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The anthropocene woven community structure of testate amoeba in Pobitora Wildlife Sanctuary, Assam

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Abstract

A preliminary study was carried out in Pobitora Wildlife Sanctuary, during December 2023 to assess the testate amoeba diversity. The sanctuary has wet mixed deciduous forest, grassland and marshy areas and is situated at the Brahmaputra floodplain region. During this study, thirty seven species of testate amoebae were recorded which belonged to nine families and twelve genus. Twenty nine species belongs to phylum Cercozoa; Genus *Centropyxis* Stein 1857, *Euglypha* Dujardin 1841, *Difflugia* Leclerc 1815, *Arcella* Ehrenberg 1830 and *Trinema* Dujardin 1841 are the dominant while family Centropyxidae has highest number of species in the study area. High abundance and species richness of testate amoebae indicates the resilient nature of the ecosystem in the forest. This sanctuary has gained importance due to its ability to serve as an ideal habitat for the Greater One Horned Rhinoceros, a vulnerable species on the IUCN Red List. The increasing contest for space and resources between this mega herbivore and humans are causing habitat destruction in the area; while the recurrence flood also enhances the habitat destruction process. This Anthropocene driven habitat has a huge impact on community structure of the animals including the microbial world. The testate amoeba community structure differs with its biotopes, indicating its capability to serve as a bioindicators. The incorporation of the study of testate amoeba diversity can serve as a potent tool to assess the change in the forests (habitats), formulate steps to conserve our forests and assess their ecological health.

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Introduction

Pobitora was established formerly as a Reserve forest in 1971 and later in 1987 it was designated as a Wildlife Sanctuary. It is situated at the southern bank of River Brahmaputra in Morigaon district, which is around 40 Kilometers from Guwahati city. The sanctuary is covered with grasslands which constitute ≥ 2/3rd of the area; ≤1/6th is covered by trees and rest is covered by water bodies (Beel). The fringes of the sanctuary are inhabited by the indigenous communities and tribal people belonging to Nath community and Karbis. The increased human footprint in the wildlife inhabits landscapes has a detrimental effect on the biodiversity. In spite of these increased anthropogenic activities, encroachment, habitat destruction, flooding, the sanctuary still is the abode for numerous wildlife along with the Greater One Horned Rhinoceros.

Testate amoebae are a eukaryotic protozoan described as an assemblage of three unrelated groups Amoebozoa, Stramenopiles and Cercozoa by Adl *et al.*, 2019. This ubiquitous organism (Finlay *et al.*, 1999, 2001, Finlay 2002) constitutes as an integral component of the microbial community and the work of Krashevska *et al.*, 2017 revealed its role in recycling nutrients in terrestrial ecosystem. The shell or test is the outermost covering which computes a unique morphological trait, having bioindicators potential. The test can withstand wide range of environmental circumstances, and helps in ecological and paleoecological studies of wetlands (Mitchel *et al.,* 2007). The testate amoeba responds to changes in the key variables of hydrology (Charman and Warner, 1997) and water chemistry (Mitchel *et al.,* 2000a). They also serve as indicators for altitude gradient (Krashevska *et al.* 2007), soil (Foissner, 1997) or air pollution (Meyer *et al.*, 2012, 2013), paleoclimate (Charman *et al.*, 2004), pH changes reconstruction (Mitchell *et al.*, 2001), Paleolimnology (Patterson *et al.*, 2002). The testate amoeba assemblage can decipher the environmental parameters of its habitat. The beels of the Pobitora Wildlife Sanctuary has a huge role in supporting the biodiversity in this forest and constitutes the fresh water ecosystem.

The grasslands and marshy areas constitute the diverse biotopes for magnificent diverse population to survive and dwell. The study of testate amoeba diversity in this sanctuary will help us to know the ecological health of this sanctuary, facing a constant threat of flood and habitat destruction.

Materials and methods

Study area

Pobitora Wildlife Sanctuary is a small protected area of Assam, located in Morigaon district covering an area of 38.85 sq. kms and has a high density of the Greater One Horned Rhinoceros. This sanctuary is situated at the Brahmaputra floodplain region and is 26.230619°N and 92.054268°E (Fig. 1). It has a unique wetland ecosystem having extensive grasslands, numerous water bodies and large swampy areas which serve as an ideal habitat for the Greater One Horned Rhinoceros. The climate of the sanctuary is characterized by sub-tropical monsoon climate having three distinct seasons of summer, monsoon and winter. Summers are hot and humid with temperature rising above 36°C. Rainfall begins from the month of May, but with commencement of monsoon from the month of June, the Brahmaputra River starts overflowing and inundating the Sanctuary. The average annual rainfall is approximately 2000 mm (Bora and Kumar, 2003). The winters are from November to March with temperature ranging from 10-15°C. The altitude of the area varies from 40-350 meters (Choudhury, 1985), and the soil is mostly the alluvial deposits of the rivers. The forest is comprised of short and tall grass species like *Phragmites kakra*, *Imperate cylindrica, Saccarum spontaneum* etc; trees species like *Syzium cumini, Ficus glomerate, Alstonias colaris, Terminalia tomentosa*, etc; and the wetlands comprises around 6.61% of the total area of the sanctuary. The faunal diversity comprises of varieties of resident and migratory birds, mammals such as Greater one horned Rhinoceros, Barking deer, Asiatic wild Buffalo, jungle cat, leopard cat, mongoose, civet cat, otter, etc, fishes, amphibians, reptiles etc. Major portion of the sanctuary is engulfed in flood waters causing the habitat destruction of wildlife.

On one hand it's bashed by recurrence flood and on the other hand it's under the pressure of habitat destruction for the wildlife's inhabitants. The increasing contest for space and resources between this mega herbivore (Greater one horned Rhinoceros) and humans is a major cause for Human-Animal conflict in and around the sanctuary. It is facing a huge threat of land area shrinkage and reduction in depth of waterbodies due to high siltation. In this Anthropocene epoch, the study of testate amoeba diversity is a sustainable approach to assess the ecological health of this protected area. Hence this study aims to record the community structure of testate amoeba in this ecological important sanctuary.

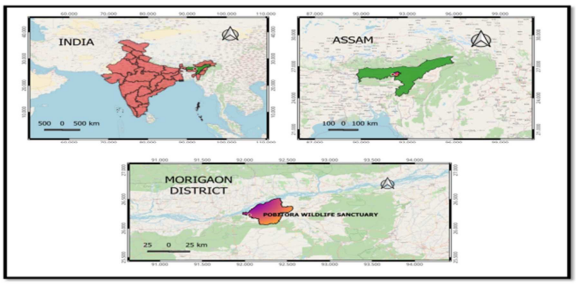

Fig. 1. Map of the study area (Pobitora Wildlife Sanctuary)

Sampling

The water samples from beels, the soil samples from the marshy areas and grasslands, and moss samples were collected from the study area at GPS fixed locations during December 2023. The samples were brought to the laboratory and studied thoroughly to assess the community structure of testate amoeba. After isolation, the testate amoeba were air dried, washed with absolute alcohol and mounted in DPX to prepare permanent slides ((Das *et al.,* 1993, 1995; Chattopadyay and Das, 2003). The key and guidelines laid by Ogden and Hedley (1980), Hoogenraad and de Groot (1942), Charman *et al.* (2000), Mitchell *et al.* (2016), Adl *et al.,* 2019 were followed for identification of the testate amoeba.

Results

The assessment of testate amoeba diversity in the study area resulted in recording 37 species belonging to 9 families and 12 genus and 2 orders. 29 species belongs to Phylum Tubulinea while 8 species belongs to Phylum Cercozoa. *Difflugia* is the prominent genus while species *C. aculeata, D. globulosa, A. gibbosa* are higher in the community structure of testate amoeba form aquatic regions. Genera *Centropyxis*, *Plagiopyxis* and *Euglypha* are prominent members in the terrestrial biotopes. The marshy areas with alluvial soil deposits are rich in *C. aerophila*, *E. tuberculata*, *E. acanthophora* and *E. rotunda*. Increased siltation load and higher organic content in the study area is indicated by the dominance of Genera *Centropyxis* and *Difflugia* (most tolerant to high nutrient concentrations) (Fig. 2, 3, and 4).

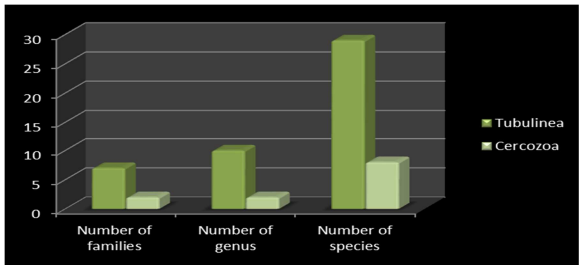

Fig. 2. Representation of testate amoeba diversity under the different phylum in the Pobitora Wildlife Sanctuary

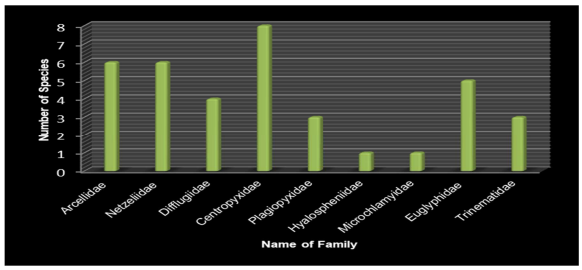

Fig. 3. Representation of testate amoeba diversity under the different family in the Pobitora Wildlife Sanctuary

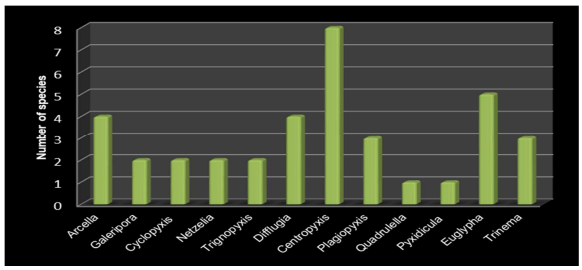

Fig. 4. Representation of testate amoeba diversity under the different genus in the Pobitora Wildlife Sanctuary

The species richness is higher in community structure of aquatic biotopes than the terrestrial biotopes. The species richness and abundance of testate amoeba diversity at the different biotopes of the study area indicates a healthy ecosystem of the forest.

Discussion

The Greater One Horned rhinoceros are the keystone species of grassland ecosystem; they are listed as the vulnerable species on the IUCN Red List and are majorly found in the northeastern India and Terai grasslands of Nepal. They are the largest among the rhino species which habitat in the tropical and subtropical grasslands, Savannas and Shrublands. The turn of the 20th Century witnessed the drastic reduction of this widespread species found in the entire northern part of Indian subcontinent. But the implementation of successful conservation strategies by Indian and Nepalese wildlife authorities helped to recover their strength from 200 to 4000 currently. In North east India, Kaziranga National Park is the home for one third of the entire population of Greater One horned rhinoceros on the globe; Pobitora Wildlife Sanctuary has around 100; Manas National Park harbors around 40 to 50 Rhinos and Dudhwa National Park has around 35-40 Rhinos. In spite of small forest cover area, the Pobitora Wildlife Sanctuary is an ecologically important forest hosting the numerous biodiversity along with the mega herbivores, the Greater One-horned rhinoceros, Asiatic wild buffalo and Asian elephant. The fringes of the sanctuary are inhabited by the tribal people, who depend on the forest resources, practice agriculture and livestock farming for their livelihood. The escalating pressure of encroachment and anthropogenic activities around the protected areas is reciprocated by the increased human animal conflict occurrences. The river Brahmaputra is the lifeline for the state of Assam. But the annual flood brought to the sanctuary by the river Brahmaputra and its tributaries in the monsoon season causes loss of habitat, death and disease outbreak leading to loss of wildlife. Moreover it increases siltation and organic pollutant load in the sanctuary leading to change in water and soil chemistry, impacting the biodiversity of the sanctuary.

The study of testate amoeba in this sanctuary provides an insight to the health of the forest ecosystem. The high diversity of testate amoeba in the study area indicates a resilient ecosystem with rich microbial community. The abundance and richness of genus *Centropyxis*, *Arcella*, *Difflugia* and *Euglypha* indicates the high water content in the study area. The community structure of testate amoeba is different at different biotopes, indicating its responsive ability to different environmental factors and capability to monitor soil microenvironmental effects (Warner and Chmielewski, 1992). The assemblage of the testate amoeba of a place differs with the physical and chemical properties of the habitat (Butler *et al.*, 1996). This specificity of occurrence/ disappearance of species in response to environmental parameters of its habitat make it an ideal tool to interpret the atmospheric conditions (Meyer *et al.*, 2012) such as NO_2 contamination (Meyer *et al.*, 2009, 2012; Nguyen- Viet *et al.*, 2004). The change in temperature of terrestrial or aquatic habitat can be sensed and reflected through the change in the morphology of testate amoeba community (Jassey *et al.*, 2013; McCarthy *et al.*, 1995). Absence of wet species during drier conditions describes their micro-topographical differentiation ability, and thus helps in water table depth reconstruction (Charman *et al.*, 2007; Krashevska *et al.*, 2020; Warner *et al.*, 2007). The stress indicator taxa *C. aculeata* is dominant in deforestation assemblage (Patterson *et al.*, 2002), the fringes of the sanctuary.

Conclusion

The outcome of the study resulted in recording a high species richness and abundance of testate amoeba in the sanctuary. The testate amoeba community structure variation to the biotope indicates its bioindicators trait to monitor the environmental parameters. The forest is an abode for mega-herbivores and other wildlife, but due to habitat destruction they are facing a challenge for survival. This sanctuary is ecologically significant due to its ability to host the Greater One horned rhinoceros and several endangered species.

The sanctuary's stability is threatened by recurrence flood, which disturbs the soil and water chemistry. Assessment of testate amoeba community helps to evaluate the ecological health of the forest. The presence of stress indicator taxa reveals the pollutant incorporation into the forest; and their study can help in monitoring pollution. The deforestation, habitat destruction and encroachment in the forest fringes can be prevented by empowering the indigenous communities and tribal groups, incorporating them in forest protection strategies, reducing their complete dependency on forest resources for their livelihoods, literacy, Eco-tourism for income generation. The protected areas are the abode for biodiversity, their conservation and protection can enhance their ecological health. Testate amoeba study is an emerging tool for sustainable monitoring of forest health. The seasonal study, pre-flood and post- flood analysis, of the testate amoeba assemblage will help to assess the impact of flood on the forest health and microbial diversity. This environmental proxy is a fantastic organism, its incorporation in forest management and conservation will have an effective outcome in assessing forest health.

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