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A Comparative Study Of Soil Inhabiting Nematodes Of Pir Panjal Biodiversity Park Of Baba Ghulam Shah Badshah University, Rajouri, J&K, India.

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A B S T R A C T

The diversity of soil-inhabiting nematodes of Pir Panjal Biodiversity Park (PPBP) of Baba Ghulam Shah Badshah University, Rajouri, Jammu and Kashmir, India was studied. Twenty five soil samples were collected at random from PPB Park. After screening the samples, 35 nematode genera were recorded. Of the total population, 54.60% were bacterivores, 20.35% omnivores, 9.85% predators and 14.08% plant parasitic. According to the trophic grouping, bacterial feeders represent the highest percentage of 45.71% followed by omnivores (22.58%), parasitic (14.28%) and fungivores (2.85%). Different diversity indices like Simpson index, Shannon-Weaner index, Menhinicks index, Inverse Simpson index (Hill's reciprocal) and Margalefs index were used to study the nematode diversity. Moreover, isolated genera were assigned different c-p values according to Bongers (1990) which showed nematode population stability in the given area.

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1. Introduction

The nematodes are the most successful invertebrate organisms after insects and occupy a lower position in the taxonomic hierarchy. They are the most abundant and probably the most diverse organisms on the earth. According to **Gunapala (1998)** four of every five multicellular organisms on this planet are nematodes. They occupy a key position in the soil food web. They help in decomposition and mineralization **(Beare *et. al.*, 1992)**. On the basis of tropic grouping, nematodes may be bacterivores, predators, fungivores, omnivores and plant parasitic **(Yeates *et al.*, 1993)**. According to **Popovici, 1984,** the nematodes that feed on fungi dominate the forest soil and the nematodes that feed on bacteria dominate the agricultural fields. Soil conditions like organic matter content **(Wasilewska, 1970; Hendrix *et al.*, 1990; Griffiths *et al.*, 1995)** provides a clear idea about the nematode activity, trophic structure and abundance. All the nematode species occurring in a particular natural or managed habitat constitutes the nematode community of that very habitat or area. These communities are very much sensitive to changes in different parameters like pH, salinity, food supply **(Yeates, 1987)**, and environment **(Samoiloff MR, 1987; Wasilewska, 1989)**. The biological and functional characteristics of these nematodes generally depends on the soil habitat characteristics. Thus, any change in the environment of their habitat affects their population dynamics. The nematodes play a pivotal role in the regulation of nutrient cycling (**Anderson RV *et al.*, 198**3) and decomposition of organic matter and play a key role in the food web of soil habitat (**Moore JC, 1991**). The biological and ecological health of the soil is obtained by the quantification of different attributes of soil nematodes through different indices which have been used in the present work.

In India 10 biogeographic zones are found. They are grouped into 26 provinces **(Rodgers and Panwar 1988)**. Indian Himalayan Region harbours diversified species of flora as well as fauna. According to Myers, it is known as Mega Hot Spot of biological diversity. The present study area is Pir Panjal Biodiversity Park that lies in the Baba Ghulam Shah Badsh

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University Rajouri. The Park is spreaded over an area of 437 acres in the Dhanore area of the famous Pir Panjal Himalayan range. The area is Rocky type and undulating. The dominant vegetation includes *Pinus roxburghii*, *Grewia oppositifolia* and *Ulmus wallichiana* In order to explore the diversity of soil nematodes of the PPB park, the nematodes were isolated using standard techniques. Generic level identification and counting was done in the laboratory. Different Ecological indices like Shannon-Weaner Index (H'), Simpson index (D), Menhinicks index (D_{Mn}), etc. were used to assess the diversity of different nematodes.

2. MATERIALS AND METHODS

2.1 Collection Of Samples:

A survey was conducted during September, 2018 for the diversity and community structure of soil nematodes of Pir Panjal Biodiversity Park. Twenty five samples were collected randomly from the PPB Park. The samples were collected in air tight bags labelled with important information like sample number, collection date, collection site, etc.

2.2 Processing Of Samples:

The nematodes were extracted by Cobb's sieving and decantation and modified Baermann's funnel techniques. The extracted nematodes were concomitantly killed and fixed using hot fixative 4:1 and dehydrated in glycerine–alcohol (5 parts glycerine + 95 parts 30% alcohol) (Seinhorst, 1959). The dehydrated nematodes were mounted in anhydrous glycerine.

2.3 Identification Of Nematodes:

After fixation and dehydration, permanent slides were made by a wax ring method using the paraffin wax and the same were studied under Olympus BX51 DIC microscope. For the identification of specimens mounted on slides upto genus level, the literature of Andrássy, 1983; Jairajpuri & Ahmed 1992 and Ahmed 1996 was consulted.

2.4 Nematode Counting:

The nematodes were counted by using a Syracuse counting dish.

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Community analysis: The parameters used for the community analysis are:

Frequency (N): Frequency of nematode genus is the number of samples in which the genus was present.

Absolute Frequency (AF %): It is the frequency of genus X × 100/ total number of samples counted.

Density (MD): It is the number of nematode specimens of the genus counted in all samples / total number of the samples collected.

Relative density (RD %): It is the mean density of the genus X ×100/ sum of the mean density of all nematode genera (Tomar et al., 2006)

Diversity indices: Following diversity indices were calculated:

Shannon-Weaner Index (H') = -ΣPi, ln Pi (Shannon and Weaner, 1949)

Simpson index (D) = -Σ Pi2

Inverse Simpson index (Hill's reciprocal) N2 = 1/D

Menhinicks index (DMn) = S/N

Margalefs index (DMg) = S-1/ln N

Where, Pi = proportion of individual of taxon i in the total population.

S = Number of species recorded.

N = Total number of individuals in the sample.

3. RESULTS

Diversity Of Nematode Genera:

A total of 25 soil samples collected from Pir Panjal Biodiversity Park which yielded thirty five nematode genera with bacterivores representing highest number (54.60%), followed by omnivores (20.35%), predators (9.85%), parasitic (14.08%), and fungivores (1.10%). In terms of taxonomic groups, the order Rhabditida represent 34.28%, followed by Dorylaimida 22.85%, Tylenchida 14.28%, Mononchida 14.28% and Aphelenchida 2.85%. On the basis of tropic grouping, bacterivores represented (45.71%), omnivores (22.85%), parasitic and predators (114.28%) and fungivores (2.85%).

The comparative study revealed that the most dominant genera were Helicotylenchus and Cuticularia whereas the genera found in least number were Jensenchus and Protorhabdis.

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The frequency of occurrence is 62% (Helicotylenchus), 57% (Cuticularia) 28% (Jensenchus) and 25% (Protorhabdis).

Frequency

Among the herbivores or root feeders the genus that was present in most samples was Helicotylenchus with 88% absolute frequency, whereas the genus that was present in few samples was Pratylenchus with 64% absolute frequency. Among the bacterial feeders, the genus Cuticularia and Diploscapter was found in most of the samples with absolute frequency 80% and 72%, respectively whereas the genus Protorhabditis was found in least samples with absolute frequency 36%. Among omnivores, i.e., the nematodes that feed on various food types, the frequently occurring genus was Nygolaimoides with AF of 76%, and the least frequent genus was Discolaimus with AF of 36%. Genus Mononchus among predatory nematodes and genus Aphellenchus among fungal feeders was found in most of the samples with an AF of 68% and 72% respectively

Mean Density:

The most dominant genera among the plant root feeders was Helicotylenchus with a mean density of 17.6 and relative density of 4.95%, and the least dominant genera was Pratylenchus with mean density of 4.8 and relative density of 1.13%. Among the fungal feeding nematodes, the only genus found was Aphelenchus with mean density 9.96 and relative density 1.10%. The genus Cuticularia with a mean density of 34.4 and relative density (RD) of 9.60% was the most dominant genus among the bacterivores nematodes. The least dominant genus was Protorhabditis with a mean density of 4.8 with relative density of 1.34%. Nygolaimoides with a mean density of 9.72 and relative density of 2.71%) was the dominant genus among Dorylaimids; whereas Discolaimus with a mean density of 7.6 and relative density of 2.12% was the least dominant genus (Table I). Among the predators, Mononchus was the most dominant genus with a mean density of 8.72 and relative density of 2.43%. Iotonchus with mean density 3.92 and relative density of 1.09%, Jensenchus with mean density of 4.08 and relative density of 1.13%) and ylonchulus ean density of 7.24

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and relative density of 2.02% were the least dominant genera.

Table I. Population structure of soil-inhabiting nematodes of Pir Panjal Biodiversity Park of BGSB University, Rajouri, Jammu and Kashmir, India.

Nematode genera	Cp value	N	AF%	MD	RD
Bacteriovores					
Protorhabditis	1	9	36	4.8	1.34018316
Mesorhabditis	1	17	68	24.68	6.89077507
Bursilla	1	13	52	8.12	2.26714318
Loffienema	1	11	44	4.08	1.13915568
Teratorhabditis	1	16	64	8.72	2.43466607
Rhabditella	1	16	64	11.2	3.12709404
Diploscapter	1	18	72	15.72	4.38909984
Diploscapteroides	1	17	68	8.4	2.34532053
Serronema	1	13	52	4.72	1.31784677
Acrobeles	2	13	52	12.12	3.38396247
Acrobeloides	2	15	60	13.72	3.83069019
Cuticularia	1	20	80	34.4	9.60464597
Curviditis	1	17	68	16.32	4.55662274
Wilsonema	2	16	64	8.2	2.28947956
Cephalobus	2	13	52	8	2.2336386
Pelodera	1	18	72	12.36	3.45097163
Omnivores					

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International Journal of
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Discolaimus	4	9	36	7.6	2.12195667
Dorylaimus	4	17	68	19.2	5.36073263
Xiphinema	4	17	68	8.36	2.33415233
Thornia	4	11	44	7.32	2.04377932
Tobrilus	3	12	48	5.72	1.5970516
Leptonchus	4	18	72	6.92	1.93209739
Amphidorylaimus	4	17	68	8.08	2.25597498
Nygolaimoides	4	19	76	9.72	2.7138709
Plant Parasitic					
Helicotylenchus	3	22	88	17.76	4.95867769
Pratylenchus	3	16	64	4.88	1.36251954
Rotylenchus	3	17	68	8.72	2.43466607
Hoplolaimus	3	19	76	7.36	2.05494751
Longidorus	4	18	72	11.72	3.27228055
Predatory					
Mononchus	4	17	68	8.72	2.43466607
Mylonchus	4	13	52	7.24	2.02144293
Jensenchus	4	10	40	4.08	1.13915568
Iotonchus	4	9	36	3.92	1.09448291
Clarkus	4	16	64	11.32	3.16059862
Fungivores					
Aphelenchus	2	18	72	3.96	1.10565111

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Table II. Summary of nematode diversity indices in Pir Panjal Biodiversity Park of BGSB University, Rajouri, Jammu Kashmir, India.

Ecological Index	Values
Shannon-Weaver Index (H')	3.40
Simpon index (D)	0.039
Inverse Simpson index (Hill's reciprocal)	26.31
Menhinicks index(D_{Mn})	0.36
Margalefs index(D_{Mg})	3.73

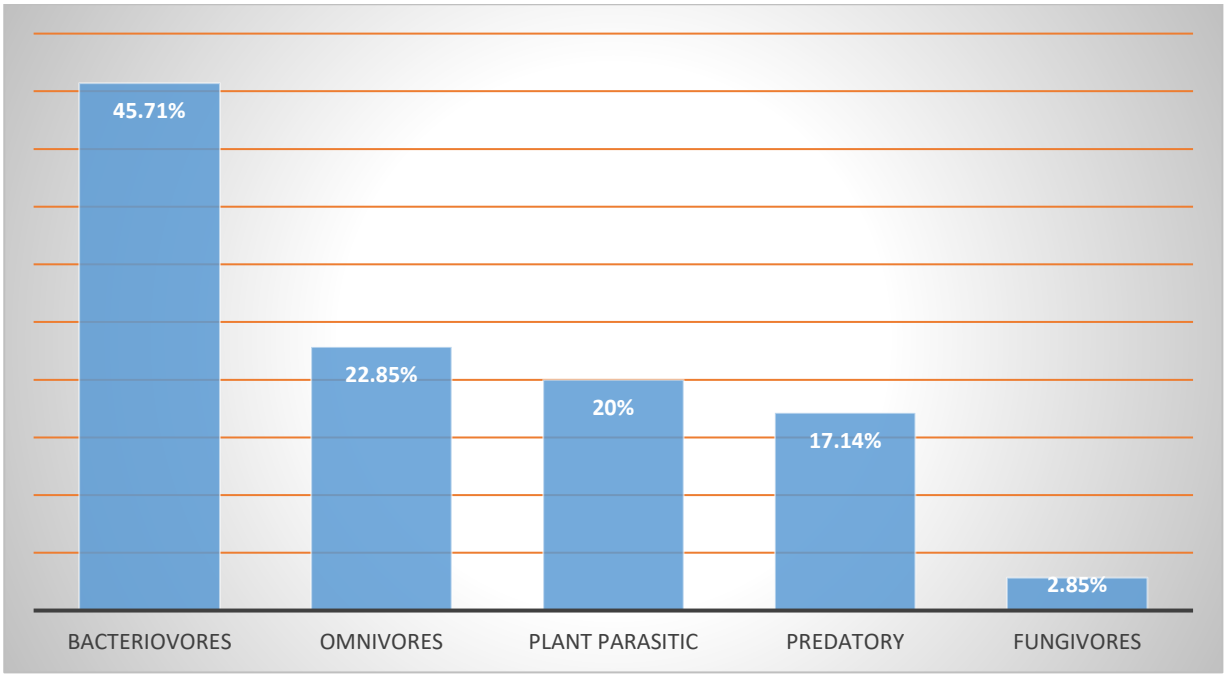

Fig. IA. Tropic diversity on the basis of Genera:

IJAMSR 2 (9) www.ijamsr.com CrossRef: https://doi.org/10.31426/ijamsr.2019.2.9.1912

International Journal of
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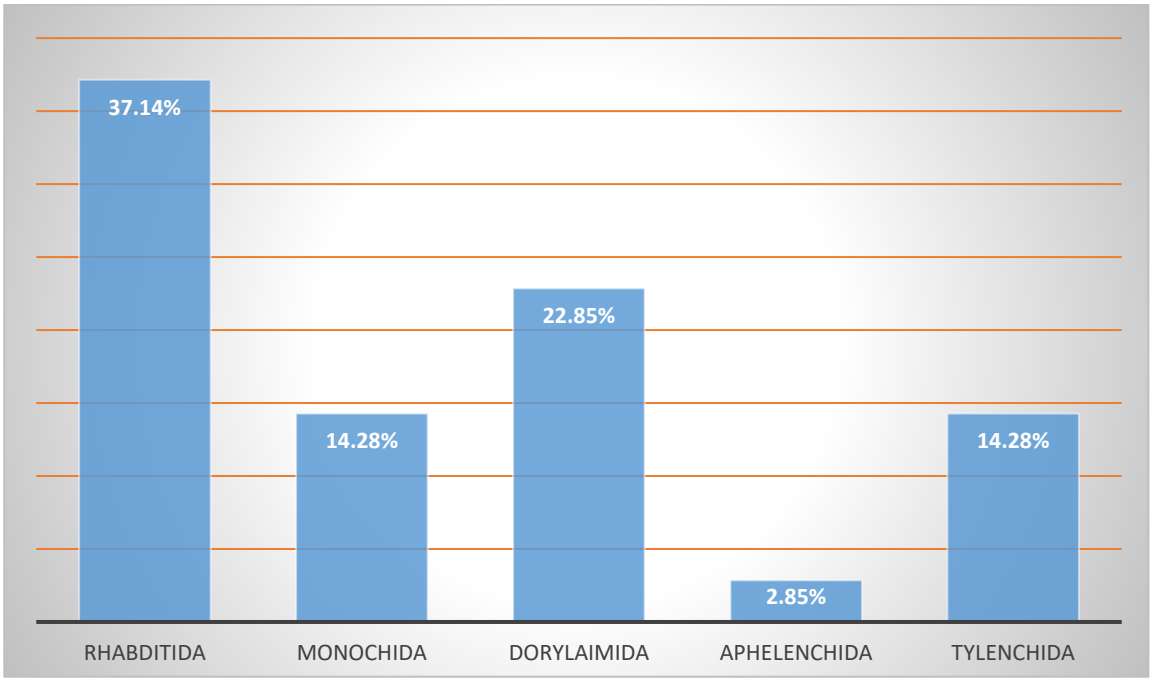

Fig. IB. Taxonomic diversity on the basis of Trophic grouping:

DISCUSSION

Soil ecosystems inhabit and support a rich diversity of fungi, bacteria, algae, protozoans, arthropods, mites, nematodes, etc. There are many organisms which act as bio indicators of the soil health. Among them nematodes are the most studied biological indicators (**Neher, 2001**). Nematodes are omnipresent, inhabiting almost every possible habitat ranging from deep ocean trenches to the highest peak mountains, marine to fresh water, polar to the tropics, etc. Their diversity and abundance depends upon ecological and edaphic factors like pH, nutrient content, moisture, etc. The other factors which influence their richness and diversity are, soil type, pore spaces, root secretions, ploughing and tilling, anthropogenic disturbances, chemical fertilizers and pesticides. In the present study, the number of genera identified were 35 representing bacterivores (16 genera), herbivores (5 genera), omnivores (8 genera), fungivores (1 genera) and predators (5 genera).

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Among these, bacterivores represent the highest number of genera [Fig. IA].

On the basis of taxonomic grouping, Order Rhabditida was the most dominant (high abundance and more genera number) followed by Order Dorylaimida (omnivores), Mononchida (predatory) and Tylenchida (plant parasitic) [Fig. IB]. The more dominance and high abundance of Dorylaimida and Mononchida is due to mild disturbances in the studied area. As far as the soil physico-chemical conditions and disturbances are concerned, Dorylaimida and Mononchida are the most sensitive nematode groups (**Forge and Simard 2001**). These two groups act as indicators of soil health (**Thomas, 1978; Sohlenius and Wasilewska**, 1984). According to trophic grouping, the most dominant group was omnivores (high density and abundance) after bacterivores, followed by parasitic nematodes and predatory nematodes. Such abundance of omnivores is clearly related to fewer disturbances in the area.

According to **Bongers (1990**), the soil environment or soil ecology can be studied by using different ecological indices. The current study of various diversity indices, like Margalefs index (D_{Mg}), Menhinicks index (D_{Mn}) indicates that this region has a high nematode species richness of 3.73 and 0.36 (Table II). The high value of the Shannon - Weaner Index (3.40) and Inverse Simpson index (26.31) exhibits high nematode diversity. These results agree with **Odum (1969**), that forests with high H' values are at mature stage.

In conclusion, our study on Pir Panjal Biodiversity Park using various diversity indices reveal high diversity of Rhabditid and Dorylaim nematodes because of no anthropogenic disturbances. As for as nematode diversity is concerned, the present study is a pioneer step to study the small portion of the Pir Panjal Range and further study needs to be conducted in order to fully understand the forest ecosystem of this region.

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