Incorporating spatial distribution into the nematode functional guild concept

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Abstract

Functional guilds defined by nematode feeding types (bacteria-feeding, fungal-feeding, omnivore, predatory and plant-feeding) are further refined by colonizer-persister class (i.e. r- and K-strategists) which reflects life-history strategy. We compared spatial organization of nematode genera belonging to the same functional guild or colonizer-persister class to determine intraguild spatial distribution behavior. A total of 360 soil samples from turfgrass lawns were collected from three locations in each of the three Ohio cities, Wooster, Massillon and Canton, in July and October, 2007. The index of aggregation, 'b' of Taylor's power law, was used to compare the spatial distributions of 21 nematode genera, six different functional guilds, five colonizer-persister classes, and total nematodes. The index of aggregation for the total nematodes was 2.0, which is the value of 'b' averaged over all the examined vertebrate and invertebrate taxa. The individual genera, the functional guilds and colonizer-persister classes had indices of aggregation that differed from 2.0. Functional guild as a group had higher 'b' value than individual genera, suggesting higher degree of aggregation at functional guild level. We found that 'b' value and colonizer-persister class is related. We conclude that the examination of spatial organization of nematodes may lead to further improvements in the practical value of nematodes as soil bioindicators.

Introduction

- **Spatial distribution** is an important life history characteristic of a species.
- Understanding spatial distribution of an organism is one of the prerequisites for understanding the ecology of any organism and its function in the habitat.
- **Nematode functional guilds** are defined by feeding type.
- **Colonizer-persister (cp) scale** describes life-history strategy of nematodes; cp-1&2 represent r-strategists, cp-4&5 represent K-strategists strategists.
- However, spatial organization of nematodes has not been considered as a criterion for defining the characteristics of colonizer-persister classification.
- **'b' parameter of Taylor's Power Law** (Taylor, 1961) can provide description of spatial organization of organisms in terms of degree of aggregation.

Hypotheses

- Nematode genera classified into the same functional guild or cp-class will differ in spatial distribution patterns.
- Spatial organization (b) is related to the cp-scale of nematodes.

Objectives

- Compare spatial distribution (Power law parameter b) of nematode genera, functional guilds and cp-classes.

Methods

- **Taylor's Power Law**
  Sample variance is proportional to a fractional power of the mean (Taylor, 1961), $V = a \cdot M^b$

$$\text{Log } [V] = A + b \cdot \log [M]$$

V = sample variance
M = sample mean
A = log (a)

- **Power law parameters**
  a: sampling factor, depends upon the size of sampling unit and is sometimes correlated with b
  b: index of aggregation:
  $b \approx 1$ denotes Poisson randomness at all densities
  $1 < b < 2$ denotes increasing aggregation with increasing b
  $b >> 2$ indicates an extremely high degree of aggregation

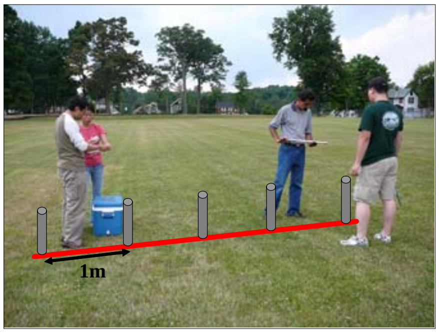

Fig. 1. Separate soil core samples were taken 1m apart from each other

- **Three cities;** Wooster, Massillon and Canton
- **Three locations** per city
- **Four transects** on turfgrass lawns per location
- **Five soil cores** per transect
- In total, **360** soil samples were collected for nematode extraction
- Soil samples taken July and October in 2007
- Nematode extraction by Baermann funnel
- Nematode identification and counting
- Functional guild assignment

Results

Table 1. Power law parameters for total nematodes, functional guilds and colonizer-persister classes

Functional Group	cp-class	n[a]	Range of Mean	Regression				
				$r^{2\,b}$	*b*	SE(*b*)	A^c	SE (*A*)
Bacterial feeding	cp-1	36	0.8-71.7	0.90	**1.96**	0.11	-0.12	0.14
	cp-2	36	5.0-82.6	0.83	**1.90**	0.15	-0.17	0.22
Fungal feeding	cp-2	36	6.9-89.4	0.80	**1.73**	0.15	0.18	0.22
Omnivore	cp-4	36	1.6-18.5	0.70	**1.41**	0.16	0.26	0.13
Plant feeding	cp-2	36	6.6-167.7	0.78	**2.39**	0.22	-0.76	0.34
	cp-3	36	1.5-82.1	0.82	**1.50**	0.12	0.53	0.17
Total		36	33.0-415.1	0.81	**1.99**	0.16	-0.44	0.36

a number of non-zero means, **b** all fits had P<0.001, **c** A=log (a)

Table 2. Power law parameters for colonizer-persister classes (cp-class)

cp class	n[a]	Range of Mean	Regression				
			$r^{2\,b}$	*b*	SE(*b*)	A^c	SE (*A*)
cp-1	36	0.8-71.7	0.91	**1.97**	0.11	-0.12	0.14
cp-2	36	26.9-275.2	0.77	**1.97**	0.18	-0.27	0.37
cp-3	36	1.6-82.1	0.81	**1.51**	0.13	0.52	0.18
cp-4	36	1.8-18.5	0.64	1.34	0.17	0.31	0.16
cp-5	27	0.1-4.2	0.89	**1.55**	0.11	0.50	0.06

a number of non-zero means, **b** all fits had P<0.001, **c** A=log (a)

- All the datasets show highly significant (*P*<0.001) fits to regression.
- Coefficients of determination were greater than 0.70 for all the datasets, except cp-4 class, *Dorylaimus* and *Filenchus*.
- As a group, total nematodes have *b* value close to 2.0 (**Table 1**).
- Among functional guilds, omnivore and plant feeders showed lower degree of aggregation, whereas plant feeders are highly aggregated.

Table 3. Power law parameters for individual nematode genera and the assigned functional guilds

Nematode Genus	Functional guilds	n[a]	Range of Mean	Regression				
				$r^{2\,b}$	*b*	SE (*b*)	A^c	SE (*A*)
Rhabditis	BF1	36	0.2-34.2	0.88	**1.91**	0.11	0.26	0.10
Panaglolaimus	BF1	35	0.4-49.3	0.90	**1.67**	0.10	0.38	0.10
Monohystara	BF1	34	0.1-14.1	0.90	**1.63**	0.09	0.44	0.05
Diplogaster	BF1	34	0.1-6.9	0.87	**1.46**	0.09	0.36	0.04
Acrobeloides	BF2	36	2.7-45.6	0.82	**1.51**	0.12	0.37	0.14
Acrobeles	BF2	22	0.1-4.1	0.88	**1.36**	0.11	0.51	0.06
Cephalobus	BF2	36	1.2-51.0	0.86	**1.71**	0.12	0.25	0.12
Eucephalobus	BF2	30	0.1-17.2	0.95	**1.71**	0.07	0.68	0.05
Plectus	BF2	36	0.2-17.5	0.88	**1.54**	0.10	0.26	0.07
Wilsonema	BF2	31	0.1-10.4	0.94	**1.57**	0.07	0.48	0.04
Aphelencoides	FF2	36	4.1-77.0	0.82	**1.77**	0.14	0.13	0.20
Aphelenchus	FF2	36	1.6-28.3	0.78	**1.66**	0.15	0.25	0.13
Monochus	PR4	35	0.1-3.7	0.88	**1.53**	0.10	0.36	0.05
Eudorylaimus	OM4	36	0.4-12.4	0.84	**1.48**	0.11	0.33	0.05
Dorylaimus	OM4	36	0.8-10.1	0.59	1.21	0.17	0.41	0.10
Filenchus	PF2	36	0.9-35.7	0.61	1.52	0.21	0.49	0.19
Tylenchus	PF2	36	2.6-158.5	0.84	**2.34**	0.17	-0.45	0.24
Paratylenchus	PF2	31	0.4-22.8	0.89	**1.75**	0.11	0.59	0.07
Helicotylenchus	PF3	35	0.1-43.5	0.93	**1.70**	0.08	0.51	0.08
Hoplolaimus	PF3	32	0.1-7.4	0.92	**1.46**	0.08	0.38	0.04
Pratylenchus	PF3	36	0.2-51.7	0.85	**1.60**	0.11	0.42	0.12

a number of non-zero means, **b** all fits had P<0.001, **c** A=log (a)

- **Fisher's exact test indicates that cp-class and *b* values are likely to be related (*P*=0.10). Low cp-classes (1&2) had higher *b* value, than high cp-classes (3,4 & 5)** (**Table 2**).
- Among 46 genera found, power law analysis was performed on 21 genera which had high enough numbers of non-zero mean and variance (**Table 3**).
- **Compared to their assigned functional guilds, individual nematode genera had lower *b* value, indicating a lower degree of aggregation.**

Conclusions

- **Functional guild as a group tends to aggregate more than individual genera.**
- **Nematode genera within a functional guild showed different degree of aggregation.**
- **Power law analysis on cp-classes reveals that spatial structure of nematodes may be related to the cp-scale and vice versa.**
- **Low cp-scale nematodes tend to aggregate more, than high cp-scale nematodes.**
- **We conclude that the examination of spatial organization of nematodes may lead to further improvements in the practical value of nematodes as soil bioindicators.**

References

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