Nematol. medit. (1976), 4: 161-170.

Institute for Plant Protection
Faculty of Agriculture, Belgrade, Jugoslavia

DISTRIBUTION OF NEMATODES IN CLUMPS OF *FESTUCA VAGINATA* (1)

by

Dj. Krnjaic and S. Krnjaic

Solitary clumps of the perennial grass *Festuca vaginata* W.K. on the loose and semi stable sands of Deliblatska Pešćara (2) constitute a basic habitat for many organisms including arthropods (Gradojvić, 1963; Bogojević, 1970), microflora (Milošević, 1964), nematodes (Krnjaić, 1971; Krnjaić and Krnjaić 1972). Our earlier research (Krnjaić, 1971; Krnjaić and Krnjaić, 1972) showed that the horizontal and vertical distribution of the nematode community is closely correlated with the distribution of basic environmental factors. The study reported here is concerned with composition and distribution of a nematode community in such a habitat in relation to environmental parameters such as temperature, moisture and organic content of the soil.

Material and Method

In biological system in which organisms are associated with the *Festuca vaginata* in its initial colonization of sands, the influence of

(1) Communication presented at the XII International Symposium of Nematology in Granada 1974.

(2) Deliblatska Pešćara is an extensive steppe area in the vicinity of Belgrade with instructured to well structured sands with vegetative cover.

various environmental factors, especially physical factors, is most pronounced in summer, when temperatures are highest and soil moisture lowest. The environment provided by this habitat and the changes, are reflected in the cenotic complex of nematodes which, is best examined in July and August. Our studies were undertaken in the second half of August, when the environmental factors have their greatest effect on the composition and distribution of the nematode complex.

The habitat where the research was undertaken lies at the foot of a bare sand dune (Veliki Vejač), which is just beginning to be colonized by vegetation. The vegetation belongs to the association *Coryspermeto-Polygonetum arenariae* (Stjepanović-Veselićić, 1953) in which the role of *F. vaginata* as a sand-binding perennial is extremely important. Clumps of this grass are able to survive under highly unfavorable conditions, and at the same time they ameliorate the microclimate.

Samples were taken with a probe at the surface and on depths 10, 20, 30, 50 and 100 cm and at radial distances of 10, 20, 30 and 50 cm from the center of the clump. Temperature, moisture and organic content of the soil were ascertained at each sampling point. Nematodes were extracted from 100 ml samples by the method of Oostenbrink (1960), and permanent preparations of specimens made by the method of Seinhorst (1962).

Species were classed as dominant if their relative abundance in the total nematode population exceeded 5%, and as subdominant if their relative abundance was in the range 2-5%. Species with 1-2% were denoted as recedent and those with less than 1% as subrecedent (Krnjaić, 1971).

Results

The nematode community of the solitary clump of *F. vaginata* investigated contained 25 species belonging to several taxa. More than a quarter (28%) belong to the order Tylenchida, six species belong to the superfamily *Tylenchoidea* and one species (*Aphelenchoides saprophilus* Franklin, 1957), to the superfamily *Aphelenchoidea*. Four species belong to the order *Rhabditida* and one [*Teratocephalus terrestris* (Bütschli, 1873), de Man 1876], to *Teratocephalida*. The greatest number of species (13) are in the order *Dorylaimida* (Table I).

Table I - *Number of species and individuals of basic taxa in a solitary clump of* Festuca vaginata.

Order	Species		Individuals	
	Number	%	Number	%
Tylenchida	7	28	383	30.54
Rhabditida	4	16	401	31.98
Teratocephalida	1	4	13	1.07
Dorylaimida	13	52	458	36.52

Table II shows that the most abundant genera are *Tylenhorhynchus* and *Eucephalobus*, and these together with 7 other dominant species, represent 75.36% of the total population. The remaining species are placed in the categories of subdominant (relative abundance 2-5%), recedent (1-2%) or subrecedent (less than 1%) (Table II).

The spatial distribution of the different species is presented in Tables III and IV. More than half the total number of individuals inhabited the zone on the vertical axis of the *F. vaginata* clump, and over 93% were within 10 cm of the centre. Further from the center the numbers of nematodes rapidly declined and some species were absent.

The fact that some species were recorded at 30 cm and even at 50 cm from the center of the clump despite being few in numbers is evidence of their wide ecological tolerance, since it shows that they may be able to survive under extremely unfavorable conditions, especially in respect of temperature.

The vertical distribution of individual species and of the community is presented in Table IV. In general three different kinds of vertical distribution can be distinguished. Most species achieved their maximum density at a depth of 10-20 cm, but some species gradually decreased in number from the surface downwards (*A. saprophilus*, Franklin, 1957, *Acrobeles* sp. 2) or were similar in numbers to about 30 cm depth *E. vitrinus*, Thorne *et* Swanger, 1936, Andrassy, 1959; *D. texanus*, Cobb, 1913, *D. simetricus*, Das, Khan *et* Loof, 1969; *Dorylaimellus vexator*, Heyns, 1963, *Leptonchus scintillans*, Loof, 1963). *Nothocriconema psammophilum*, Krnjaić *et* Loof, 1973, and *Xiphinema mediterraneum*, Martelli *et* Lamberti, 1967, were not found at or near the surface.

Table II - *Dominance of nematode species in a* F. vaginata *clump.*

Group	Species	No individuals	Relat. abundance %
Dominant species (R.a. > 5%)	*Tylenchorhynchus* sp.	154	12.28
	Eucephalobus sp. 1 *	152	12.12
	Eucephalobus sp. 2 *	117	9.33
	Leptonchus scintillans Loof, 1963	98	7.81
	Aphelenchoides saprophilus Franklin, 1957	96	7.66
	Acrobeles sp. 1 *	96	7.66
	Hemicycliophora epicharoides Loof, 1968	84	6.70
	Nygolaimus sp.	83	6.62
	Dorylaimellus vexator Heyns, 1963	65	5.18
Subdominant species (R.a. 2-5%)	*Discolaimoides simetricus* Das Khan *et* Loof, 1969	48	3.83
	Eudorylaimus sp.	43	3.43
	Acrobeles sp. 2 *	36	2.87
	Discolaimus texanus Cobb, 1913	27	2.15
Recedent species (R.a. 1-2%)	*Aporcelaimus* sp.	25	1.99
	Tylenchus davainei Bastian, 1865	23	1.83
	Eudorylaimus vitrinus (Thorne *et* Swanger, 1936) Andrassy, 1959	18	1.44
	Ditylenchus sp.	13	1.04
	Teratocephalus terrestris (Bütschli, 1873), de Man, 1876	13	1.04
Subrecedent species (R.a.< 1%)	*Enchodorella deliblatica* Krnjaić, 1970	12	0.96
	Carcharolaimus sp.	11	0.88
	Macroposthonia xenoplax Raski, 1952	10	0.80
	Eudorylaimus pratensis de Man, 1880	10	0.80
	Xiphinema mediterraneum Martelli *et* Lamberti, 1967	9	0.72
	Discolaimoides bulbiferus (Cobb, 1906), Heyns, 1963	9	0.72
	Nothocriconema psammophilum Krnjaić *et* Loof, 1973	3	0.24

* Label in collection.

Table III - *Horizontal distribution of nematodes in a* F. vaginata *clump.*

Species	Distance from the centre of the clump (cm)					
	0	10	20	30	50	Total
1. *Tylenchus davainei*	11	7	3	1	1	23
2. *Tylenchorhynchus* sp.	82	59	8	4	1	154
3. *Ditylenchus* sp.	4	6	2		1	13
4. *Macroposthonia xenoplax*	2	5	3			10
5. *Nothocriconema psammophilum*	2	1				3
6. *Hemicycliophora epicharoides*	51	23	7	3		84
7. *Aphelenchoides saprophilus*	45	39	2	7	3	96
8. *Eucephalobus* sp. 1 *	94	41	14	3		152
9. *Eucephalobus* sp. 2 *	62	46	8	1		117
10. *Acrobeles* sp. 1 *	51	39	4	2		96
11. *Acrobeles* sp. 2 *	13	14	6	2		35
12. *Teratocephalus terrestris*	4	7	2			13
13. *Eudorylaimus vitrinus*	5	13				18
14. *Eudorylaimus* sp.	21	22				43
15. *Eudorylaimus pratensis*	7	3				10
16. *Discolaimus texanus*	14	9	4			27
17. *Discolaimoides bulbiferus*	6	3				9
18. *Discolaimoides simetricus*	27	15	3	3		48
19. *Carcharolaimus* sp.	6	5				11
20. *Aporcelaimus* sp.	9	12	4			25
21. *Xiphinema mediterraneum*	4	5				9
22. *Enchodorella deliblatica*	7	4	1			12
23. *Dorylaimellus vexator*	40	18	7			65
24. *Nygolaimus* sp.	65	13	3	2		83
25. *Leptonchus scintillans*	64	25	8	1		98
Number of individuals	695	434	89	29	6	1,254
Number of species	25	25	18	11	4	25

* Label in collection.

The spatial distribution of the nematodes was analyzed in relation to some aspects of the environment. Table VI shows the horizontal distribution of the total number of species and of individuals compared with the distribution of temperature, moisture and organic matter. Temperature increased with increasing distance from the

Table IV - *Vertical distribution of nematodes in* F. vaginata *clump.*

Species	Depth (cm)						Total
	0	10	20	30	50	100	
1. *Tylenchus davainei*	2	17	4				23
2. *Tylenchorhynchus* sp.	3	26	31	42	41	11	154
3. *Ditylenchus* sp.	4	7	2				13
4. *Macroposthonia xenoplax*	1	3	3	2	1		10
5. *Nothocriconema psammophilum*		2	1				3
6. *Hemicycliophora epicharoides*	5	5	14	25	27	8	84
7. *Aphelenchoides saprophilus*	32	27	19	10	8		96
8. *Eucephalobus* sp. 1 *	38	72	21	18	3		152
9. *Eucephalobus* sp. 2 *	13	44	45	15			117
10. *Acrobeles* sp. 1 *	9	13	46	26	2		96
11. *Acrobeles* sp. 2 *	12	8	10	6			36
12. *Teratocephalus terrestris*	2	5	4	2			13
13. *Eudorylaimus vitrinus*	5	5	4	4			18
14. *Eudorylaimus* sp.	6	7	15	14	1		43
15. *Eudorylaimus pratensis*	2	2	5	1			10
16. *Discolaimus texanus*	7	6	5	7	2		27
17. *Discolaimoides bulbiferus*	1	3	2	3			9
18. *Discolaimoides simetricus*	12	11	15	10			48
19. *Carcharolaimus* sp.	3	2	3	3			11
20. *Aporcelaimus* sp.	4	12	9				25
21. *Xiphinema mediterraneum*			1	5	2	1	9
22. *Enchodorella deliblatica*	2	4	3	3			12
23. *Dorylaimellus vexator*	17	12	12	18	6		65
24. *Nygolaimus* sp.	6	7	35	27	8		83
25. *Leptonchus scintillans*	11	14	42	19	12		98
Number of individuals	197	314	350	260	113	20	1,254
Number of species	23	24	25	21	12	3	25

* Label in collection.

centre of the clump whereas soil moisture and organic matter decreased. Nematode species and individuals declined in numbers with increasing distance from the centre. Vertical distribution of nematode in relation to environmental factors is shown in Table V.

In summer the surface layer of the sand gets very hot (43.3°C-summer) and has a low relative humidity, but temperature decreases moisture increases with depth. A considerable number of species were found in the surface layer, but in low abundance. With increasing depth, the number of species increased, and also the number of individuals, reaching a maximun at 20 cm. Although the upper layers, contained the greatest amount of organic matter, they did not support the largest nematode populations primarily because of the high temperature and low moisture content. On the other hand, in the deeper layers nematode populations are probably limited by the paucity of nutrients.

Discussion

At first sight it would seem that the nematode community in the *F. vaginata* root zone was rather poor in species and abundance. But in view of the specific character of the habitat 25 species is not a small number. The presence even of this number is made possible by the openess of the stand, allowing the continous transfer of nematode inocula from neighboring, richer habitats. This transfer is maintained by the almost constant winds blowing in this area (Krnjaić and Krnjaić, 1972). Under similar conditions on sand dunes in New Zealand, Yeates (1967) found rather more species but with a lower total abundance, but these differences might be accounted for by certain specific features of the habitats, and also by differences in sampling and extraction. However the nematode fauna found around *Ammophila arenariae* Link in the Baltic region was richer (Kisiel, 1970) than that found in our results.

In habitats with a less severe microclimate and greater trophic capacity the number of species and their abundance are much greater (Ovegaard-Nielsen 1949, Johnson *et al.* 1973) but in any case the compound action of diverse soil environmental factors must be taken into account (Wallace, 1963). In the succession of plant communities on Deliblatska Pešćara the number of species and the abundance of nematodes is directly correlated with the degree of coherence (binding) of the sands, i.e. with the environmental conditions (Krnjaić 1971).

Table V - *Horizontal distribution of the nematodes in relation to temperature, moisture and organic matter in a* F. vaginata *clump.*

	Distance from the centre of clump (cm)				
	0	10	20	30	50
Number of species	25	25	18	11	4
Number of individuals	696	434	89	29	6
Temperature (°C)	23.3	25.3	31.9	32.7	33.3
Relative humidity (%)	3.43	3 23	2.97	2.57	2.51
Organic matter (%)	2.53	2 05	1.56	1.45	1.31

Table VI - *Vertical distribution of nematodes in relation to temperature, moisture and organic matter in a* F. vaginata *clump.*

	Depth (cm)					
	0	10	20	30	50	100
Number of species	23	24	25	21	12	3
Number of individuals	197	314	350	260	113	20
Temperature (°C)	43.3	31.8	25.9	23.7	20.0	—
Relative humidity (%)	0·19	1.08	1.92	2 86	4.02	7.59
Organic matter (%)	4 12	3.83	1.82	0.64	0.23	0.07

The pioneer vegetation of the sand dunes moderates the unfavorable influence of the severe environmental factors (high summer temperatures, low moisture) in proportion to its abundance and coverage. In the case of the perennial grass *F. vaginata*, we have shown that it can ben populated by a nematode community of specific qualitative composition and spatial distribution. An analysis of this composition allows us to draw conclusions about the role and status of the different species represented and about their trophic position in an ecosystem in *statu nascendi.*

SUMMARY

Solitary clumps of *Festuca vaginata* pioneering sand dunes in Deliblatska Pešćara constitute initial habitats for nematodes, which form a cenotic complex in the area of a clump. The population analyzed contained 25 species, or which the following were the most abundant: *Tylenchorhynchus sp., Eucephalobus sp., Leptonchus scintillans, Aphelenchoides saprophilus, Hemicycliophora epicharoides.* These together with another four species constituted the dominant group, with a total relative abundance of 75.36%. The remaining 16 species of the nematode community were allocated according to their abundance relative to the entire population into the subdominant (4 species with total rel. abundance 12.28%), recedent (5 species, with total rel. abundance 7.34%), and subrecedent (7 species, with total rel. abundance 5.12%) categories. The horizontal and vertical distribution of the different species was correlated with changes in temperature, relative humidity and organic matter.

RIASSUNTO

Distribuzione dei nematodi in zolle di Festuca vaginata.

Zolle isolate di *Festuca vaginata*, che colonizzano le dune di Deliblatska Pešćara, costituiscono un habitat iniziale per i nematodi che formano un complesso cenotico nell'area delle zolle. La popolazione studiata era costituita da 25 specie tra cui le più abbondanti erano: *Tylenchorhynchus* sp., *Eucephalobus* sp., *Leptonchus scintillans, Aphelenchoides saprophilus, Hemicycliophora epicharoides.* Queste, insieme con altre quattro specie costituivano il gruppo dominante con un'abbondanza relativa del 75,36%. Le restanti sedici specie della comunità sono state suddivise secondo la loro abbondanza relativa all'intera popolazione nelle categorie: subdominante (quattro specie con un totale di abbondanza relativa del 12,28%), recedente (cinque specie con un totale di abbondanza relativa del 7,34%) e subrecedente (sette specie con un totale di abbondanza relativa del 5,12%). La distribuzione orizzontale e verticale delle differenti specie è stata correlata con le variazioni di temperatura, umidità relativa e sostanza organica nel terreno.

RÉSUMÉ

Distribution des nématodes dans les haies de Festuca vaginata.

Des haies isolées de *Festuca vaginata* dans les dunes de Deliblatska Pešćara constituent l'habitat initial pour les nématodes. La population étudiée est constituée par 25 espèces dont les plus abondantes sont: *Tylenchorhynchus* sp., *Eucephalobus* sp., *Leptonchus scintillans, Aphelenchoides saprophilus, Hemicycliophora epicharoides.* Ces espèces, avec autre quatres, représentent le groupe dominant, avec une abondance relative du 75,36%. Les autres 16 espèces présentes ont été subdivisées selon l'abundance relative de toute la population dans ces catégories: subdominante (quatre espèces avec l'abundance relative de 12,28%), reculante (cinq espèces avec l'abundance relative de 7,34%) et subreculante (sept espèces avec l'abundance relative de 5,12%). La distribution horizontale et verticale des différentes espèces a été étudié en corrélation avec la température, l'humidité relative et la teneur en nature organique du sol.

LITERATURE CITED

BOGOJEVIĆ J., 1970 - Dinamika i sukcesija naselja Collembola na raznim staništima Deliblatske pešćare. Dok. dis. Bgd. (unpbl.).

GRADOJEVIĆ Z., 1963 - Naselja Arthropoda travih zajednica Deliblatske pešćare. Dok. dis. Bgd. (unpbl.).

JOHNSON S. R., FERRIS V. R. and FERRIS J. M., 1973 - Nematode community structure forest woodlands. I Relationships based on simplarity coefficients of nematoda species. J. *Nematol., 4*: 175-183.

KISIEL N. 1970 - Studies on the ecology of nematodes inhabiting on *Ammophila arenariae* community on beaches and dunes of the Baltic sea shore. *Z.N.W.S.R. Szezcin, 34*: 111-150.

KRNJAIĆ DJ., 1971 - Naselja nematoda u ekološki diferenciranim staništima Deliblatske pešćare. Dok. dis. Bgd. (unpbl.).

KRNJAIĆ DJ. and KRNJAIĆ S., 1972 - Influence of some factors on the distribution of nematodes in soil. XIth. Int. Symp. Nematol. Reading 3-8 Sept. 1972: 39.

MILOŠEVIĆ R., 1964 - Mikroflora i njena dinamika na raznim staništima Deliblatske pešćare. Dok. dis. Bgd. (unpbl.).

OOSTENBRINK M., 1960 - Estimating nematode populations by some selected methods. In Nematology Ed. Sasser and Jenkins. Univ. Carol. Press: 85-102.

OVERGAARD-NIELSEN C., 1949 - Studies on the soil microfauna: The soil inhabiting nematodes. *Nat. Jutl., 2*: 1-132.

SEINHORST J. W., 1962 - On the killing, fixation and transfering to glycerin of nematodes. *Nematologica, 8*: 429-442.

STJEPANOVIĆ-VESELIČIC L., 1953 - Vegetacija Deliblatske pešćare. Sr. ak. nauka pos. izdanje 216: 113 pp.

WALLACE H. R., 1963 - The Biology of Plant Parasitic Nematodes. Edward Arnold, London: 285 pp.

YEATES G. V., 1967 - Studies of nematodes from dune sands: 9 Quantitative comparison of the Nematode Faunas of six localites. *N.Z. J. Sci., 10*: 927-948.

Accepted for publication on 12 March 1976.