Eco. Env. & Cons. 30 (Nov. Suppl. Issue) : 2024; pp. (S12-S16)
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ISSN 0971–765X

DOI No. http://doi.org/10.53550/EEC.2024.v30i07s.003

The effect of physico-chemical parameters on Nemertean distribution in Subarnarekha Estuary, Bay of Bengal, India: A case study

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(Received 9 April, 2024; Accepted 4 June, 2024)

ABSTRACT

The present investigation aimed to evaluate the correlation between physicochemical parameters and the abundance of nemertean species in the Subarnarekha estuary, located in Odisha, India. Karl Pearson's correlation coefficient was employed to analyze the relationship between various physicochemical factors and the abundance of Nemerteans. The findings revealed that elevated concentrations of physicochemical parameters such as pH, temperature, salinity, chemical oxygen demand (COD), and dissolved oxygen (DO) had a detrimental impact on the abundance of nemertean species *Zygonemertes* sp., particularly during the monsoon season at the sampling site. Canonical Correspondence Analysis (CCA) was conducted to assess the connection between environmental variables and nemertean species, highlighting the significant influence of physico-chemical parameters on the distribution of nemerteans within the estuarine ecosystem of the Subarnarekha River in Odisha, India.

Key words : *Nemertea, Bay of Bengal, Physico-chemical parameter, CCA, Correlation*

Introduction

Most ecological studies on nemerteans have primarily focused on their feeding behavior and interactions with prey (Gibson, 1998). However, there remains a considerable gap in our understanding of how environmental factors impact the lives of nemerteans. Limited research has been conducted on how nemerteans respond to changes in temperature, pH, and salinity Zhao and Sun (2006), Gibson (1972), Moore and Gibson (1985), Ferraris and Norenburg (1988), Charmantier and Charmantier-Daures (1991), Roe (1993), and Okazaki *et al.* (2001).

No study has yet delved into the relationship between physico-chemical parameters and nemertean abundance. Consequently, our current investigation aims to fill this gap by examining the influence of physico-chemical factors on nemertean abundance in the Subarnarekha estuary in Odisha, India. This particular estuary faces potential anthropogenic pressures, adding significance to understanding the dynamics between environmental conditions and nemertean populations in this region.

Materials and Methods

The Subarnarekha River, coursing through the Indian states of Jharkhand, West Bengal, and Odisha, discharges into the Bay of Bengal. Unfortunately, this vital watercourse is facing significant disturbances attributed to unregulated mining along its banks and diverse trawler activities. Our chosen sampling site, Talsari coast in Odisha (21.622963N, 87.40585E), lies at the mouth of the Subarnarekha

estuary. For a comprehensive understanding of water quality, we conducted seasonal sampling of percolated water from depths ranging between 20 to 30 cm. The sampling period extended from January 2020 to December 2021, encompassing three seasons: Post-monsoon (November–February), Pre-monsoon (March–June), and monsoon season (July–October). Each parameter was assessed with three replicates, and the results were meticulously recorded. To measure water temperature, a mercury thermometer was employed. Additionally, pH, turbidity, and conductivity were determined using an automatic water quality checker (TOA, model no-WQC22A, Japan). Dissolved oxygen and biochemical oxygen demand (BOD) were assessed using Winkler's method, salinity through the Mohr Knudsen method, and chemical oxygen demand (COD) via the Proteus multiparameter COD Sensor. Total dissolved solids (TDS) were measured using a portable TDS meter (HI9811-51). In parallel, for nemertean species abundance analysis, samples were collected from a 300-meter creek in the Subarnarekha estuary using the line transect method. Consistent sampling areas and manual labor were employed for nemertean sample collection. Identification of nemertean species involved both external morphology and internal histology assessments. Karl Pearson's correlation coefficient was utilized to establish correlations among various physico-chemical attributes and distinct nemertean assemblages. Canonical Correspondence Analysis (CCA) was performed using Palaeontological Statistics (PAST) Software Version 4.13 to unveil relationships between Nemertean and physico-chemical parameters. The length and direction of arrows in the CCA plot indicated the relative importance and direction of correlations between variables.

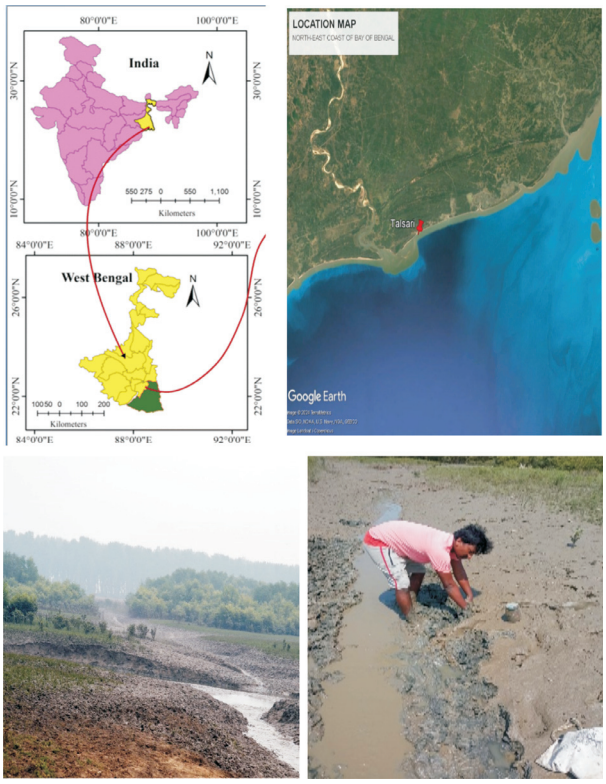

Fig. 1. Location map showing sampling site

Results and Discussion

Studying the physico-chemical parameters is crucial for understanding their impact on Nemertea distribution. Water quality is influenced by various factors such as geology, hydrology, climate, and human activities (Boon *et al*., 1992; Bartram and Balance, 1996). The physico-chemical parameters of percolated water in the Subarnarekha estuary are presented in Table 1. Among these parameters, water temperature significantly influences Nemertea growth (Sun, 2006). In the Subarnarekha estuary, the lowest recorded temperature (22.4°C) occurs during

Table 1. Physico-chemical parameter analysis

	2020	2021	2020	2021	2020	2021
	Pre-monsoon		Monsoon		Post-monsoon	
pH	8.67	8.32	8.25	8.14	8.46	8.33
Temp(°C)	31.6	31.7	30	29.8	22.4	23.1
DO (mg/l)	8.67	8.78	7.22	7.68	7.93	8.28
BOD (mg/l)	4.35	4.1	4.9	4.06	4.83	4
COD	563	501	489	506	466	460
Salinity (%)	31.6	31.4	16.3	16.2	22.7	22.8
TDS	782	778	990	886	681	726
Turbidity (NTU)	595	481	802	639	557	582
Conductivity (Ms/c)	1.7	1.9	1.83	1.79	1.76	1.92

post-monsoon, while the highest (31.7 °C) is in pre-monsoon. Turbidity peaks at 802 NTU during the monsoon and drops to a minimum of 481 NTU in the pre-monsoon period. Total dissolved solids reach a maximum of 990 mg/l during the monsoon and decrease to 681 mg/l in post-monsoon. Dissolved oxygen levels are critical for stream health and aquatic life protection (Chang, 2002). Throughout the year, dissolved oxygen ranges from a maximum of 8.78 mg/l (pre-monsoon) to a minimum of 7.22 mg/l (Monsoon). The pH value remains relatively high at 8.67, indicating alkalinity in the Subarnarekha River. BOD levels fluctuate with seasons, with the highest (4.9 mg/l) during the monsoon and the lowest (4 mg/l) in post-monsoon. Salinity varies from a minimum of 16.2% during the monsoon to a maximum of 31.6% in pre-monsoon. Conductivity remains stable between 1.7 Ms/c and 1.92 Ms/c throughout the study. COD levels peak at 563 mg/l in the pre-monsoon and decrease to 460 mg/l in the post-monsoon.

Nemertean Community

A total of six nemertea species are studied. Preliminary investigation shows among them two species (*Zygonemertes* sp. and *Prosadenoporus* sp.) belong to the class Hoplonemertea and other four species belong to the class Pilidiophora. *Cerebratulus* sp. (class Pilidiophora, order Heteronemertea) shows high abundance throughout the study. The seasonal abundance of these six species of nemertea is presented in Figure 3.

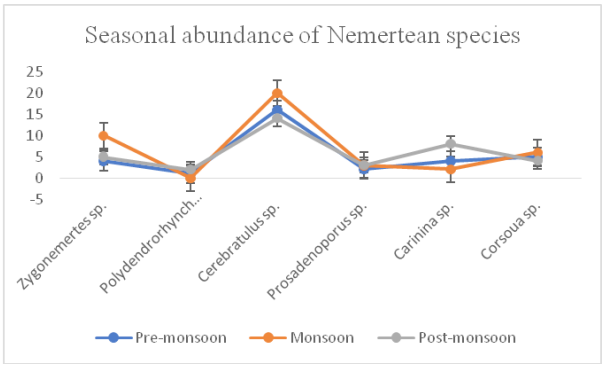

Fig. 3. Seasonal abundance of nemertean species

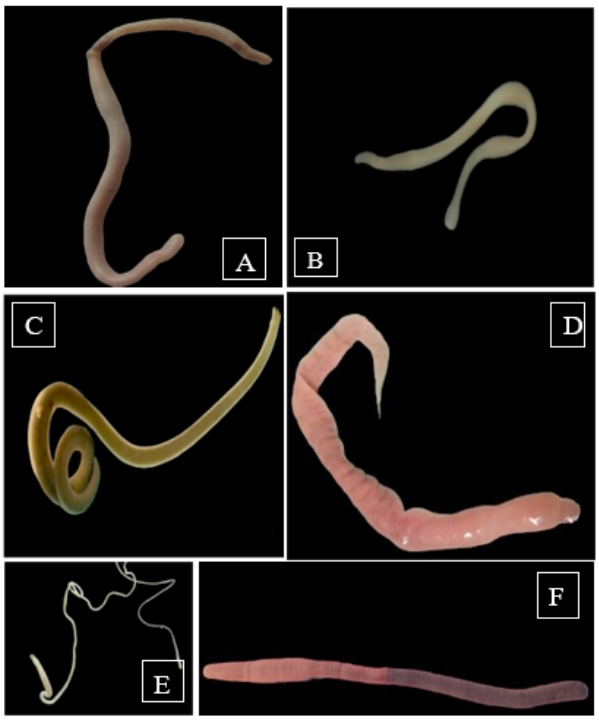

Fig. 2. Studied Nemertean species: A) *Zygonemertes* sp. B) *Corsoua* sp. C) *Prosadenoporus* sp. D) *Polydendrorhynchus* sp. E) *Carinina* sp.F) *Cerebratulus* sp.

Correlation between physico-chemical parameters and Nemertea

Karl Pearson's correlation coefficient

Karl Pearson's correlation coefficients calculated between various physico-chemical attributes and density of nemertea in the Subarnarekha estuary have been presented in Figure 4. *Zygonemertes* sp. has a positive correlation with BOD (r=0.72) TDS (r=0.89) Turbidity (r=0.96) and Conductivity (r=0.95) at level p<0.05 while *Polydendrorhynchus* sp. has a positive correlation with pH(r=0.50) DO (r=0.49) and Salinity (r=0.42) at level p<0.05. Conductivity and turbidity have a positive correlation with *Zygonemertes* sp. (r=0.95, r=0.96), *Cerebratulus* sp. (r=0.69, r=0.98), *Prosadenoporus* sp. (r=0.84, r=0.37) and *Corsoua* sp. (r=0.54,r=0.93) respectively at level p<0.05. TDS shows a negative correlation with *Polydendrorhynchus* sp. (r=-0.98, P<0.05) and *Carinina* sp. (r=-0.93, P<0.05). Salinity negatively correlates with all the species except *Polydendrorhynchus* sp. (r=0.42, p<0.05) and *Carinina* sp.(r=0.24, p<0.05). COD shows a positive correlation with *Cerebratulus* sp.(r=0.03,p<0.05) and *Corsoua* sp.(r=0.23, p<0.05) which is very little. So, it has less effect on these two species. With the other nemertean species, COD shows a negative correlation. Overall, BOD shows a positive correlation with all the species as it shows a negative correlation with

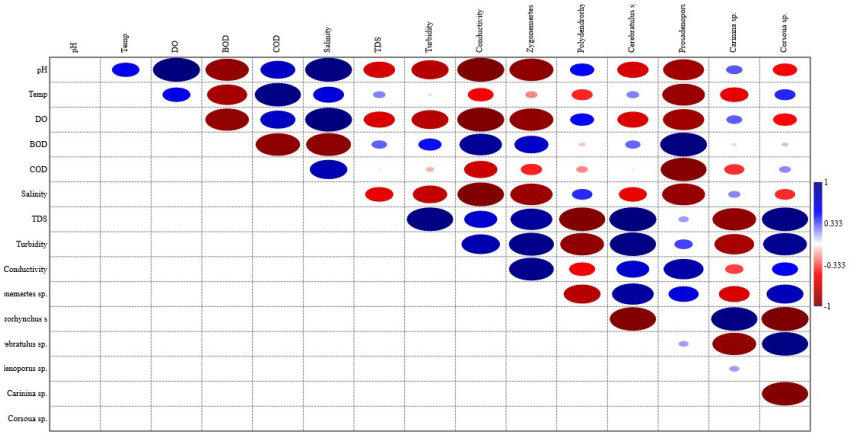

Fig. 4. Pearson's correlation coefficient between physico-chemical parameter and nemertean Abundance

only *Polydendrorhynchus* sp.(r=-0.12,p<0.05) which is negligible. *Cerebratulus* sp. (r=0.25,p<0.05) and *Corsoua* sp.(r=0.43,p<0.05) show a positive correlation with temperature. *Polydendrorhynchus* sp. (r=0.50, p<0.05) and *Carinina* sp.(r=0.33, p<0.05) have a positive correlation with pH.

Canonical Correspondence Analysis (CCA)

Canonical Correspondence Analysis (CCA) method was used to determine the relationships between phytoplankton and environmental variables. The arrow length indicates the importance of variable and shows positive or negative correlations with axis (Abrantes *et al*., 2006; Liu *et al*., 2010).

CCA biplot scores of physico-chemical parameters at study site of Subarnarekha estuary from January 2020 to December 2021.

	Axis 1	Axis2
Zygonemertes sp.	-0.94668	-1.73733
Polydendrorhynchus sp.	3.04615	0.309426
Cerebratulus sp.	-0.30925	0.675647
Prosadenoporus sp.	0.184547	-1.0488
Carinina sp.	2.01968	-0.589292
Corsoua sp.	-0.362725	0.995939
pH	0.530184	0.832859
Temp	-0.395018	0.929271
DO	0.520019	0.839411
BOD	-0.151803	-0.983823
COD	-0.192456	0.986264
Salinity	0.448206	0.881162
TDS	-0.98689	-0.133974
Turbidity	-0.941487	-0.31082
Conductivity	-0.567281	-0.807482

At the sampling site, CCA has been drawn between 9 physico-chemical parameters and 6 species of Nemertea. *Polydendrorhynchus* sp., *Prosadenoporus* sp., and *Carinina* sp. showed a positive correlation with axis 2 which indicates the effect of pH, DO, and Salinity on their distribution. *Zygonemertes* sp. showed a positive correlation with TDS, Turbidity, Conductivity, and BOD. However, *Cerebratulus* sp. and *Corsoua* sp. indicated a positive relationship with COD and temperature.

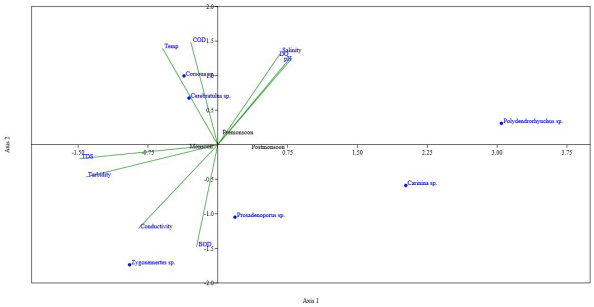

Fig. 5. CCA plot between physico-chemical parameter and nemertean Abundance

Conclusion

This paper recapitulates the seasonal variations of physico-chemical parameters and their influences on the nemertean community of Subarnarekha estuary with an expedition of statistical data output. Physico-chemical parameter shows labyrinthine and heterogeneous relations with the species. Species reveal a remarkable adaptation ability and flourish within a specific range of physico-chemical parameters such as pH, salinity, BOD, etc. Therefore, it is necessary to understand these relationships for proper environmental management, and conservation efforts and to prognosticating the impacts of climate change.

Acknowledgements

We are grateful to all the laboratory members of the Coastal Ecology Research Laboratory. We are also thankful to CSIR-HRDG, India, and DST SERB (TAR/2018/000335) for their financial support.

Authors' contributions: SKG designed the study. SD, JM, BM and SKG, SB collected the samples. SD, SB, and JM performed the physicochemical analysis of water. SD, JM, BM, and SKG drafted the manuscript. All authors read and approved the manuscript's final version.

Competing interests: The authors declare that they have no competing interests.

Consent for publication: All of the authors agreed to publish the paper.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used [ChatGPT] to improve language and readability. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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