Changes in abundance, diversity and metabolic footprint of soil nematode community along an elevation gradient under temperate vegetation cover in Banihal-Pass of Pir-Panjal mountain range

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1 **Changes in abundance, diversity and metabolic footprint of soil nematode community along an**
2 **elevation gradient under temperate vegetation cover in Banihal-Pass of Pir-Panjal mountain range.**

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25 **Abstract**

26 Despite enormous diversity, abundance and their role in ecosystem processes, little is known about how
27 community structures of soil-inhabiting nematodes differ across elevation gradient. For this, soil
28 nematode communities were investigated along an elevation gradient of 1000 to 2500 m asl across a
29 temperate vegetation in Banihal-Pass of Pir-Panjal mountain range. We aimed to determine how the
30 elevation gradient affect the nematode community structure, diversity and contribution to belowground
31 carbon assimilation in the form of metabolic footprint. Our results showed that total nematode abundance
32 and the abundance of different trophic groups (fungivores, herbivores and omnivores) declined with the
33 increase of elevation. Shannon index, generic richness and evenness index indicated that nematode
34 communities were more diverse at lower elevations and declined significantly with increase in elevation.
35 Nematode community showed a pattern of decline in overall metabolic footprint with the increase of
36 elevation. Nematode abundances and diversity proved to be more sensitive to elevation induced changes
37 as more abundant and diverse nematode assemblage are supported at lower elevations. Overall it appears
38 nematode abundance, diversity and contribution to belowground carbon cycling is stronger at lower
39 elevations and gradually keep declining towards higher elevations under temperate vegetation cover in
40 Banihal-pass of Pir-Panjal mountain range.

41 **Keywords:** Soil nematodes, elevation gradient, abundance, diversity, metabolic footprint, belowground
42 ecosystem

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49 **1. Introduction**

50 Soils harbour some of the most diverse microbial community on earth, provide shelter to 25% world-
51 wide described species and thus considered as a crucial biodiversity reservoir¹⁻⁶. Soil organism's
52 distribution patterns play critical roles in determining the above and belowground primary production and
53 its composition^{7,8}. Elevation and its related factors significantly affect the soil abiotic characteristics and
54 the density/biomass patterns of nematode communities, thus alter the microbial functions of soil
55 ecosystem⁹⁻¹²

56 All chemical and physical changes in the soil are rapidly reflected through changes in richness and
57 composition of nematode species¹³. In addition to diversity and functional indices which are useful
58 descriptive tools for assessment of food web and ecosystem condition, various metabolic footprint
59 indices¹⁴ have been developed to estimate contribution of nematodes to various ecosystem services and
60 functions. Among the landscape properties, altitude rather than vegetation cover is found to have vital
61 effect on nematode community¹⁵, because altitudinal climatic conditions strongly constrain the
62 availability and turnover of basal resources and can be viewed as nature's own field experiments¹⁶.
63 Various elevation patterns of diversity have been studied across a wide range of taxonomic groups in
64 aboveground organisms, including trees, mammals, birds, insects and amphibians¹⁷. However, elevational
65 diversity patterns of belowground organisms, especially those of soil invertebrates which often represent
66 decomposer subsystems, have remained understudied^{18,4}.

67 In the present study, we tried to unravel the distribution and contribution of soil dwelling nematodes to
68 belowground soil food web from 1000 to 2500 m asl elevation gradient along a pristine temperate forest
69 vegetation cover at Banihal-Pass of Pir-Panjal mountain range which lies in the Western Himalayan
70 region. We assessed total and trophic abundance, biomass, alpha diversity, and metabolic footprint pattern
71 of soil nematodes along the elevation gradient. Since that abiotic factors shape species distributions,
72 fostering fewer species and abundance at high elevations due to harsh climatic conditions compared to

low elevations. Keeping this in consideration, we hypothesized: (1) a decline in nematode abundance and diversity with increasing elevation and (2) metabolic footprint of nematodes will be suitable indicators of elevation change.

3. Results

3.1 Physicochemical properties of soil along elevation gradient

Among the abiotic factors (Table 1), soil moisture ($r = 0.87$, $p = 0.0001$; Fig. 1A), soil organic matter ($r = 0.92$, $p = 0.0001$; Fig. 1B) and proportion of clay ($r = 0.92$, $p = 0.0001$; Fig. 1C) showed significant positive correlation with elevation. While as soil pH ($r = -0.87$, $p = 0.0001$; Fig. 1D) significantly declined with increasing elevation.

3.2 Changes in abundance and biomass of nematode community along elevation gradient

The total nematode abundance, biomass and diversity were correlated and tested with simple linear regression with elevation (Table 1). From 45 soil samples 30955 nematodes were assigned to 49 different genera (Table 2) in five different trophic groups (bacterivore-12, fungivore-12, omnivore-4, predatory-8 and herbivore-13). Total nematode abundance (Fig. 2A) as well as abundance of fungivores, omnivores and herbivores (Fig. 2C-E) are negatively correlated with the increase of elevation, whereas the abundance of bacterivores and predators (Fig. 2B & 2F) did not show any definite pattern. Similarly, the total nematode biomass (Fig. 3A) and biomass of the three trophic groups decreased with elevation (Fig. 3C-E). However, the biomass of both bacterivore and predatory nematodes (Fig. 3B & 3F) did not show any significant decline with elevation.

3.3 Diversity indices and metabolic footprint along elevation gradient

All measured alpha diversity indices reflected a significant negative (Table 1) correlation with the increase of elevation. The values of H ($r = -0.49$, $df = 43$), GR ($r = -0.32$, $df = 43$) and J ($r = -0.42$, $df = 43$) negatively correlated with increasing elevation (Fig. 4A-C). The composite metabolic footprint,

96 enrichment footprint and structure footprint all decreased with increasing elevation (Fig. 5A-C) indicating
97 the amount of carbon entering the soil food-web from total nematode assemblages.

98 *3.4 Relationship of soil nematode assemblages with soil physiochemical properties:*

99 Total nematode abundance was negatively correlated with soil moisture (Fig. 6A) and proportion of
100 clay (Fig. 6D) and positively correlated with pH (Fig 6G). No significant correlation was observed
101 between soil moisture and nematode generic richness (Fig. 6B). However, generic negatively correlated
102 with proportion of clay (Fig. 6E) and positively correlated with pH (Fig.6H). Soil moisture (Fig. 6C) and
103 proportion of clay (Fig. 6F) showed negative influence on diversity (H'), While as pH showed positive
104 influence on diversity (Fig.6I).

105 **4. Discussion**

106 Elevation is a complicated, indirect gradient along which several environmental variables shift,
107 resulting in a fundamental diversity gradient trend in animal and plant biogeography. The temperate
108 vegetation in higher altitudes of Banihal-Pass of Pir-Panjal mountain range experiences extremely harsh
109 climatic conditions with almost half of the precipitation received in the form of snow, because soil
110 remains deep frozen in winter months and experiences significant temperature fluctuations.

111 In line with our first hypothesis here we observed that total soil nematode abundance and diversity exhibit
112 a significant decline with elevational gradient which is consistent with the results of some earlier studies
113 on nematodes^{19, 20} and with other soil fauna including springtails and mites²¹, and other
114 microarthropods^{22,23}. In contrast to this, various patterns are found to occur in nematode community along
115 the elevation, at mid-elevation maximum diversity and species richness have been documented^{24,25}, in
116 alpine grasslands abundance and diversity increased with elevation²⁶. However similar studies on
117 nematodes along gradient did not find any definite pattern^{27,28}. As mentioned earlier mountains in Pir-
118 Panjal range tend to have greater climatic adversities that alter soil conditions, and it is possible that due

119 these altered soil conditions explains the survival of sparse and coexistence of fewer nematode species in
120 the higher elevations. Several environmental gradients are held responsible for shaping soil nematode
121 communities. Among the environmental conditions that shift strongly with elevation is temperature,
122 which gradually decreased with elevation (Fig. S1) and proved detrimental for nematode community like
123 other soil organisms. Nematodes are found to be very sensitive to temperature changes with optimal of
124 20–25°C for the survival and propagation, any change in temperature from optimum value leads to
125 significant inhibition in nematode population^{29,30,31}. In our study, temperature was below optimum value
126 possibly affecting soil nematode abundance and diversity as conditions were much harsher at higher
127 elevations. Increased soil organic matter and moisture along the elevation gradient (Fig.1) had a negative
128 impact on nematode abundance and diversity, although they are considered as positive drivers of their
129 community^{32,25,33}. The reason for this may be the presence of more proportion of clay in soil at higher
130 altitude which reduced the porosity of soil and litter decomposition rate, enhancing water retention that
131 leads to damp soil formation and anaerobic conditions under coniferous vegetation canopy which is rich
132 in lignin³⁴. The reason for the decrease in soil pH with elevation may be due to the litter accumulation that
133 negatively effects the nematode community, as found in other soil biota³⁵.

134 Variation in nematode abundance belonging to different trophic groups were also observed. Abundance
135 of herbivores, fungivores and omnivores significantly declined with altitude which is in line with Veen et
136 al.³⁶. A potential explanation for these findings is that herbivore nematodes are favoured in soils colonized
137 by diverse assemblages of plants with well-developed fine root systems. At higher altitudes vegetation is
138 sparse under forest canopy, possibly depriving food for herbivores which is in accordance with another
139 studies that reported a reduction in the abundance of plant-feeders with altitude^{37,12}. For herbivore
140 nematodes, bottom-up effects from plant communities are thought to be more important than top-down
141 pressure from predators³⁸. Elevation has no effect on bacterial feeding nematodes in our study, which may
142 be due to basal characteristics bacterial feeders in food web that are mostly dominated by basal fauna.

143 However another studies^{26,29} reported a definite pattern of increase in bacterivore nematode from lower to
144 higher elevations. The non-significant decline of predatory nematodes could be due to their key position
145 in the soil food web, where they can switch on to different prey based on availability.

146 Similar results were reported by Kergunteuil et al.²⁶.

147 The metabolic footprint provides information on magnitude of carbon and energy flow in soil food
148 webs¹⁴. The nematode metabolic footprint consists of composite metabolic footprint, enrichment footprint
149 and structure footprint which are the representatives of whole nematode community¹⁴. In our study, we
150 found that the carbon assimilation in soil food web from autotrophic organisms decreased with elevation
151 as found in composite metabolic footprint, enrichment footprint and structure footprint. The enrichment
152 footprint is considered to be an indicator of resource entry into the soil food web³⁹. The decline of
153 enrichment footprint with elevation showed less entry of resources in the soil food web at high elevation
154 because of slower decomposition rates influenced by low temperature and winter permafrost. Structure
155 footprint reflects metabolic activity of higher trophic level nematodes, which have regulatory function in
156 the food web^{40,41}. The decrease in structure footprint with elevation may be related to decrease of resource
157 entry in the food web at higher elevation, indicating a possible bottom-up control of the soil food web.
158 Overall, this decrease in carbon assimilation of whole nematode community could be attributed to
159 retention of more carbon in tree biomass than in soil of these temperate forests at higher elevation,
160 although productivity is high⁴². However, decline in the efficiency of carbon to enter the soil faunal food
161 web through nematodes with increasing altitude may be due to decrease in the availability of amplifiable
162 prey for nematodes. Thus for the mitigation of elevated atmospheric carbon, high altitude forest soils
163 cannot be relied. Additional expansion of lower altitude forests in these regions need to be considered for
164 mitigating and stabilising the elevated atmospheric carbon in soil food webs. Accordingly our second
165 hypothesis that nematode metabolic footprint are the suitable indicators of elevation change suggests
166 whether carbon is partitioned in the soil food web or not.

167 5. Conclusion

168 Our findings from this study indicated that a more abundant and diverse nematode assemblage are
169 supported at lower elevations and keep diminishing along elevation gradient under temperate vegetation
170 cover in Banihal-Pass of Pir-Panjal mountain range. Temperature and local soil microhabitat are the main
171 elevation induced environmental factors which shape the pattern of nematodes. We also observed that the
172 role played by nematodes in carbon cycling decreases with elevation as the carbon footprint of nematodes
173 showed significant decline. However, as elevation gradients are complex in mountain environments,
174 further studies focused on vegetation type, temporal dynamics and biotic interactions of nematodes are
175 needed to validate, whether this pattern is general.

176 2. Methods

177 2.1 Study site

178 The study site was situated in Banihal-Pass (33.4370°N, 75.1939°E) of Pir-Panjal mountain range. The
179 region owing to its topography falls in typical temperate zone with maximum elevation of 2832 m. The
180 area experiences a mean annual temperature and precipitation of 15.1°C and 1363 mm respectively.
181 However, change in temperature with elevation was calculated by lapse rate of 0.6°C/100 m ²⁵(Dong et al.
182 2017) using an annual base temperature of 15.1°C of the study site (Fig. S1). At higher altitudes
183 significant amount of precipitation is received in the form of snowfall. The climate varies with altitude
184 (IMD 2014). The soils of the region are organic rich brown forest soils and podzolic soils. The
185 vegetation cover at altitudes between 1000 and 2000 m asl is of temperate deciduous type mostly
186 dominated by *Pinus roxburghii*, *Robinia pseudoacacia*, *Populus* spp., *Ulmus villosa*, *Aesculus indica*,
187 *Juglans regia*, *Salix* spp. The zone between 2000 and 2500 m asl is of temperate coniferous vegetation
188 having predominance of *Abies pindrow*, *Pinus welichiana* and *Cedrus deodara*. Above 2500 m asl, the
189 vegetation cover is mostly alpine tundra and alpine pastures.

190 2.2 Soil sampling

191 Sampling was conducted in the month of April 2018. A total of 45 soil samples were collected from 15
192 elevations along a mountain separated from each by ~100 m of elevation. At each elevation, three separate
193 quadrats of 5 m² were selected, spaced approximately 50 m apart in a horizontal line. From each quadrat
194 five sub-samples, four from corners and one from centre at a depth 0–15 cm were combined to form a
195 composite sample of 500 g. These samples were transported to lab within two days.

196 2.3 Soil analysis

197 Physicochemical analysis of soil: About 350 g of the soil out of the initial bulk was used for measuring
198 soil properties (soil moisture, soil organic matter, pH, and soil texture). Soil moisture was measured
199 gravimetrically by drying at 40°C for seven days. SOM was estimated following loss on ignition
200 method⁴³. Soil pH was measured by forming a suspension of 20 g of soil in 40 ml of deionised water
201 using pH meter (ECPHTUTOR). Soil texture was calculated as the relative proportion of sand, silt, and
202 clay expressed as percentage.

203 2.4 Nematode extraction and identification

204 From 100 g of fresh soil sample, nematodes were extracted via decanting and sieving following the
205 Cobb's method⁴⁴. Each soil sample was put into a 1 L beaker and mixed with tap water. The water
206 suspension was stirred and decanted into another 1 L beaker through 2 mm mesh sieve to remove stones
207 and large debris. The water suspension was mixed further and then decanted through 53 µm mesh sieve.
208 The material left on the sieve was collected in 250 ml beaker and further extraction was carried out by
209 Baerman's funnel method. Nematodes were removed for 2 days, stored at 4 °C, fixed in TAF and counted
210 using inverted microscope (Olympus SZX10). Additionally, 200 individuals per sample were identified to
211 generic level using compound microscope (Olympus BX41), with the aid of various texts^{45,46,47,48,49}. The
212 genera identified were also assigned to different functional guilds^{50,40}.

213 2.5 Community analysis

214 Nematode abundance and trophic abundance was adjusted as total number of individuals in 100 g of
215 dry soil. Alpha diversity of nematodes were calculated by Shannon index ($H = -\sum_{i=1}^n P_i \ln P_i$), generic
216 richness, Chao1 = $S + F_1(F_1 - 1)/(2(F_2 + 1))$ (where S is number of genera; F1 and F2 indicate genera
217 represented by one and two individuals of a genus in a sample respectively) and evenness index ($J =$
218 $H/\ln S$); indices were analysed with PAST 3.26⁵¹. The metabolic footprints which estimates magnitude of
219 ecosystem services and functions provided by nematodes to the soil food web were calculated using the
220 equations:

$$221 W = (D^2 \times L)/(1.6 \times 10^6)^{52}$$

$$222 F = \sum (N_t (0.1(W_t/m_t) + 0.273 (W_t 0.75)))^{14}$$

223 Where W is the nematode biomass (μg), D and L are maximum body diameter (μm) and body length
224 (μm) respectively, N_t is the number of nematodes in genus t, W_t is the estimated body weight of genus t,
225 and m_t is the c-p group of the genus t. Metabolic footprints were calculated using the NINJA online
226 program⁵³.

227 2.6 Statistical analysis

228 Spearman correlation and simple linear regression was used to study the effect of elevation on abiotic
229 factors, soil nematode community as well as relationship of soil abiotic factors with soil nematode
230 communities. All statistical analysis and graphs were prepared with the help of software GraphPad
231 Prism 8.0.2⁵⁴. P was considered significant below 0.05. Analysis of four abiotic factors of 45 soil samples
232 was correlated with elevation and tested with simple linear regression.

233

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Authors' contributions

SA conducted survey in the month of April 2018; conducted all community and statistical analyses; and led writing of the manuscript. WA helped to develop the study design and also contributed in the editing of manuscript. ALL the authors contributed to writing and editing the manuscript. The authors read and approved the final manuscript.

Competing interests

The authors declare that they do not have any competing interests.

Fig. 1: Effect of elevation on soil moisture (A), soil organic matter (B), proportion of clay (C) and pH (D). Equation for Y , R^2 (coefficient of determination), p value of linear regression and line of linear regression are shown.

Fig. 2: Relationship between elevation and total abundance of nematodes (A), trophic groups: Bacterivores (B), Fungivores (C), Herbivores (D), Omnivore (E), Predators (F). Equation for Y , R^2 (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

Fig. 3: Relationship between elevation and total biomass of nematodes (A), biomass of trophic groups: Bacterivores (B), Fungivores (C), Herbivores (D), Omnivores (E), Predators (F). Equation for Y , R^2 (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

Fig. 4: Relationship between elevation and total nematode diversity (A), generic richness (B) and evenness (C). Equation for Y , R^2 (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

Fig. 5: Relationship between elevation and composite metabolic footprint (A), enrichment footprint (B) and structure footprint (C). Equation for Y , R^2 (correlation coefficient), p (significance) of linear regression and regression line are displayed.

Fig. 6: Relationship of soil moisture, and proportion of clay with total nematode abundance, GR and H' (A-I). Equation for Y , R^2 (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

Fig. S1: Effect of elevation on Mean Annual Temperature ($^{\circ}\text{C}$).

Abbreviations

m asl: meters above sea level; MAT: mean annual temperature; IMD: Indian Meteorological Department; SOM: Soil organic matter; TAF: Triethanolamine formaldehyde; TNEM: total nematode

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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402 **Authors' information**

403 SA, HN and ZI are members of research team of Prof. Wasim Ahmad who is expertise in the field of
404 nematode systematics and ecology. SA and HN are working as doctoral students in NBR Lab, Department
405 of Zoology, ZI is working as a faculty in the same department.

Table 1 Slope coefficients, *P* values and standard errors (SE) for linear regressions showing the relationships between elevation and abiotic factors, nematode abundance, biomass, diversity and metabolic footprint.

Category	Variables	Slope	<i>P</i> value	SE
Abiotic factors	Soil moisture	0.02847	<0.0001	0.0023
	Soil organic matter	0.008233	<0.0001	0.0005
	Clay proportion	0.01970	<0.0001	0.0011
	Soil pH	-0.00174	<0.0001	0.0001
Abundance	Total nematodes	-0.5068	0.0042	0.1676
	Bacterivores	-0.1713	0.0530	0.0821
	Fungivores	-0.1707	0.0231	0.0724
	Herbivores	-0.1067	0.0099	0.0395
	Omnivores	-0.02952	0.0052	0.0100
	Predators	-0.02851	0.1003	0.0169
Biomass	Total nematodes	-0.00042	0.0042	0.0001
	Bacterivores	-8.93100	0.0530	4.8390
	Fungivores	-5.78500	0.0231	2.4500
	Omnivores	-0.06194	0.0099	0.0209
	Predators	-0.00011	0.0052	8.3780
Diversity	Shannon index (<i>H</i>)	-0.00046	0.0004	0.0001
	Generic richness (Chao1)	-0.00262	0.0216	0.0010
	Evenness (<i>J</i>)	-0.00012	0.0024	3.8860
Metabolic footprint	Composite	-0.1347	0.0013	0.0390
	Enrichment	-0.02629	0.0196	0.0108
	Structure	-0.04426	0.0260	0.0192

Table 2. Mean relative abundance of nematode genera (%) along elevation gradient. (n=3). ^a Elevation in metres above sea level
^bFunctional guild is composite of trophic group and cp value:Ba, Bacterivore; Fu, Fungivore; He, Herbivore; Om, Omnivore; Pr, Predator. Trophic groups and cp values are after Yeates et al. (1993) and Bongers and (Bongers 1988), respectively.

Genus	Functional guild ^b	Elevation ^a														
		1000 m	1100 m	1200 m	1300 m	1400 m	1500 m	1600 m	1700 m	1800 m	1900 m	2000 m	2100 m	2200 m	2300 m	2400 m
Bacterivores																
<i>Acrobeles</i>	Ba2	0.0	0.0	2.5	0.0	5.3	0.0	0.0	6.4	0.0	20.4	0.0	0.0	26.1	1.3	0.2
<i>Acrobeloides</i>	Ba2	21.0	40.4	20.8	32.5	10.7	52.0	43.7	5.4	32.5	10.6	46.0	59.6	20.5	48.3	34.2
<i>Alaimus</i>	Ba4	3.9	1.6	0.5	2.8	2.1	0.1	1.1	0.1	0.0	0.2	1.3	0.0	17.6	0.2	0.0
<i>Cephalobus</i>	Ba2	3.9	2.7	2.0	2.8	5.1	0.7	1.0	2.1	2.4	1.9	0.4	3.7	2.5	1.2	1.2
<i>Chiloplacus</i>	Ba2	0.0	0.0	0.0	0.0	0.0	0.4	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Diplogaster</i>	Ba1	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
<i>Eucephalobus</i>	Ba2	0.4	0.0	0.0	0.0	0.1	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	4.3
<i>Mesorhabditis</i>	Ba1	12.4	2.8	1.5	1.1	10.7	14.6	1.2	9.6	3.1	2.6	2.0	1.1	1.2	11.9	12.6
<i>Monhystera</i>	Ba2	0.1	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Plectus</i>	Ba2	1.7	2.7	3.9	1.8	2.8	0.4	3.0	3.9	1.9	12.7	2.0	4.5	0.7	2.9	5.7
<i>Prismatolaimus</i>	Ba3	1.6	3.2	0.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0
<i>Wilsonema</i>	Ba2	0.2	0.6	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fungivores																
<i>Aglenchus</i>	Fu2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	0.0	1.1	2.0
<i>Aphelenchoides</i>	Fu2	0.2	0.2	1.4	0.0	13.1	2.2	2.0	0.0	0.0	0.0	0.0	0.0	0.2	5.1	13.7
<i>Aphelenchus</i>	Fu2	4.2	14.8	15.6	10.1	0.2	10.1	17.4	7.7	15.6	4.2	10.8	8.3	4.5	7.1	3.1
<i>Axonchium</i>	Fu5	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Belondira</i>	Fu5	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Ditylenchus</i>	Fu2	0.0	0.0	0.0	0.0	0.0	0.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Doryllium</i>	Fu4	1.1	0.2	8.7	14.8	0.6	2.4	8.2	12.8	2.2	2.7	3.1	3.7	7.6	3.1	0.3
<i>Filenchus</i>	Fu2	1.3	0.0	4.9	2.4	14.5	0.9	6.4	4.3	1.7	1.5	4.3	2.9	3.7	4.7	3.6
<i>Oxydiris</i>	Fu5	0.0	0.0	0.5	0.5	4.1	0.0	0.0	0.0	0.0	0.4	0.6	1.0	1.5	0.2	1.5
<i>Tylencholaimellus</i>	Fu4	3.8	2.4	0.3	2.6	3.9	0.9	0.6	8.4	1.1	0.0	1.9	3.0	3.2	0.5	1.3
<i>Tylencholaimus</i>	Fu4	0.0	0.0	0.2	0.0	3.1	1.6	0.3	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0
<i>Tylenchus</i>	Fu2	0.0	0.2	1.4	4.6	5.9	0.0	0.9	0.5	0.5	0.0	1.3	2.2	0.3	0.5	0.0
<i>Diphtherophora</i>	He2	0.0	0.0	0.8	0.0	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Herbivores																
<i>Enchodelus</i>	He4	0.7	1.1	0.0	7.7	0.4	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0
<i>Helicorylenchus</i>	He3	11.1	4.2	5.1	3.6	0.0	2.1	0.0	14.9	24.2	12.2	0.7	0.9	3.1	1.7	3.8
<i>Hemicriconemoides</i>	He3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
<i>Hoplolaimus</i>	He3	0.4	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0
<i>Longidorus</i>	He5	0.9	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Merlinius</i>	He3	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	1.2	1.2	0.0	0.0	0.0	0.0
<i>Oriverutus</i>	He4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Paralongidorus</i>	He5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Pratylenchus</i>	He3	20.8	0.0	1.6	1.5	0.0	0.0	0.2	15.8	4.4	3.9	0.5	1.4	0.0	0.9	0.0
<i>Psilenchus</i>	He2	1.1	0.7	1.3	0.7	2.0	0.0	0.9	0.0	0.4	0.0	0.7	0.3	0.2	0.2	0.4
<i>Rotylenchus</i>	He3	0.1	9.0	1.4	0.0	2.9	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0
<i>Tylenchorhynchus</i>	He3	0.0	0.0	1.3	0.2	0.2	0.0	0.0	0.2	3.3	0.1	0.0	0.0	0.1	0.0	0.0
Omnivores																
<i>Crassolabium</i>	Om4	0.0	0.0	0.0	0.2	0.0	0.0	1.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Eudorylaimus</i>	Om4	2.1	4.8	1.8	1.7	7.6	0.0	3.4	0.0	0.9	2.6	4.3	0.8	1.0	2.8	3.8
<i>Mesodorylaimus</i>	Om4	0.6	0.3	2.4	0.2	2.5	7.9	1.7	1.9	0.0	0.1	1.5	0.0	0.0	0.5	0.0
<i>Microdorylaimus</i>	Om4	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Predators																
<i>Aporcelaimellus</i>	Pr5	3.8	2.2	0.4	0.7	0.0	0.6	1.5	2.3	1.4	3.2	10.7	2.2	1.4	1.7	2.8
<i>Clarkus</i>	Pr4	1.4	0.0	1.4	0.7	0.2	0.2	0.0	0.9	0.0	0.4	0.4	1.3	0.8	0.3	1.5
<i>Discolaimoides</i>	Pr5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0
<i>Discolaimus</i>	Pr5	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	1.8	2.1	1.1	0.1	0.0	0.1
<i>Ironus</i>	Pr4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Metaporcelaimus</i>	Pr5	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Moshajia</i>	Pr5	0.0	0.0	0.0	0.5	0.0	1.3	1.8	0.2	0.7	0.0	0.2	0.0	0.0	0.0	0.0
<i>Mylonchulus</i>	Pr4	1.1	5.2	2.7	3.8	0.3	0.0	0.4	0.0	1.1	6.2	2.8	1.9	3.1	1.0	3.8

Figures

Figure 1

Effect of elevation on soil moisture (A), soil organic matter (B), proportion of clay (C) and pH (D). Equation for Y, R² (coefficient of determination), p value of linear regression and line of linear regression are shown.

Figure 2

Relationship between elevation and total abundance of nematodes (A), trophic groups: Bacterivores (B), Fungivores (C), Herbivores (D), Omnivore (E), Predators (F). Equation for Y, R² (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

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Relationship between elevation and total biomass of nematodes (A), biomass of trophic groups: Bacterivores (B), Fungivores (C), Herbivores (D), Omnivores (E), Predators (F). Equation for Y, R² (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

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Figure 6

Relationship of soil moisture, and proportion of clay with total nematode abundance, GR and H' (A-I). Equation for Y, R2 (coefficient of determination), p (significance) of linear regression and regression line are displayed only for significant relationships.

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