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Marine Meiobenthic Nematode Assemblages as Potential Bioindicators and Carbon Sequesters in Coastal Sediments

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ABSTRACT

Marine environments as carbon sinks play a major role in carbon sequestration and are now under constant threat of pollution from multiple sources. Marine meiobenthic nematodes due to their limited mobility serve as potential bioindicators of environmental conditions. The present paper is focused to assess the marine nematode assemblages and its role in carbon sequestration along with the sedimentological variables in Arthunkal, Kerala, India, during the year 2012-2014. Five stations (I, II, III, IV and V) were selected for the study. Seasonal samples for geo-chemical variables were analysed using standard procedures and marine free living nematodes were collected, identified and carbon sequestration was calculated as per standard methods. CCA plot was computed using PRIMER Vs 6 software. The faunal composition consisted of twelve families and fifteen genera. Of this *Sabateria* sp. contributed to high percentage of carbon content whereas *Tricoma* sp. low percentage. From CCA analysis, it was evident that *Desmodora sp., Halalaimus sp., Sabatieria sp., Halichoanolaimus sp.* and *Parodontophora sp.* were found to be strongly influenced by clay, organic carbon, total phosphorus, silt and potassium whereas *Oxystomina sp., Dorylaimopsis* sp. and *Tricoma* sp. were more related to sand (%). Considering the total carbon sequestered by the nematodes, highest contribution was recorded at station II and lowest at station III. As these marine nematode resources provide valuable ecosystem services, we must protect them by regular bio monitoring programmes to maintain global biodiversity and for climate change mitigation.

Key words : *Marine Ecosystem, Meiobenthic nematodes, Hydro-geochemical variables, Carbon sequestration, Bio monitoring.*

Introduction

Marine and coastal environments, the most ecologically and socio-economically important habitats, are under constant threat of pollution from multiple sources. Being the largest carbon pool on Earth, they play an important role in regulating global climate changes (Zhang *et al.,* 2017). High carbon sequestration capacity and storage rates strongly suggest that conservation of these key coastal systems may be a very cost-effective tool in mitigating climate change. Concerns regarding the increase of atmospheric partial pressure of carbon dioxide have focused attention on the biological carbon pump, because the ocean sequesters one-fourth to one-third of the carbon released by human activities each year. Marine meiobenthic nematodes, accounting for about 60-90% of meiofauna in marine sediments, are important both in cycling carbon and for redistributing it vertically in the water column and laterally across ocean basins (Thompson and Miller, 2017). Due to their sessile habitat, and intimate association with sediments, nematodes are known to accumulate various contaminants. They serve as good indicators of environmental stress and are also involved in bio monitoring programs (Abebe *et al*., 2011).

Arthunkal is a coastal hamlet, the economy of which mainly resides in the fishery sector - the source of livelihood for the fishing communities. Detailed information regarding the carbon sequestration potential of marine nematodes is lacking along the coast of India. So the present study, evaluated the amount of carbon content sequestered by nematodes and the influence of sedimentological variables in nematode distribution pattern at Arthunkal in Arabian Sea, the north-western extension of the tropical Indian Ocean, Kerala, India.

Materials and Methods

Study Area

The present study was conducted seasonally (premonsoon, monsoon and post monsoon) along the coast of Arthunkal in Arabian Sea ($9^0$39’19’’N and $76^0$17’23’’E), Kerala, India during 2012-2014. Samples were taken from five stations (stations I, II, III, IV and V) representing depths of 5 m, 10 m, 15 m, 20 m and 30 m from the shoreline along one transect (Figure 1).

Sampling Methods

Sediment samples were collected using a Van Veen grab (0.1 m^2 mouth area) and sub sampled using a corer of 2.5 cm diameter and 10 cm length. The collected samples were sieved using 0.5 mm and 63 µm sieves and the nematode fauna were fixed in 70% alcohol for identification using standard keys ((Platt and Warwick, 1988) and carbon sequestration was assessed (Jensen, 1984). From the collected sediments, temperature was recorded using a thermometer (range=0-50 ±0.01^{0}C accuracy), pH and Eh by a Water Analyzer (Systronics-model 371), organic carbon by Wet Oxidation Method (El Wakeel and Riley, 1957), textural analysis by pipette analysis (Krumbein and Petti John., 1938), total nitrogen by Micro-Kjeldahl method (Jackson, 1973), total phosphorus by spectrophotometric method (Murphy and Riley, 1962) and potassium with a flame photometer (APHA, 1998).

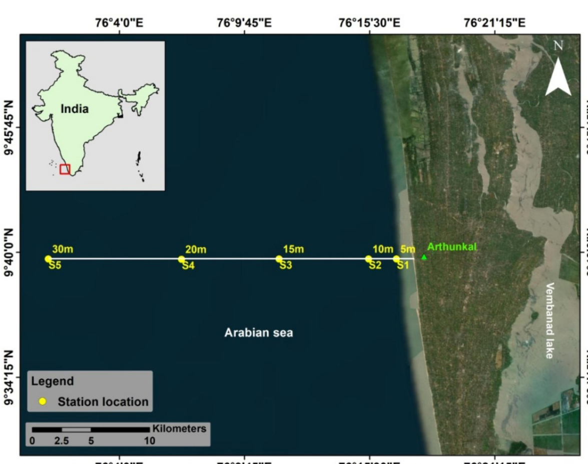

Fig. 1. Study area and Sampling stations

Data analysis

CCA analysis of sedimentological variables and nematode assemblages were computed using Primer Vs 6.

Results and Discussion

Carbon sequestration by Marine nematodes

The faunal composition consisted of fifteen genera. This included twelve families of nematodes viz., Oxystominidae, Oncholaimidae, Comesomatidae, Selachinematidae, Desmodoridae, Microlaimidae, Chromadoridae, Ceramonematidae, Desmoscolecidae, Sphaerolaimidae, Linhomoeidae and Axonolaimidae (Table 1, Figure 2-4). Nematodes are involved in biological carbon pump and they probably play a significant role in regulating the direction and magnitude of detrital carbon flow (Findlay *et al*., 1982). Of the twelve families, *Sabateria* sp. of family Comesomatidae contributed to high percentage of carbon content of 10.85 µg- at station V during post monsoon and 4.28 µg at station I during monsoon. The family Comesomatidae is characterized by the presence of many organic load indicators. Family Comesomatidae was the most dominant among nematode families in the Arctic Konjsfords (Krishnapriya *et al*., 2018). The genus *Parodontophora* of Axonolaimidae family recorded maximum carbon content of 5.38 µg at station I during pre monsoon. Changes in community composition should profoundly affect the efficiency of the biological pump which induces regional differences in the accumulation and preservation of organic carbon in the sediments (Rocha, 2003). Biological pump (BP) and microbial carbon pump (MCP) are the two most important biologically driven carbon sequestration mechanisms known to date (Jiao *et al*., 2010). As a community grazer, nematodes feed on bacteria, affecting microbial carbon pump too. Considering the total carbon sequestered by the nematodes along the coast, highest contribution of 12.33 µg was recorded at station V and lowest contribution of 0.28 µg was indicated at station II. Nematodes have plentiful interactions with other soil organisms and play critical roles in soil nutrient cycling and in the flow of energy (Makulec *et al*., 2014).

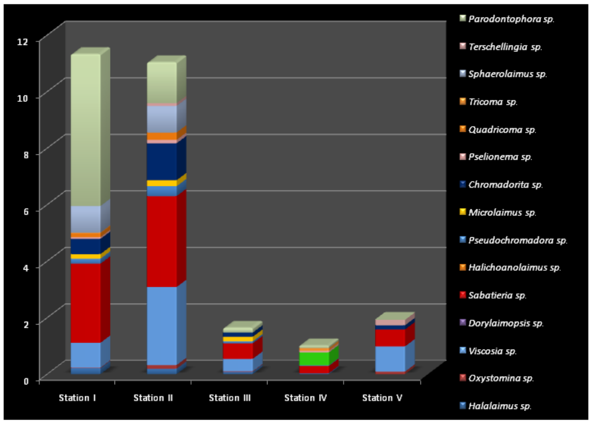

Fig. 2. Seasonal average variations in the carbon content of nematodes (ind. /10cm^2) in Arthunkal coast during pre monsoon.

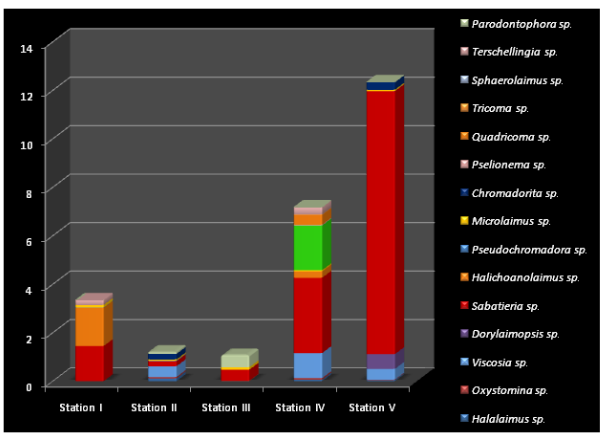

Fig. 3. Seasonal average variations in the carbon content of nematodes (ind. /10 cm^2) in Arthunkal coast during monsoon.

CCA plot for marine meiobenthic nematodes and sedimentological variables

In the station-sedimentological CCA biplot (Figure 5), Axis 1 explains 27.15% of species variation with an Eigen value of 0.17 while Axis 2 explains 21.35% with an Eigen value of 0.13 (Table 2). In CCA biplot stations having high sediment organic carbon, clay, total phosphorus, silt and potassium were positioned at the upper right quadrant and the nematodes such as *Desmodora* sp., *Halalaimus* sp., *Sabatieria* sp., *Halichoanolaimus* sp., and *Parodontophora* sp. were well distributed in these stations. They were found to be strongly related to and influenced by clay, organic carbon, total phosphorus, silt and potassium of the sediment. Richer communities develop in shallower areas where there is a higher overall input of organic matter (Vincx *et al*., 1994).

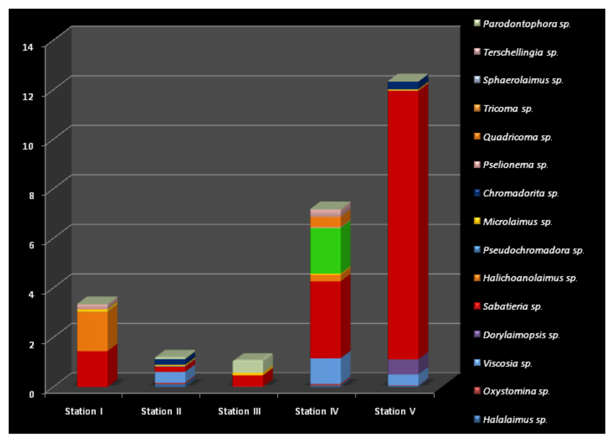

Fig. 4. Seasonal average variations in the carbon content of nematodes (ind. /10cm^2) in Arthunkal coast during post monsoon.

Table 1. Occurence and distribution of nematode families

Family	Station I	Station II	Station III	Station IV	Station V
Oxystominidae	+	+	+	+	+
Oncholaimidae	+	+	+	+	+
Comesomatidae	+	+	+	+	+
Selachinematidae	+	-	-	+	-
Desmodoridae	+	+	+	+	+
Microlaimidae	+	+	+	+	+
Chromadoridae	+	+	+	+	+
Ceramonematidae	+	+	-	+	+
Desmoscolecidae	+	+	-	+	+
Sphaerolaimidae	-	+	-	-	-
Linhomoeidae	+	+	+	+	+
Axonolaimidae	+	+	+	+	+

Stations with high sediment pH were located at lower right quadrant. The nematodes such as *Viscosia* sp., *Microlaimus* sp. and *Terschellingia* sp. were well distributed in these stations which had strong relation to sediment pH. The stations with high redox potential and sediment temperature were located at upper left quadrant. The species like *Chromadorita* sp. and *Quadricoma* sp. were well distributed in these stations which showed strong relation to redox potential and sediment temperature. The stations with high sand content were positioned at lower left quadrant. The species such as *Oxystomina* sp. and *Tricoma* sp. showed more relation to sand (%). The distribution and abundance of meiobenthic nematodes were also strongly related to sediment granulometry (Somerfield *et al.*, 1995).

Table 2. CCA Values for meiobenthic nematodes and sedimentological variables

Axis	Eigenvalue	%
1	0.1704	27.15
2	0.13399	21.35
3	0.090178	14.37

Conclusion

The present study provides a comprehensive account on the amount of carbon content that can be sequestered by nematodes in marine sediments. The occurrence of the r- strategist viz; *Viscosia* sp. and also deposit feeder *Sabatieria* sp. that were found to distribute well at stations II and III can be regarded as indicators of organic load. CCA plot also revealed strong correlation of *Sabatieria sp.* to geochemical variables such as clay, organic carbon, total phosphorus, silt and potassium of the sediment. The composition, abundance and distribution status of nematodes along the coast can be used as early warning indicators of environmental disturbances. So it is essential to protect this valuable marine ecosystem and also its biodiversity by regular bio monitoring and sustainable utilization of resources in the pelagic-benthic zones for preserving it for future generations.

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Conflict of interest

I, the corresponding author, hereby declare that no conflict of interest exists and has obtained permission from all the authors for submission of the manuscript.

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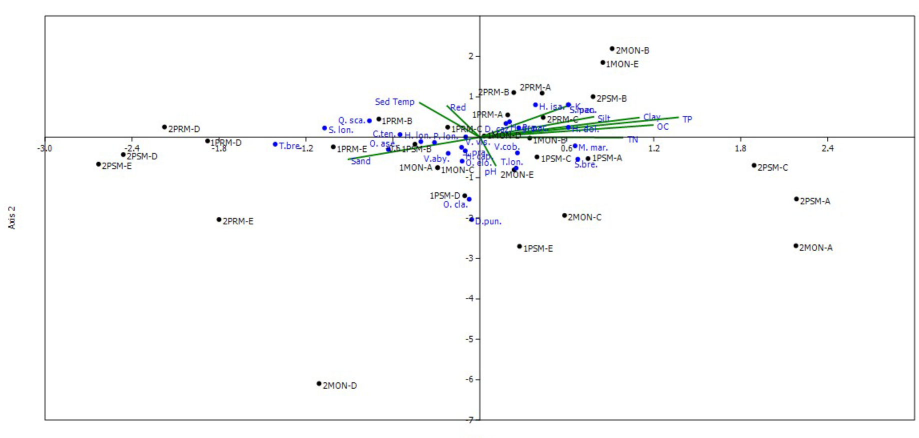

Fig. 5. CCA plot between marine nematodes and sedimentological variables

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