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Diversity and community structure of soil nematodes associated from Meghalaya

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Abstract
A survey was conducted and soil samples were collected from rhizosphere of Arecanut (*Areca catechu*), Orange (*Citrus* L.), Bamboo (Robet) (*Bambusa vulgaris*), Jackfruit (*Artocarpus heterophyllus*), Guava (*Psidium guajava*), Pine (*Pinus* L.), Pea (*Pisum sativum* L.), Bamboo (Local) (*Bambusa vulgaris*), Pineapple (*Ananas comosus* L.), Rice (*Oryza sativa*) and Ageratum (*Ageratum conyzoides*) from different localities in and around the district of Shilong, Meghalaya to explore diversity and community structure of soil nematodes in 2019. Different nematode genera and trophic groups were assessed in terms of absolute frequency, density and prominence value. A total of 22 soil nematodes have been encountered and among them, nine belong to plant parasitic nematodes *viz*., *Helicotylenchus* sp., *Tylenchorhynchus* sp., *Xiphinema* sp., *Hoplolaimus* sp., *Meloidogyne* sp., *Longidorus* sp., *Pratylenchus* sp., *Hemicriconemoides* sp., and *Hirschmanniella* sp., whereas seven belong to predaceous nematodes viz., *Iotonchus* sp., *Mylonchulus* sp., *Mononchoides* sp., *Hadronchoides* sp., *Paramylonchulus* sp., *Parahadronchus* sp. and *Diplogaster* sp. and six to bacteriovorus nematodes viz., *Rhabditis* sp., *Tratorhabditis* sp., *Mesorhabditis* sp., *Panagrolaimus* sp., *Acrobeloides* sp., *Cephalobus* sp. Community analysis showed that *Helicotylenchus* sp. was more frequently followed by *Tylenchorhynchus* sp., whereas *M. incognita* was the most abundant and prominent plant parasitic nematode in the community. This preliminary study indicates that there is a significant diversity of nematode fauna that are under explored and hence there is an urgent need to explore undertake a systematic study to map the nematode biodiversity and their role in agriculture in Meghalaya which mainly depends on organic cultivation.

Keywords: Distribution, diversity, nematodes, community analysis

Introduction
Meghalaya is a hilly state in northeastern India with Shilong as its capital. The state is bordered to the south by Bangladeshi divisions of Mymensingh and Sylhet, to the west by the Bangladeshi division of Rangpur, and to north and east by Indian state Assam. Agriculture production in Meghalaya is affected by various biotic and abiotic factors, among which plant parasitic nematodes could be one of the major constraints.

Soil nematode communities and their structural changes have been found to be one of the best biological tools for assessing soil processes and plant conditions in terrestrial ecosystems [1]. Study on nematode community is essential to evaluate the role of nematodes with the soil ecosystem [2]. Plant parasitic nematodes are recognized to alter the production of crops while predaceous nematodes serve as useful bio-control agents [3] and predaceous and free-living nematodes are bio indicators [4]. Predaceous nematodes are an important constituent of nematode community since they are potential biological control agents [5] and could be used as bio-indicators for measuring ecological changes in a region [4]. Meaningful explanations of the equivalent relationships between plant parasitic, predaceous and free-living nematodes may be made using techniques indicating relative diversity, relative frequency, relative density etc. [6, 7]. Community structure of plant parasitic nematodes of different geographical locations is widely studied [6, 8].

To know the importance of soil nematodes in the ecosystem, one needs to have a thorough knowledge of nematode community structure in different habitats. Hence, present study was undertaken to determine the status of diversity and community profile of nematodes associated with different crops from in and around the district of Shilong, Meghalaya.

Materials and Methods
Soil samples collection site
Soil samples were randomly collected from rhizosphere of Arecanut (*Areca catechu*), Orange (*Citrus* L.), Bamboo (Robet) (*Bambusa vulgaris*), Jackfruit (*Artocarpus heterophyllus*), Guava

(*Psidium guajava*), Pine (*Pinus* L.), Pea (*Pisum sativum* L.), Bamboo (Local) (*Bambusa vulgaris*), Pineapple (*Ananas comosus* L.), Rice (*Oryza sativa*) and Ageratum (*Ageratum conyzoides*) from different locations of Shilong, Meghalaya. Within collection site, soil sample were collected at a depth of 10-20 cm using a hand trowel, each sample containing a composite from 3-5 random subsamples. These samples were mixed to make a composite sample and from this 100 cc of soil was taken for further processing. The hand trowel was sterilized with 70% ethanol before leaving the sampling site. Samples were placed in polyethylene bags to minimize dehydration and labelled providing all necessary information and transported in to the laboratory.

Isolation of nematodes from soil

Soil samples were processed for nematode extraction by Cobb's sieving and decanting method [9]. Nematode suspension was collected and processed further for identification.

Identification of nematodes

Nematodes were fixed and processed to dehydration as per the method described [10] and prepared slides for identification. Identification up to generic level was done using taxonomic key described [11, 12, 13, 14, 15, 16].

Counting of nematodes

Nematodes were collected and fixed in hot TAF (Triethelene Amine Formaline) and stored for population analysis. The population of nematodes in each sample was counted five times with the help of Syracuse counting dish under the stereoscopic zoom microscope and mean value was determined.

Community analysis

Community analysis was made by determining parameters *viz.*, absolute frequency, density and prominence value as described [6].

Results and Discussion

Generic diversity of nematodes

A total of 22 nematode genera have been encountered during present survey. Among them, nine belong to plant feeder nematodes *viz.*, *Helicotylenchus* sp., *Tylenchorhynchus* sp., *Xiphinema* sp., *Hoplolaimus* sp., *Meloidogyne* sp., *Longidorus* sp., *Pratylenchus* sp., *Hemicriconemoides* sp., and *Hirschmanniella* sp., whereas seven belong to predaceous nematodes viz., *Iotonchus* sp., *Mylonchulus* sp., *Mononchoides* sp., *Hadronchoides* sp., *Paramylonchulus* sp., *Parahadronchus* sp., *Diplogaster* sp. and six to bacteriovorus nematodes viz., *Rhabditis* sp., *Tratorhabditis* sp., *Mesorhabditis* sp., *Panagrolaimus* sp., *Acrobeloides* sp., *Cephalobus* sp.

Community analysis of soil nematodes

Among the plant parasitic nematodes, *Helicotylenchus* sp. was the most frequent (AF – 58.3%), followed by *Tylenchorhynchus* sp. (AF- 41.7%; D- 2.5; PV- 16.1%), whereas *Meloidogyne* sp. most abundant (D – 30.8) and prominent (PV - 154%). Other plant parasitic nematodes, *Hirschmanniella* sp., *Pratylenchus* sp., and *Hemicriconemoides* sp. were less frequent, abundant and prominent (AF- 8.3%; D- 3.25,1.2 and 0.16; PV- 9.3, 3.4 and 0.46%, respectively) in the community (Table 1).

In case of predatory nematodes, *Iotonchus* sp. was more frequent, abundant and prominent (AF- 25%; D- 0.42; PV- 2.1%) followed by *Mylonchulus* sp. (AF- 16.7%; D- 0.42; PV-1.71%). On the other hand, *Mononchoides* sp. *Hadronchoides* sp., and *Paramylonchulus* sp. were less frequent, abundant and prominent (AF- 1.31%; D- 0.16; PV- 0.46%) nematodes in the community (Table 1).

In case of bacteriovorus nematodes viz., *Rhabditis* sp. (AF- 33.3%; D- 1.83; PV- 14.6%) followed by *Tratorhabditis* sp. (AF- 25%; D- 2.92; PV- 14.6) were more frequent, abundant and prominent nematode genera. Less frequent, abundant and prominent nematode in the community was *Cephalobus* sp. (AF- 8.3%; D- 0.42; PV- 1.21) (Table 1).

Distribution of nematodes

Present survey revealed that, spiral nematode, *Helicotylenchus* sp. was a key nematode and found in almost seven crops followed by *Tylenchorhynchus* sp. that was associated with six crops. Important rice root nematode, *Hirschmanniella* sp. was associated only with paddy. An average of 3 – 8 nematode genera were associated with each crop. Among them 1-5 genera belonged to plant feeder nematodes while 1-3 nematode genera belonged to predatory and microbivorus nematode (Table 2).

Diversity among the soil nematodes could not be compared due to lack of information but it may be assumed that diversity vary considerably with habitat, area and the number of individuals [16]. Predatory nematode species form an important component of nematode community of soil ecosystem. There is a need to assess various ecological parameters governing population structure to explore their possibility in plant parasitic nematode management. The information generated from present study could be useful for the management point of view in this area.

It is concluded that, *Helicotylenchus* sp. and *Tylenchorhynchus* sp. were key nematodes found in the areas of Meghalaya surveyed, whereas *Meloidogyne* sp. was most abundant and prominent group in the community. This preliminary study also indicates that a more systematic survey across different seasons and areas in both agri and horticultural crops will be more helpful in mapping the distribution of various nematodes in Shilong, Meghalaya for better understanding of their role in agriculture as the state is predominantly following organic cultivation.

Table 1: Community analysis of plant and soil nematodes associated from Shilong.

Group	Nematodes	AF (%)	AD	PV
Plant Feeder nematodes				
	Helicotylenchus sp.	58.3	6.41	48.9
	Tylenchorhynchus sp.	41.7	2.5	16.1
	Xiphinema sp.	41.7	2.1	13.5
	Hoplolaimus sp.	41.7	2.25	14.5
	Meloidogyne sp.	25.0	30.8	154.0
	Longidorus sp.	16.7	0.33	1.34

	Pratylenchus sp.	8.3	1.2	3.4
	Hemicriconemoides sp.	8.3	0.16	0.46
	Hirschmanniella sp.	8.3	3.25	9.3
Predatory Nematodes				
	Iotonchus sp.	25.0	0.42	2.1
	Mylonchulus sp.	16.7	0.42	1.71
	Parahadronchus sp.	8.3	0.42	1.21
	Diplogaster sp.	8.3	0.66	1.90
	Mononchoides sp.	8.3	0.16	0.46
	Hadronchoides sp.	8.3	0.16	0.46
	Paramylonchulus sp.	8.3	0.16	0.46
Microbivorus Nematodes				
	Rhabditis sp.	33.3	1.83	10.5
	Tratorhabditis sp.	25.0	2.92	14.6
	Mesorhabditis sp.	25.0	1.92	9.6
	Panagrolaimus sp.	16.7	1.0	4.08
	Acrobeloides sp.	16.7	1.83	7.47
	Cephalobus sp.	8.3	0.42	1.21

AF - Absolute Frequency; AD - Absolute Density; PV - Prominence value

Table 2: Plant and soil nematodes associated with different crops which cultivated at Shilong.

Group / Nematodes	Crops											
	Jack	**Fern**	**Bamboo (Local)**	**Pine**	**Pineapple**	**Pea**	**Arecanut**	**Bamboo (Robet)**	**Guava**	**Citrus**	**Paddy**	**Ageratum**
Plant Feeder nematodes												
Helicotylenchus sp.	+	+	-	+	+	-	-	+	+	+	-	-
Tylenchorhynchus sp.	+		-	-	+	+	+	-	+	-	+	+
Xiphinema sp.	-	+	+	+	-	-	-	-	-	+	+	-
Hoplolaimus sp.	-	-	-	-	-	-	+	+	-	+	+	+
Longidorus sp.	-	-	-	-	-	-	+	+	-	-	-	-
Pratylenchus sp.	-	-	-	-	-	-	-	-	+	-	-	-
Hemicriconemoides sp.	-	-	-	-	-	-	-	-	+	-	-	
Meloidogyne sp.	-	-	-	-	-	-	-	-	-	+	+	+
Hirschmanniella sp.	-	-	-	-	-	-	-	-	-	-	+	-
Predatory Nematodes												
Iotonchus sp.	+	-	-	-	-	-	+	+	-	-	-	-
Hadronchoides sp.	-	-	-	+	-	-	-	-	-	-	-	-
Mononchoides sp.	-	-	-	-	-	+	-	-	-	-	-	-
Paramylonchulus sp.	-	-	-	-	-	-	-	+	-		-	-
Mylonchulus sp.	-	-	-	-	-	-	-	-	+	+	-	-
Diplogaster sp.	-	-	-	-	-	-	-	-	+	-	-	-
Parahadronchus sp.	-	-	-	-	-	-	-	-	+	-	-	-
Microbivorus Nematodes												
Acrobeloides sp.	+	-	-	-	-	-	-	-	-	-	+	-
Cephalobus sp.	-	+	-	-	-	-	-	-	-	-	-	-
Tratorhabditis sp.	-	-	+	+	-	-	+	-		-	-	-
Panagrolaimus sp.	-	-	+		-	-		+	-	-	-	-
Rhabditis sp.	-	-	+	+	+	+	-	+	-	-	-	-
Mesorhabditis sp.	-	-	-	-	-	-	+	-	+	-	-	-

+ Present; - Absent

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