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Community Analysis of Soil Nematodes from five Wildlife Sanctuaries of West Bengal (Ballavpur, Bethuadahari, Bibhutibhushan, Raiganj, Ramnabagan), India

Pavel Dutta[1], Ritika Datta[1,2], Anjum Nasreen Rizvi[1*]

[1]Zoological Survey of India, M-Block, New Alipore, Kolkata–700053, India.
[2]University of Calcutta, 87/1, College Street, Kolkata–700 073, India.
*Corresponding author. E-mail: anrizvi@gmail.com;

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***Abstract*— *Soil nematode community analysis was carried out in five Wildlife sanctuaries (WLS) of West Bengal, namely, Ballavpur, Bethuadahari, Bibhutibhushan, Raiganj and Ramnabagan. The study documented a total of 53 nematode genera belonging to 11 orders and 27 families. In terms of taxonomic diversity, the order Tylenchida exhibited the greatest variety at Ballavpur, Bethuadahari and Ramnabagan WLS. In contrast, the order rhabditida was the most diverse at Bibhutibhushan and Raiganj WLS. In terms of trophic composition, bacterivores represented the highest generic diversity at Ballavpur, Bibhutibhushan, Raiganj, and Ramnabagan, except for Bethuadahari, where plant parasites represented the highest generic diversity. In terms of trophic groups, bacterivores were the most abundant at Bethuadahari, Bibhutibhushan and Raiganj WLS, whereas plant parasites were the most abundant at Ballavpur and Ramnabagan WLS. The Shannon-Weaver (H') diversity and Maturity Index (MI) were highest at Ballavpur WLS with values 1.58 ± 0.01 and 2.62 ± 0.01, respectively. The MI value indicates the study areas are less disturbed. The food web indices, Channel Index (CI), Enrichment Index (EI), and Structural Index (SI), indicate that the study area supports a resource-rich and well-organized soil ecosystem. The present study serves as a preliminary analysis of soil nematodes from these WLS, and this data will be helpful for future long-term ecological monitoring.*

***Keywords*— Abundance, diversity, enrichment, maturity index, trophic bb**

I. INTRODUCTION

Soil nematodes are among the most diverse multicellular organisms living in terrestrial habitats, found in nearly all types of soils. Their population density can be extremely high, with millions of individuals from various taxa present in just one square meter of soil [1]. Functionally, nematodes are classified according to their feeding habits, including bacterial-feeders, fungal-feeders, plant parasites, omnivores, and predators [2]. Bacterial and fungal feeders play a crucial role in breaking down organic matter and recycling nutrients in soil, releasing plant-available nutrients such as nitrogen [3]. On the other hand, plant-parasitic nematodes can negatively affect crop productivity by damaging roots and increasing plants' vulnerability to pathogens [4]. Predatory and omnivorous nematodes feed on other nematodes and small invertebrates, helping regulate nematode populations and maintain the stability of the soil food web [5].

This diversity is determined by various biotic and abiotic factors, including soil type, moisture, temperature, vegetation and land management practices [2]. As a result, they are often used as bioindicators of soil health and environmental disturbance because changes in their community structure can indicate shifts in ecosystem processes [5].

Worldwide, several researchers have conducted studies on the community analysis of soil nematodes in forests, such as [6, 7, 8, 9, 10, 11, 12, 13, 14, 15]. Recent studies from

India include [16, 17, 18, 19]. While soil nematode communities have been studied in various regions of India, there is a notable lack of data from the five wildlife sanctuaries in West Bengal. This gap motivated our research to examine the diversity and abundance of soil-inhabiting nematodes in these specific areas of West Bengal. We excluded the order Dorylaimida from the study because work has already been published on Dorylaimida in this particular region [20]. The main aim of our study was to quantify the diversity and abundance of soil nematodes in five wildlife sanctuaries located across five different districts of West Bengal, India.

II. MATERIAL AND METHODS

Soil samples were collected from the forest ecosystem of five wildlife sanctuaries of West Bengal, namely Ballavpur, Bethuadahari, Bibhutibhushan, Raiganj and Ramnabagan, located in five different districts (Birbhum, Nadia, North 24 Parganas, North Dinajpur and Bardhaman, respectively) of West Bengal (Table 1). A narrow-bladed shovel or spade was used for soil sampling. Random sampling was conducted to a depth of 20 cm or more, and a total of 60 soil samples (N=60) were collected from these areas. The collected soil samples were subsequently placed in polythene bags and properly labelled. After labelling, soil samples were brought to the laboratory for further processing**.** Nematodes were extracted from samples using Cobb's sieving and decanting method [21], followed by a modified Baermann's funnel technique [22]. After that, extracted nematodes were fixed instantly in their characteristic body posture by Seinhorst's method in hot formaldehyde acetic acid solution [23]. Later on, the specimens were kept in a cavity block containing glycerine alcohol solution and were transformed in a desiccator for at least 2-3 weeks for proper dehydration. After dehydration, permanent slides were made following the wax ring method [24]. The mounted specimens were studied under a BX-53 DIC Olympus microscope with Cellsens software. Soil nematodes were counted and identified up to the generic level and then classified into trophic groups, namely bacterivores, fungivores, plant parasites and predators [1]. The c-p groups were assigned to the genera as described by [25].

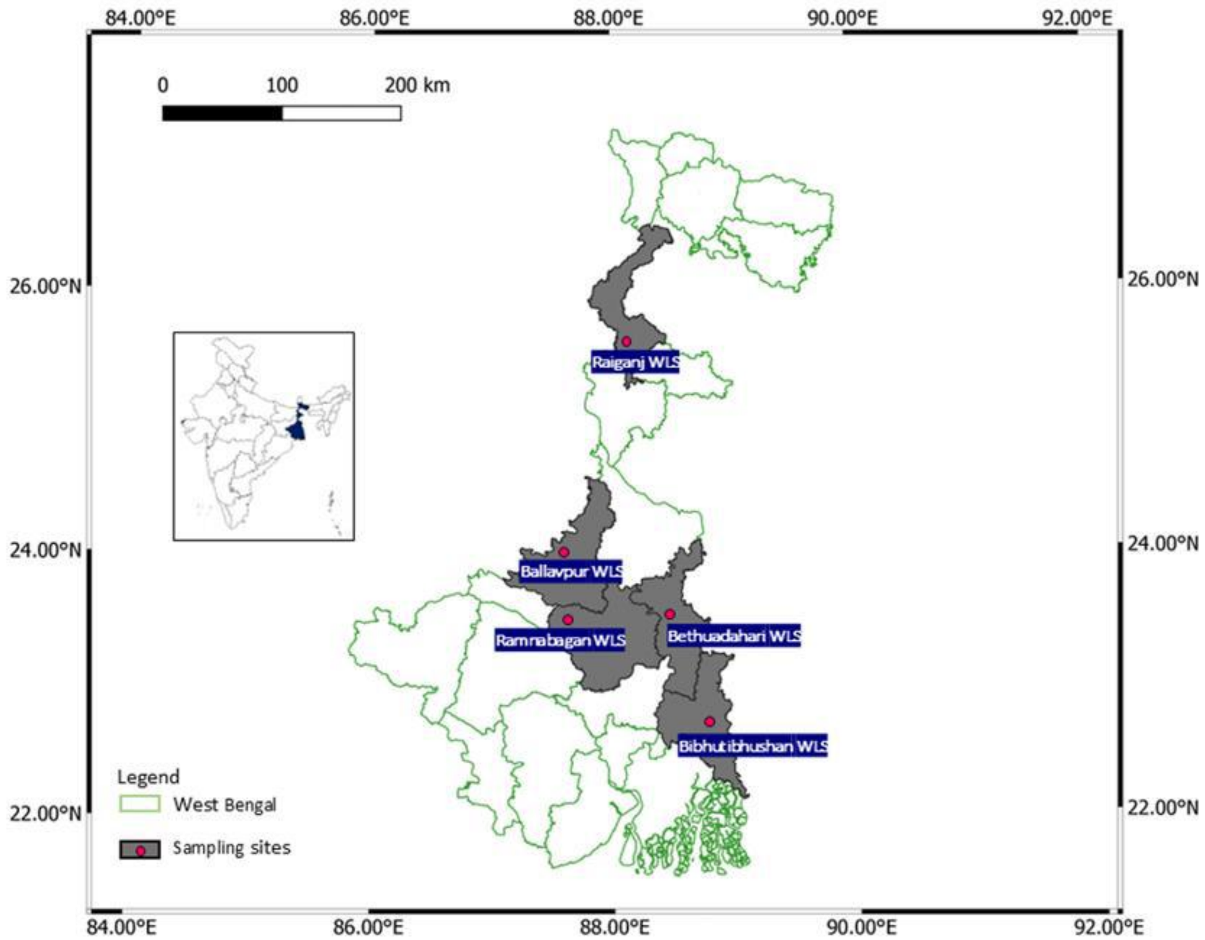

Fig. 1: Sampling locations across five districts of West Bengal

Table 1. Geographic coordinates of sampling sites at five wildlife sanctuaries in West Bengal. Abbreviations for the WLS are mentioned within parenthesis.

Sl no.	Location	Districts	Latitude (N)	Longitude (E)
1.	Ballavpur WLS (Ba)	Birbhum	23°40'936"	87°40'865"
2.	Bethuadahari WLS (Be)	Nadia	23°35'703"	88°23'781"
3.	Bibhutibhushan WLS (Bi)	North 24 Pargana	23°11'215"	88°76'552"
4.	Raiganj WLS (Rai)	North Dinajpur	25°38'246"	88°07'241"
5.	Ramnabagan WLS (Ra)	Bardhaman	23°15'094"	87°51'163"

Community analysis and diversity indices calculated

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

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

Mean density (D): Total nematode specimens of the genus found in samples /total number of collected samples.

Relative density (RD %): Mean density of the genus / Sum of the mean density of all nematode genera X 100.

Shannon's diversity (H'): -Σ pi ln pi;

Where Pi represents the proportion of individuals belonging to Taxon *i* within the total population.

Maturity indices (MI) were calculated based on c-p values assigned to different genera of soil nematodes [25].

MI= Σvi× fi/n,

Where vi is the c-p value of the family and frequency of family i in the sample, and n is the total number of individuals in the sample

Plant parasitic index (PPI) was used to assess the nutrient stability [26, 27].

The functional structure of the community was measured by the Wasilewska index (WI), enrichment index (EI), Channel index (CI) and structural index (SI).

Wasilewska index (WI) represents the ratio of bacterial feeders (BF) plus fungal feeders (FF) to plant parasites (PP) as WI = (BF + FF)/PP [28].

Channel index (CI): It reflects the dominance of fungal versus bacterial decomposition pathways in the soil food web.

$$CI = (Fu_2*0.8/ Ba_1*3.2 + Fu_2*0.8) * 100 \ [29].$$

Enrichment index (EI): The Enrichment Index (EI) reflects the overall biomass of opportunistic bacterivorous (Ba_1 and Ba_2) and fungivorous (Fu_2) nematodes that emerge as a result of organic matter decomposition [29].

$$EI= 100 * e/ (e+b), \text{ where } e = (Ba_1* 3.2) + (Fu_2* 0.8), \ b= (Ba_2+ Fu_2)* 0.8$$

Structure index (SI): The Structural Index reflects the complexity of the soil food web and the extent of interactions among its components within the ecosystem [29].

$$SI = 100* s/(s + b), \text{ Where } s = (Ba+ Pr + Fu + Om, n=3–5) \text{ and } b =Ba_2+ Fu_2$$

Ba: Bacteriovores, Pr: Predatory, Fu: fungivorous & Om: omnivorous nematodes; subscript 1 to 5 represent C-P scale; 3.2 and 0.8 are weighted faunal components [29, 30].

III. RESULT AND DISCUSSION

3.1 Taxonomic diversity

The study revealed a total of 53 nematode genera, belonging to 11 orders and 27 families, collected from soil samples of five Wildlife Sanctuaries in West Bengal. In terms of taxonomic diversity, the order Tylenchida was the most diverse, followed by Rhabditida at Ballavpur, Bethuadahari and Ramnabagan WLS. Order Rhabditida was the most varied, followed by order Tylenchida at Bibhutibhushan and Raiganj WLS (Fig. 2).

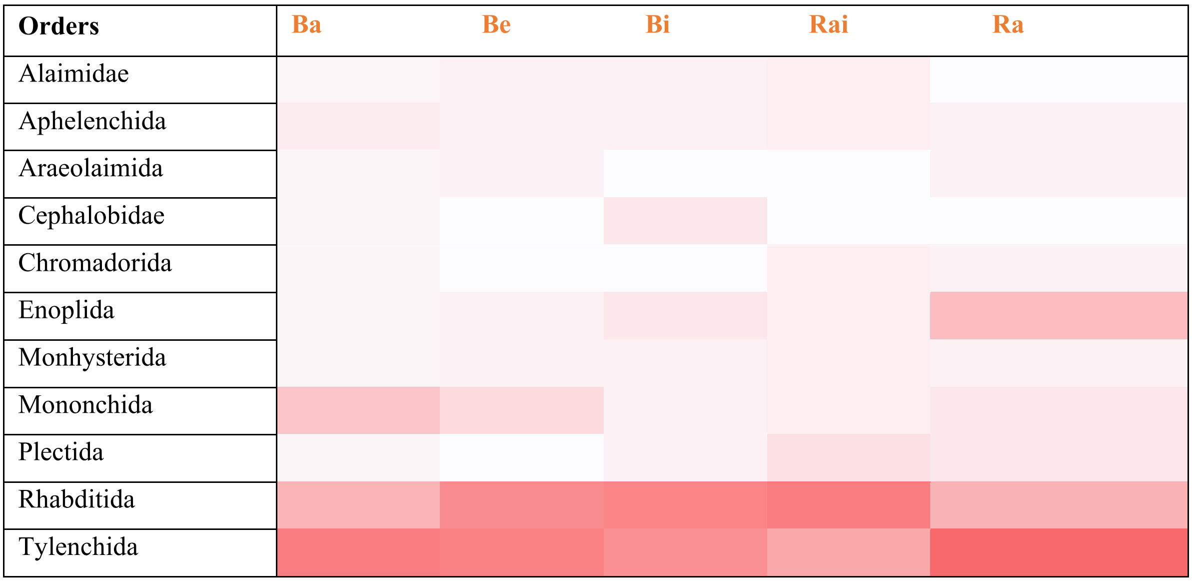

Fig. 2: Soil nematode taxonomic diversity at five WLS of West Bengal

Regarding trophic abundance, Ballavpur WLS represented the highest percentage of plant parasites (43%), followed by bacterivores (33%); Bethuadahari WLS represented the highest percentage of bacterivores (41 %) followed by plant parasites (40%); Bibhutibhushan showed the highest percentage of bacterivores (54%) followed by plant parasites (33%) and Ramnabagan WLS represented highest percentage of plant parasites (43%) followed by bacterivores (39%). The percentage of predators and fungivores was much less compared to the bacterivores and plant parasites within the five WLS. The results indicated that the highest percentage of bacterivores was from Raiganj WLS, followed by Bibhutibhusan WLS; the highest percentage of plant parasites was represented by both Ballavpur and Ramnabagan WLS (Fig. 3a). The highest generic diversity of bacterivores was represented from four WLS-Ballavpur, Bibhutibhushan, Raiganj and Ramnabagan. In contrast, the generic diversity of Plant parasites was highest only at Bethuadahari WLS (Fig. 3b).

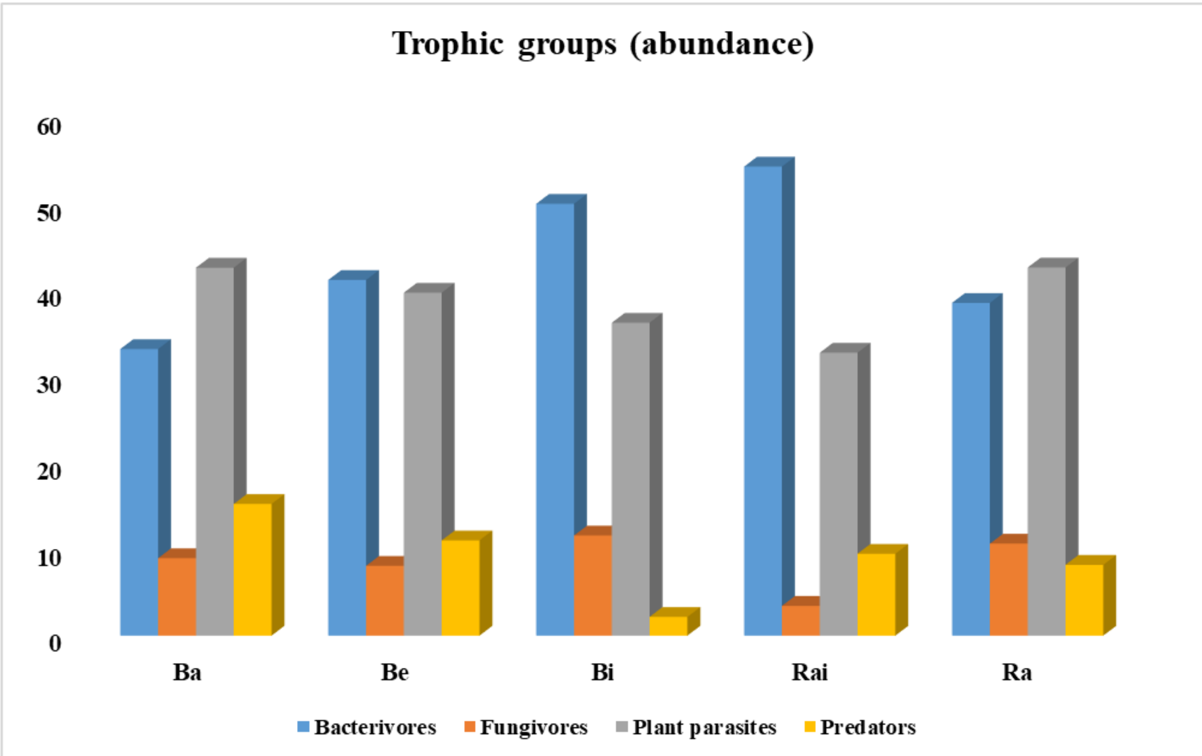

Fig. 3a: Abundance of Trophic groups of soil nematodes

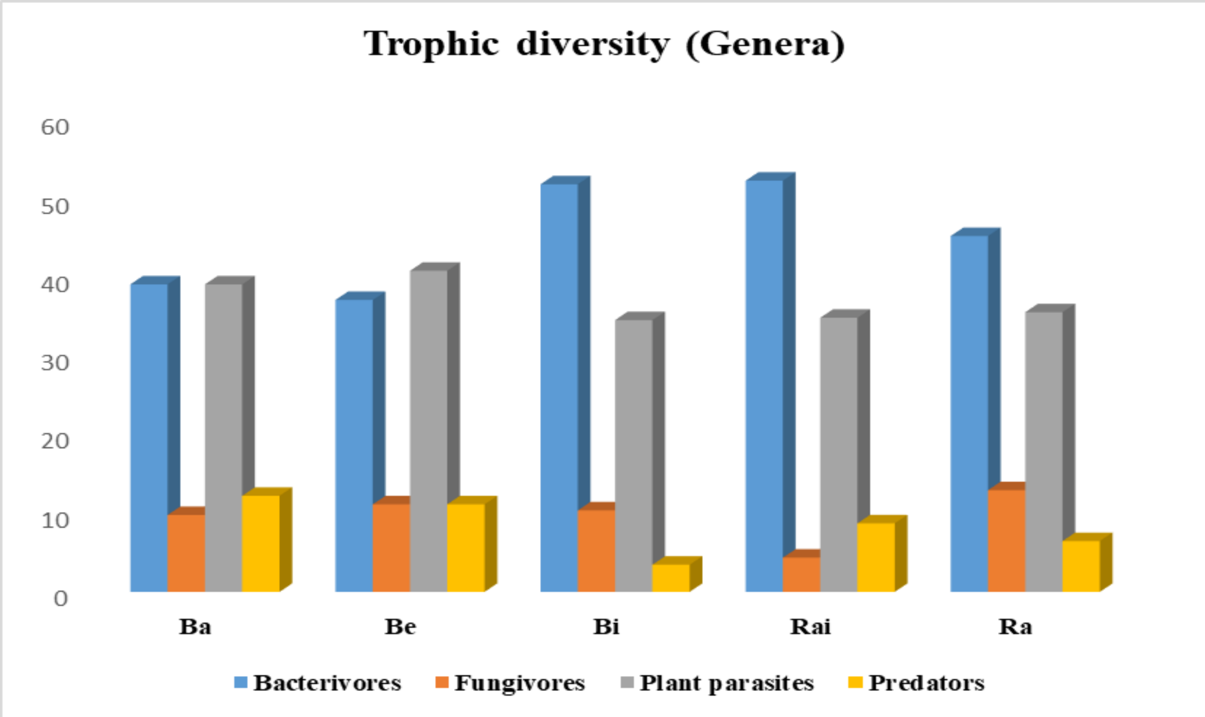

Fig. 3b: Generic diversity of trophic groups

3.2 Nematode diversity

Frequency: In the present study, Genus *Helicotylenchus, Tylenchorhynchus, Rotylenchulus,* and *Ironus* were the most dominant genera, exhibiting the highest frequency of occurrence (N=9, each) among all the nematode communities from these five wildlife sanctuaries (Ballavpur, Bethuadahari, Bibhutibhushan, Raiganj and Ramnabagan).

Among the bacterivores, the genus *Bursilla* showed the highest absolute frequency (N=26 and AF=43 %), whereas *Macrolaimellus and Panagrellus* were recorded the least among them (N=3 and AF=5%). Among fungivores, genus *Aphelenchoides* was the most frequent (N=17 and AF=28%), whereas the least frequent genus was *Aphelenchus* (N=5 and AF=8%).

Regarding plant parasites, the most frequent genus was *Helicotylenchus* (N=38 and AF=63%), whereas the least frequent genus was *Neopsilenchus* (N=4 and AF=7%). The genus *Ironus* showed the highest absolute frequency among all predatory nematodes (N=31 and AF= 52%), in contrast, the least frequent genus was *Parahadronchus* (N=3 and AF= 5%).

3.3 Trophic Relationship among Soil Nematodes

Frequency: After analysing the soil nematode community of all five wildlife sanctuaries, Plant parasites from Ballavpur WLS were found to be the most prevalent group in the entire nematode community, with N=4.62 and AF=38.54. Fungivores from Ramnabagan WLS and Raiganj WLS were the least frequent in the community, with N=2 and AF=16.66 each.

Density: Plant parasites from Ballavpur WLS were the most dominant group in the whole nematode community with D=0.93 and Relative Density (RD) = 3.04, whereas Predators from Bibhutibhushan and Ramnabagan WLS were the least dominant with D=0.34 and RD=1.75 & 1.47 respectively.

Table 2. Nematode community analysis in the five Wildlife Sanctuaries of West Bengal Park (N = 60).

Genera	**Frequency**					**AF%**					**MD**					**RD%**				
Bacteriovores	**Ba**	**Be**	**Bi**	**Rai**	**Ra**	**Ba**	**Be**	**Bi**	**Rai**	**Ra**	**Ba**	**Be**	**Bi**	**Rai**	**Ra**	**Ba**	**Be**	**Bi**	**Rai**	**Ra**
Acrobeles	6	2	3	0	4	50.0	16.7	25.0	0.0	33.3	0.58	0.25	0.42	0.00	0.75	1.91	1.05	2.12	0.00	3.23
Acrobeloides	5	2	6	2	5	41.7	16.7	50.0	16.7	41.7	0.42	0.25	0.75	0.25	0.67	1.36	1.05	3.81	1.23	2.87
Alaimus	5	3	4	7	2	41.7	25.0	33.3	58.3	16.7	0.50	0.92	0.42	0.58	0.33	1.63	3.83	2.12	2.87	1.43
Bursilla	8	5	3	4	6	66.7	41.7	25.0	33.3	50.0	1.00	1.33	0.67	0.58	0.83	3.27	5.58	3.39	2.87	3.58

Cephalobus	7	5	4	4	2	58.3	41.7	33.3	33.3	16.7	1.08	0.92	0.75	0.58	0.67	3.54	3.83	3.81	2.87	2.87
Chiloplacus	1	5	6	5	4	8.3	41.7	50.0	41.7	33.3	0.17	0.42	0.75	0.67	0.42	0.54	1.74	3.81	3.28	1.79
Chronogaster	4	0	4	5	2	33.3	0.0	33.3	41.7	16.7	0.67	0.00	0.42	0.67	0.33	2.18	0.00	2.12	3.28	1.43
Cruznema	1	4	0	1	0	8.3	33.3	0.0	8.3	0.0	0.17	0.58	0.00	0.08	0.00	0.54	2.44	0.00	0.41	0.00
Eucephalobus	6	2	7	2	5	50.0	16.7	58.3	16.7	41.7	1.17	0.75	1.00	0.67	0.92	3.81	3.14	5.08	3.28	3.94
Macrolaimellus	0	2	0	1	0	0.0	16.7	0.0	8.3	0.0	0.00	0.33	0.00	0.25	0.00	0.00	1.39	0.00	1.23	0.00
Mesorhabditis	5	6	5	3	4	41.7	50.0	41.7	25.0	33.3	0.75	0.58	0.67	0.42	0.50	2.45	2.44	3.39	2.05	2.15
Panagrellus	0	0	2	0	1	0.0	0.0	16.7	0.0	8.3	0.00	0.00	0.25	0.00	0.17	0.00	0.00	1.27	0.00	0.72
Panagrolaimus	1	0	4	6	0	8.3	0.0	33.3	50.0	0.0	0.17	0.00	0.42	0.92	0.00	0.54	0.00	2.12	4.51	0.00
Paraphanolaimus	0	1	1	0	4	0.0	8.3	8.3	0.0	33.3	0.00	0.17	0.08	0.00	0.42	0.00	0.70	0.42	0.00	1.79
Plectus	1	1	0	2	1	8.3	8.3	0.0	16.7	8.3	0.17	0.08	0.00	0.33	0.08	0.54	0.35	0.00	1.64	0.36
Prismatolaimus	2	3	2	6	4	16.7	25.0	16.7	50.0	33.3	0.33	0.25	0.25	0.58	0.33	1.09	1.05	1.27	2.87	1.43
Protorhabditis	4	6	5	7	2	33.3	50.0	41.7	58.3	16.7	0.42	0.75	0.50	0.92	0.17	1.36	3.14	2.54	4.51	0.72
Pseudacrobeles	8	4	3	3	7	66.7	33.3	25.0	25.0	58.3	1.00	0.67	0.75	0.33	0.75	3.27	2.79	3.81	1.64	3.23
Rhabdolaimus	5	2	0	0	1	41.7	16.7	0.0	0.0	8.3	0.75	0.33	0.00	0.00	0.08	2.45	1.39	0.00	0.00	0.36
Zeldia	1	0	1	0	4	8.3	0.0	8.3	0.0	33.3	0.17	0.00	0.08	0.00	0.42	0.54	0.00	0.42	0.00	1.79
Fungivores																				
Aphelenchoides	6	3	2	3	3	50.0	25.0	16.7	25.0	25.0	0.75	0.42	0.50	0.42	0.58	2.45	1.74	2.54	2.05	2.51
Aphelenchus	1	3	0	1	0	8.3	25.0	0.0	8.3	0.0	0.17	0.50	0.00	0.25	0.00	0.54	2.09	0.00	1.23	0.00
Filenchus	4	2	3	2	1	33.3	16.7	25.0	16.7	8.3	0.42	0.75	0.92	0.50	0.17	1.36	3.14	4.66	2.46	0.72
Plant parasites																				
Aglenchus	3	0	0	2	4	25.0	0.0	0.0	16.7	33.3	0.42	0.00	0.00	0.25	0.42	1.36	0.00	0.00	1.23	1.79
Atetylenchus	6	2	4	2	8	50.0	16.7	33.3	16.7	66.7	0.58	0.42	0.33	0.42	0.92	1.91	1.74	1.69	2.05	3.94
Cephalenchus	0	4	0	1	0	0.0	33.3	0.0	8.3	0.0	0.00	0.33	0.00	0.17	0.00	0.00	1.39	0.00	0.82	0.00
Criconema	3	0	3	0	2	25.0	0.0	25.0	0.0	16.7	0.33	0.00	0.25	0.00	0.17	1.09	0.00	1.27	0.00	0.72
Ditylenchus	3	0	0	0	4	25.0	0.0	0.0	0.0	33.3	0.75	0.00	0.00	0.00	0.42	2.45	0.00	0.00	0.00	1.79
Helicotylenchus	6	8	9	8	7	50.0	66.7	75.0	66.7	58.3	1.92	2.08	1.75	2.75	2.33	6.27	8.71	8.90	13.52	10.04
Hemicriconemoides	3	4	0	2	1	25.0	33.3	0.0	16.7	8.3	0.42	0.58	0.00	0.25	0.33	1.36	2.44	0.00	1.23	1.43
Hemicycliophora	0	2	3	0	4	0.0	16.7	25.0	0.0	33.3	0.00	0.25	0.58	0.00	0.17	0.00	1.05	2.97	0.00	0.72
Hirschmanniella	3	2	6	0	0	25.0	16.7	50.0	0.0	0.0	0.67	0.92	0.58	0.00	0.00	2.18	3.83	2.97	0.00	0.00
Histotylenchus	2	0	3	0	2	16.7	0.0	25.0	0.0	16.7	0.67	0.00	0.33	0.00	0.50	2.18	0.00	1.69	0.00	2.15
Hoplolaimus	3	4	7	0	7	25.0	33.3	58.3	0.0	58.3	0.75	0.42	1.00	0.00	0.92	2.45	1.74	5.08	0.00	3.94
Neopsilenchus	0	0	0	0	4	0.0	0.0	0.0	0.0	33.3	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	1.43
Pratylenchus	5	4	3	2	5	41.7	33.3	25.0	16.7	41.7	0.75	0.58	0.00	0.00	0.00	2.45	2.44	0.00	0.00	0.00
Psilenchus	0	1	1	6	0	0.0	8.3	8.3	50.0	0.0	0.00	0.00	0.00	1.42	0.00	0.00	0.00	0.00	6.97	0.00
Rotylenchulus	6	9	7	4	5	50.0	75.0	58.3	33.3	41.7	1.75	0.92	0.00	0.00	1.17	5.72	3.83	0.00	0.00	5.02
Telotylenchus	5	0	3	3	1	41.7	0.0	25.0	25.0	8.3	0.75	0.00	0.33	0.42	0.17	2.45	0.00	1.69	2.05	0.72
Trichotylenchus	6	0	0	0	0	50.0	0.0	0.0	0.0	0.0	1.00	0.00	0.00	0.00	0.00	3.27	0.00	0.00	0.00	0.00
Trophurus	8	7	4	7	6	66.7	58.3	33.3	58.3	50.0	1.83	2.25	1.58	1.33	2.17	5.99	9.41	8.05	6.56	9.32

Tylenchus	5	4	3	0	3	41.7	33.3	25.0	0.0	25.0	0.67	0.50	0.33	0.00	0.33	2.18	2.09	1.69	0.00	1.43
Tylenchorhynchus	7	8	4	9	8	58.3	66.7	33.3	75.0	66.7	1.67	1.25	0.58	1.33	1.58	5.45	5.23	2.97	6.56	6.81
Predators																				
Achromadora	1	0	0	3	2	8.3	0.0	0.0	25.0	16.7	0.08	0.00	0.00	0.33	0.25	0.27	0.00	0.00	1.64	1.08
Iotonchus	5	6	3	2	4	41.7	50.0	25.0	16.7	33.3	0.67	1.00	0.42	0.67	0.83	2.18	4.18	2.12	3.28	3.58
Ironus	6	5	5	9	6	50.0	41.7	41.7	75.0	50.0	1.00	0.92	0.67	1.17	0.83	3.27	3.83	3.39	5.74	3.58
Mulveyellus	3	0	1	1	2	25.0	0.0	8.3	8.3	16.7	0.33	0.00	0.17	0.17	0.08	1.09	0.00	0.85	0.82	0.36
Mylonchulus	4	2	0	2	1	33.3	16.7	0.0	16.7	8.3	0.83	0.33	0.00	0.42	0.25	2.72	1.39	0.00	2.05	1.08
Parahadronchus	2	0	1	0	0	16.7	0.0	8.3	0.0	0.0	0.67	0.00	0.25	0.00	0.00	2.18	0.00	1.27	0.00	0.00
Paramylonchulus	4	0	1	0	1	33.3	0.0	8.3	0.0	8.3	0.67	0.00	0.17	0.00	0.25	2.18	0.00	0.85	0.00	1.08
Prionchulus	3	2	0	2	0	25.0	16.7	0.0	16.7	0.0	0.58	0.42	0.00	0.25	0.00	1.91	1.74	0.00	1.23	0.00
Sporonchulus	0	2	1	0	1	0.0	16.7	8.3	0.0	8.3	0.00	0.50	0.33	0.00	0.17	0.00	2.09	1.69	0.00	0.72
Tripylina	0	0	4	0	1	0.0	0.0	33.3	0.0	8.3	0.00	0.00	0.42	0.00	0.08	0.00	0.00	2.12	0.00	0.36

Table 3. Community relationship between different trophic groups of nematodes. (BF: Bacterivores; FF: Fungivores; PP: Plant Parasites; PR: Predators).

	BACTERIVORES					FUNGIVORES					PLANT PARASITES					PREDATORS				
	Ba	Be	Bi	Rai	Ra	Ba	Be	Bi	Rai	Ra	Ba	Be	Bi	Rai	Ra	Ba	Be	Bi	Rai	Ra
Frequency	4.11 ±0.16	3.31 ± 0.02	3.75 ± 0.006	3.86 ±0.04	3.41 ± 0.02	3.66 ±0.006	2.67 ± 0.5	6.5 ± 0.13	3 ± 0.03	2 ± 0.08	6.37 ± 0.12	4.53 ± 0.03	4.29 ±0.02	4 ± 0.01	4.44 ±0.02	4.37 ±0.02	3.8 ± 0.001	2.29 ±0.07	3.17 ±0.03	2.25 ±0.07
AF%	34.31 ± 0.2	27.6 ±0.03	31.25 ± 0.14	32.22 ±0.19	28.43 ±0.006	30.55 ± 0.11	22.22 ± 0.30	20.83 ±0.37	16.66 ±0.58	16.65 ±0.58	38.54 ± 0.51	37.82 ±0.47	35.71 ±0.37	34.84 ±0.32	36.97 ±0.43	29.12 ±0.04	28.33 ±0.001	19.04 ±0.46	26.32 ± 0.9	18.75 ±0.47
MD	0.58 ±0.005	0.53 ± 0.002	0.51 ± 0.003	0.52 ± 0.002	0.46 ± 0.005	0.44 ± 0.006	0.55 ±0.001	0.7 ± 0.006	0.38 ±.009	0.375± 0.009	0.93 ± 0.018	0.87 ±0.015	0.69 ± 0.06	0.75 ± 0.009	0.79 ±0.01	0.6 ± 0.06	0.63 ± 0.003	0.34 ±0.01	0.5 ± 0.003	0.34 ±0.01
RD%	1.82 ± 0.035	2.24 ±0.014	2.59 ±0.003	2.56 ±0.002	1.98 ± 0.02	1.45 ±0.05	2.32 ±0.01	3.6 ± 0.05	1.91 ±0.03	1.61 ±0.04	3.04 ±0.026	3.65± 0.056	3.54 ±0.051	4.55 ±0.101	3.41 ±0.04	1.97 ±0.02	2.64 ± 0.006	1.75 ±0.03	2.45 ±0.003	1.47 ±0.05

3.4 Nematode Community Indices

The maturity index (MI) of the soil nematodes in the five Wildlife sanctuaries ranged from (2.52±0.5) to (2.62±0.01), with the lowest value recorded at Bethuadahari WLS and the highest at Ballavpur WLS. The Shannon Diversity Index (H') varied from (1.45± 0.29) to (1.58± 0.01), with the lowest value from Raiganj WLS and the highest value from Ballavpur WLS. The Plant Parasitic Index (PPI) Varied from (1.27± 0.25) to (1.86± 0.37) (Table 4).

Table 4. Various ecological indices of soil nematodes in five Wildlife Sanctuaries of West Bengal (Mean ± SE)

	Ba	Be	Bi	Rai	Ra
MI	2.62 ± 0.01	2.52± 0.5	2.53± 0.5	2.57± 0.5	2.55± 0.5
H’	1.58 ± 0.01	1.5 ± 0.3	1.52 ± 0.3	1.45 ± 0.29	1.55 ± 0.31
PPI	1.74 ± 0.4	1.31 ± 0.26	1.86 ± 0.37	1.27 ± 0.25	1.32 ± 0.26
PPI/MI	0.66 ± 0.01	0.52 ± 0.1	0.74 ± 0.1	0.49 ± 0.09	0.52 ± 0.1
WI	0.72 ± 0.04	0.97 ± 0.004	1.25 ± 0.06	1.08 ± 0.02	0.72 ± 0.04
EI	68.2 ± 0.05	73.88 ± 1.18	65.27 ± 0.53	74.4 ± 1.29	58 ± 1.99
CI	15.67 ± 0.24	13.13 ± 0.26	14.89 ± 0.09	10.82 ± 0.72	17.64 ± 0.65
SI	76.58 ± 0.71	74.7 ± 0.34	66 ± 1.4	78 ± 1.0	69.7 ± 0.66

The present study on the soil-inhabiting nematodes of West Bengal Protected Areas revealed a total of 53 genera belonging to 11 orders and 27 families. Both plant parasites and bacterivores exhibited the highest generic diversity, with bacterivores showing the highest abundance, followed by plant parasites. Among all the taxonomic groups, Order Tylenchida represented the highest number of genera with a total of 19 genera, followed by Order Rhabditida with a total of 17 genera. Earlier research [11, 31, 32, 33] on soil-inhabiting nematodes in forest areas also found the dominance of bacterivores.

Shannon’s diversity index (H’) of the study area varied from (1.45±0.29) to (1.58± 0.01), with the lowest value at Raiganj WLS and the highest from Ballavpur WLS. Higher values of H’ indicate the ecosystem to be more diverse, whereas lower values indicate the area to be less diverse. The results from the present study show that the areas are not highly diverse. The Maturity Index (MI) varied from (2.52± 0.5) to (2.62± 0.01). Lower value of MI denotes the area to be disturbed, whereas higher values represent the area to be less disturbed. Comparing the five WLS, it can be stated that the highest value of H’ and MI at Ballavpur suggests that this area is less disturbed in comparison to the other WLS.

The plant parasitic index denotes whether a community is disturbed or not, where higher values reflect less disturbance and lower values denote higher disturbance in the area [25]. The present study reflects a considerably higher value of PPI; thus, it can be inferred that the Wildlife sanctuaries are less disturbed.

Food web indices, including the Channel Index (CI), Enrichment Index (EI), and Structural Index (SI), evaluate the structure, function, and nutrient dynamics of the soil ecosystem based on nematode community composition [29].

The Enrichment Index (EI) indicates the dominance of opportunistic organisms, which indicates whether the soil is enriched with nutrients or not. In this study, the value of EI ranged from (58 ±1.99) to (74.4 ± 1.29), suggesting that the study areas are nutrient-rich. Similar results were found in other studies, such as [34] and [35], where higher EI values were associated with bacterial decomposition pathways in the soil.

The Channel index (CI) indicates whether the soil organic matter is enriched with bacteria or fungi. Higher values of CI suggest fungal dominance and lower values reflect bacterial dominance [29]. The present study observed that the value of CI of all five study areas was relatively low, ranging from (10.82± 0.72) to (17.64± 0.65) (Table 4). This decline in the value of CI suggests that the study areas are nitrogen-enriched, which promotes the soil food web toward bacterial-driven decomposition pathways. Some previous studies [34, 36, 37] have also observed that nitrogen-enriched soils tend to exhibit reduced CI values, indicating a shift toward bacterial-driven decomposition processes.

The Structural Index (SI) reflects the level of development and stability within a soil ecosystem, where higher values show a well-structured or mature system and lower values indicate disturbance [29]. Previous studies have shown that the value of SI was higher in forest areas due to the greater abundance of omnivorous and predatory organisms, which contribute to a more complex food web with multiple trophic interactions [38]. In the present study, the value of SI ranges from (66 ± 1.4) to (78 ± 1.0). This higher value of SI supports the earlier findings [29, 30, 39] that associate elevated SI values with relatively undisturbed ecosystems.

IV. CONCLUSION

The analysis of soil nematode communities across five Wildlife Sanctuaries in West Bengal—Ballavpur, Bethuadahari, Bibhutibhushan, Raiganj, and

Ramnabagan—showed significant taxonomic and trophic diversity. The dominance of the order Tylenchida in some sanctuaries and Rhabditida in others reflects habitat-specific ecological conditions. Bacterivores appeared as the most diverse and abundant trophic group in most of the locations, highlighting active microbial decomposition. Simultaneously, the prevalence of plant-parasitic nematodes at particular locations suggests localised plant-nematode interactions. Overall, the findings not only deepen the understanding of nematode diversity in Indian forest soils but also emphasise the utility of nematode communities as reliable bioindicators of soil health. This baseline data can serve as a valuable reference point for long-term ecological monitoring in the region.

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