND METHODS

Details have been published (9) on the location of the 15 sites sampled, the methods of sampling, and soil processing. Briefly, three composite soil samples of 1 liter were collected from each site four times from February to September 1968, and 250 cm^3 soil were processed by the sieving Baermann-funnel method. The data were converted to means of nematodes/100 cm^3 soil for the year. A brief description of the sites is given in Table 3.

Prominence values (density $\sqrt{\text{frequency}}$) (2), biomass (1), and importance values (the sum of relative density, relative frequency, and relative dominance) (4) were calculated for each nematode species at each site. Relative biomass was substituted for relative dominance in the importance value. Biomass figures are based on 30 adult females. The use of only females in biomass calculation results in a higher value than actually occurred because juveniles were present in the population but the actual proportions were not measured. If species were unidentified, representative biomass figures were calculated from preserved specimens. Used to calculate a similarity matrix was Sorensen's (15) index, $[2c/(a + b)] \times 100$, where c is the number of species common to both sites and a and b are the respective total number of species in sites A and B. Diversity of nematode species was measured by the Shannon and Wiener (7, 11) information measure to base *e*.

$$H' = -\sum_{i=1}^{s} p_i \log p_i$$

where s is the number of species at each site and p_i is the relative abundance of the ith species. Used for the concentration of dominance was Simpson's (7, 12) index,

$$\sum_{i=1}^{s} \left(\frac{n}{N}\right)^2$$

where n equals the number or biomass of nematodes at the ith site and N equals the nematode number or biomass in all sites.

RESULTS

Twenty-one species of plant-parasitic nematodes were identified from the Kalsow Prairie, although others were present that were unidentifiable (Table 1). Members of the Aphelenchoidea, Tylenchinae, Psilenchinae, and the Dorylaimoidea, exclusive of *Longidorus, Trichodorus,* and

TABLE 1. Prominence value and importance values of plant-parasitic nematodes/100 cm^3 soil in the Kalsow Prairie, Iowa. 1968. Nematodes are arranged in declining order of the importance values.

Nematode	Prominence value	Importance value
Tylenchorohynchus maximus Allen	116.8	35.3
Xiphinema americanum Cobb	49.0	29.7
Trichodorus proximus Allen	24.1	20.2
Merlinius joctus (Thorne) Sher	61.0	18.3
Xiphinema chambersi Thorne	13.4	18.3
Tylenchorhynchus sp.	53.9	17.9
Helicotylenchus sp.	62.9	17.7
Helicotylenchus pseudorobustus (Steiner) Golden	55.0	15.3
Tylenchorhynchus nudus Allen	34.9	12.0
Helicotylenchus leiocephalus Sher	25.2	11.8
Hoplolaimus galeatus (Cobb) Filipjev & Shuurmans—Stekhoven	8.0	10.9
Helicotylenchus hydrophilus Sher	23.3	10.2
Helicotylenchus dihystera (Cobb) Sher	24.8	8.8
Helicotylenchus digonicus Perry	16.0	8.7
Pratylenchus spp.	10.6	8.1
Aorolaimus torpidus Thorne and Malek	10.9	7.9
Helicotylenchus exallus Sher	11.7	5.5
Gracilacus aciculus (Brown) Raski	10.3	4.7
Paratylenchus projectus Jenkins	5.2	4.3
Criconemoides spp.	2.3	3.9
Hemicycliophora similis Thorne	3.3	3.7
Paratylenchus microdorus Andrássy	6.7	3.5
Tylenchorhynchus silvaticus Ferris	4.4	3.5
Helicotylenchus platyurus Perry	4.4	3.3
Hirschmanniella sp.	1.8	3.3
Discocriconemella inaratus Hoffmann	1.0	3.0
Longidorus sp.	0.4	2.8
Heterodera sp.	2.2	2.5
Gracilacus sp.	0.3	0.8

Xiphinema, are not included because many are mycophagous or are predatory.

Prominence and importance values: Tylenchorhynchus maximus was the most prominent nematode in the prairie, its prominence value being almost twice that of the other prominent species, *Helicotylenchus* spp., *Merlinius joctus,* and *H. pseudorobustus* (Table 1). *Tylenchorhynchus maximus* and *Xiphinema americanum* had the two highest importance values in the prairie (Table 1).

Diversity: Measurement of diversity, by using nematode numbers compared with biomass, sometimes resulted in considerable differences in indices and order of diversity (Table 2). For example, site 13 was the second-most diverse community when nematode numbers were used but was eighth-most diverse when biomass was used. Also, site 7 was the tenth-most diverse nematode community when numbers were used but fourth-most diverse when biomass was used. Other comparisons varied less or not at all in order of diversities.

Concentration of dominance: When used in Simpson's index, comparison of numbers with biomass varied even more than in the diversity index (Table 3). In 9 of the 15 sites, nematodes listed as dominant when numbers were used were not among the dominant nematodes when biomass was used. Only four sites (1, 2, 5, 9) had similar indices for nematode density and biomass. The indices at the remaining sites differed by about 50%, with the greatest difference at site 12, which differed by a factor of 2.4.

Similarity index. A coefficient of similarity, based on the presence-absence, of 27.0% was found when the known plant-parasitic nematodes of the Kalsow Prairie were compared with those of a mixed-grass plains study in South Dakota (13). The similarity coefficient for tall grass prairies in Ohio (Reidel and Norton, unpublished) and the Kalsow Prairie was 47.4%, and that of the South Dakota study and Ohio was 24.3%.

TABLE 2. Nematode community diversity indices by nematode number and biomass. Kalsow Prairie, Iowa. 1968. Sites are arranged by decreasing diversity of nematode communities using the Shannon-Wiener index.

Index based on nematode numbers/100 cm^3 soil		Index base on nematode biomass/100 cm^3 soil	
Site	Index	Site	Index
2	2.102	2	1.922
13	1.958	10	1.920
4	1.952	5	1.825
12	1.936	7	1.771
5	1.807	3	1.766
10	1.786	8	1.699
6	1.685	4	1.569
14	1.575	13	1.560
8	1.566	12	1.398
7	1.541	6	1.369
3	1.432	9	1.363
9	1.392	11	1.128
11	1.380	14	1.249
1	1.296	1	1.244
15	0.919	15	1.123

DISCUSSION

The most clear-cut diversity observations relating nematodes and vegetation are those of potholes, pothole boundaries, and grazed areas compared with ungrazed areas. The pothole centers (sites 3 and 15) are not diverse and are generally dominated by *Polygonum coccineum, Lysimachia hybrida, Scirpus fluviatilis,* and *Carex* spp. (3). The diversity indices for nematode numbers also were low. The pothole boundaries, sites 4 and 14, which had higher diversities for nematode communities were more diverse also in vegetation (3). There were no clear trends when nematode biomass was used instead of numbers.

Smolik and Rogers (14) found no differences in total nematode numbers or biomass between 2-to-3-year grazed and ungrazed pastures in the shrub-steppe ecosystem in Washington. Their findings contrasted with results obtained from the mixed-grass study in South Dakota where nematode biomass was higher in the 7-to-9-year ungrazed treatments (13). In our study the grazed treatments contained both the lowest (site 6) and the highest (site 9) nematode biomasses of all sites. When a diversity index based on nematode numbers was calculated, the grazed areas (sites 6, 7, 8, and 9) had nematode diversities in the middle to lower half of the indices of all sites. *Andropogon gerardi* covered about 90% of the grazed area (3). Although 68 other plant species were found in the grazed area, the dominance of *A. gerardi*

TABLE 3. Sites, dominant plants, concentration of dominance indices by nematode numbers and biomass in communities in Kalsow Prairie, Iowa. 1968. Sites are arranged by increasing Simpson index.

			Index based on nematode numbers/100 cm³ soil		Index based on nematode biomass/100 cm³ soil		
Site	Site description	Dominant plants	Index	Dominant nematodes	Site	Index	Dominant nematodes
2	Upland, north of soil drift	*Andropogon gerardi* Vitnam *Helianthus laetiflorus* Pers. *Poa pratensis* L. *Sporobolus heterolepis* Gray	0.144	*Helicotylenchus dihystera*	2	0.171	*Xiphinema americanum* *Aorolaimus torpidus* *Tylenchorhynchus maximus*
13	Depression on summit	*Calamagrostis canadensis* (Michx.) Nutt.	0.168	*Tylenchorhynchus silvaticus*	10	0.188	*Helicotylenchus* spp.
12	Burned north-facing slope	*A. gerardi* *Panicum leibergii* (Vassey) Scribn.	0.170	*Xiphinema americanum* *H. dihystera*	7	0.204	*Helicotylenchus exallus* *T. maximus*
4	Pothole boundary	*C. canadensis* *Carex* sp. *Phalaris arundinacea* L.	0.180	*Tylenchorhynchus* sp. *Merlinius joctus* *Hoplolaimus galeatus*	5	0.211	*Helicotylenchus digonicus* *X. americanum* *Trichodorus proximus*
5	Near top of west-facing slope	*A. gerardi* *Aster ericoides* L. *P. pratensis*	0.226	*Helicotylenchus digonicus* *Tylenchorhynchus maximus*	3	0.214	*Hoplolaimus galeatus* *Helicotylenchus hydrophilus* *X. americanum*
6	Grazed west-facing slope	*Asclepias syriaca* L. *Circium arvense* (L.) Scop. *P. pratensis*	0.251	*T. maximus*	8	0.215	*X. americanum* *T. maximus*
14	Burned pothole boundary on summit	*C. canadensis* *S. pectinata* Link	0.256	*Tylenchorhynchus* sp. *Helicotylenchus hydrophilius* *Xiphinema chambersi*	13	0.258	*X. americanum* *T. proximus*

10	Bottom of intersection of a north- and west-facing slope	*P. pratensis* *Solidago canadensis* L.	0.258	*Helicotylenchus* sp.	4	0.293	*H. galeatus* *T. proximus*
8	Burned grazed summit	*A. gerardi* *P. pratensis* *S. canadensis*	0.306	*Helicotylenchus pseudorobustus* *T. maximus*	9	0.299	*T. maximus* *X. americanum* *Helicotylenchus leiocephalus*
7	Grazed low area	*A. syriaca* *P. pratensis* *S. canadensis*	0.312	*Helicotylenchus exallus*	6	0.341	*T. maximus* *T. proximus*
11	North-facing slope	*P. pratensis* *S. canadensis*	0.317	*Helicotylenchus* spp. *X. americanum*	1	0.370	*X. americanum* *Tylenchorhynchus nudus*
9	Grazed gentle southeast slope	*A. gerardi* *P. pratensis* *S. canadensis*	0.319	*Helicotylenchus leiocephalus*	15	0.377	*Xiphinema chambersi* *Merlinius joctus*
3	Pothole center	*Carex* sp. *Polygonum coccineum* Muhl *Scirpus fluviatilis* (Torr.) Gray	0.334	*H. hydrophilus* *M. joctus*	12	0.404	*X. americanum*
1	Flat upland soil drift (from adjacent cultivated field)	*Chenopodium album* L. *Setaria virdis* (L.) Beauv. *S. lutescens* (Weigel) F. T. Hubb	0.401	*Tylenchorhynchus nudus*	14	0.424	*X. chambersi*
15	Burned pothole center on summit	*Carex* sp. *Lysimachia hybrida* Michx. *P. coccineum*	0.532	*M. joctus*	11	0.456	*X. americanum*

would result in a low Shannon-Wiener index. Observations on nearby pastures support Weaver's (17) statement that the prairie flora degenerates under long-term grazing. Brotherson (3) doubts that succession to the vegetative type of most of the prairie will occur in the next 100 years. If that is true, it might be expected that reversion of the plant-parasitic nematode fauna might be equally slow. The agreement of the low similarity indices of the Iowa and Ohio studies with that of South Dakota (13) probably reflects the differences between the mesic prairies of Iowa and Ohio compared with that of a dryland prairie of South Dakota.

Importance values and Shannon-Weiner or Simpson's indices are experimental tools the value of which can be achieved only through extensive use over time. The philosophy behind a given method will dictate a method's use in most instances. A diversity index or concentration of dominance is often used when structure is of interest; prominence values, importance values, frequency, or density measures are used when descriptions and classifications of nematode communities are the goal. The use of several methods of analyses become complementary in that we learn more about the community.

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