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# Revealing the Diatom Ecological Signatures' Secrets on Stream Water Quality in Karnataka

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The deterioration of stream physicochemical and biological quality results from alterations in water chemistry and physical habitat attributes. Diatoms are often utilized to assess stream water quality because of their capacity to integrate water chemistry over time and to reflect the cumulative impacts of various stressors on stream biota. However, especially in upstream areas, understanding of the primary diatom community patterns in streams remains limited. The purpose of this study was to investigate the influence of water chemistry and watershed variables on stream diatom populations. Canonical correspondence analysis was employed to determine the environmental quality of the habitat and variations in water characteristics, revealing substantial relationships with surface type, water temperature, oxygen content, and nutritional substances. Achnanthidium minutissimum, Cocconeis placentula, and Oricymba japonica have significant affinities for settings characterized by fixed surfaces and translucent water. Our findings illustrate the synergistic impact of several factors that affect diatom patterns and reveal the correlation between diatom biodiversity and stream conditions.
**Keywords:** Diatoms, Physico-chemical parameters, Diversity, CCA, Streams..

## 1. Introduction

Aquatic systems are complex and encompass diverse environments that support a variety of organisms with unique traits and specialized niches (Dudgeon et al., 2006). The structural qualities of running water are significant as they define the associated species. Regrettably, the increasing dependence on freshwater supplies for diverse human activities has adversely impacted ecosystems and wildlife. Phytoplankton, as the principal producers in freshwater ecosystems, are essential for understanding aquatic ecosystems, monitoring ecological disturbances caused by various physico-chemical factors, and addressing diverse environmental challenges. Phytoplankton supports authentic potamoplanktonic groups alone in the greatest delta rivers, as noted by Allan in 1995. In smaller streams, "phytoplankton" consists of floating algae that have been detached from the silt at the bottom or from upstream lakes and ponds. Stream communities typically exhibit significant spatially-structured diversity when assessed over extensive regions (Li et al., 2001; Heino et al., 2003; Parsons et al., 2003). Consequently, it is essential to precisely ascertain the proportionate contributions of minor spatial components and local environmental factors.

Moreover, the environmental characteristics of aquatic ecosystems are evaluated using several species, including fish, macroinvertebrates, and algae. Biological assemblages are often characterized by many biological traits, including diversity, abundance, and functional categories. Diversity metrics are essential in bioassessment since they are believed to correspond with environmental health (Magurran, 2004). The impact of pollution on variety can result in either an increase or a decrease, contingent upon the nature of the disturbance (Patrick et al., 1954; Patrick, 1967; Stevenson, 1984, 2006). The assemblage of algal species in a certain locale is significantly affected by multiple environmental variables, including salinity, temperature, pH, water flow velocity, light availability, water depth, substrate accessibility, and the chemical composition of the water. Thus, the presence of particular algal species in a water body might yield significant information into its properties. Algae function as dependable indicators of water quality, rendering them essential for evaluating aquatic ecosystems. Diatoms, a kind of algae, provide straightforward species-level identification and inhabit many river ecosystems. The richness and abundance of diatom species can vary markedly due to their preferences for particular microhabitats within these rivers (Vyverman et al., 2007). However, the flow patterns and substrate types, characteristic of lotic habitats, significantly influence diatom populations. Francoeur and Biggs (2006) indicate that both high and low flow conditions can affect ecosystem organization. Diatom habitats are characterized by diversity, with certain species demonstrating a distinct preference for particular microhabitats (Tang et al., 2006), elucidating their irregular distribution over various regions (Stevenson and Pan, 1999; Rimet, 2009).

Diatoms serve as significant indicators of water quality owing to their traits, including selective colonization and sensitivity to variations in nutrient conditions (Hering et al., 2006; Neustupa et al., 2013; Fidlerová and Hlbiková, 2016). Historically, research on diatoms in the Indian peninsula has been confined to a limited number of streams and water bodies across specific states with diverse physiographic characteristics (Nandan and Patel, 1984; Mishra and Saksena, 1993; Trivedy and Khatavkar, 1996; Nautiyal et al., 2004; Sharma et al., 2007; Nautiyal and Verma, 2009; Ramanujam and Siangbood, 2009; Sah and Hema, 2010; Baba et al., 2011; Siangbood and Ramanujam, 2014; Dwivedi and Misra, 2015). Although much study on periphyton exists in southern Indian water bodies, most studies predominantly concentrate on the variety of the algal population (Suresh et al., 2011; Selvin-Samuel et al., 2012). Nonetheless, a restricted number of studies investigate the ecological dimensions of these species and environments (Venkatachalapathy and Karthikeyan, 2012; Venkatachalapathy et al., 2013).

The main purpose of this study was to do a thorough examination and record of the benthic diatom population makeup. Furthermore, we sought to elucidate the relationships between these diatom communities and diverse environmental variables across several geographic zones within the upland area along the primary river and its tributaries in the Thungabhadra river system in Karnataka.

## 2. Materials and Methods

Study area

The rivers of Karnataka fulfill essential roles within the state, such as supplying potable water and accommodating domestic need. They are essential in agriculture, providing irrigation and facilitating electricity generation. Moreover, in some areas, these rivers function as transit routes and are essential to the tourism sector of the state. Numerous rivers flow in both eastward and westward directions within the geographical confines of Karnataka. The majority of these rivers begins in the Western Ghats and traverse towards the eastern region of the state. The rivers that ultimately discharge into the Bay of Bengal are among the largest in Karnataka. As a result, the majority of the principal east-flowing rivers in the state are interstate rivers, indicating that they traverse state boundaries.

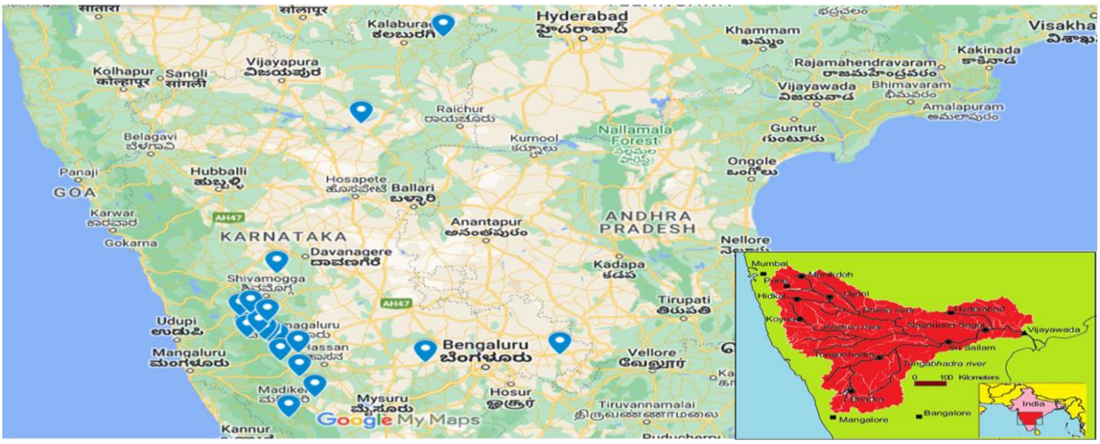


Figure 1: Map shown the study localities of streams in Karnataka

This investigation encompasses the Krishna River and its tributaries, specifically the Jaladurga and Kodli rivers (Figure 1). The Krishna River originates in the Western Ghats near Mahabaleshwar, traverses Wai, and proceeds eastward until it converges with the Bay of Bengal. The study also encompasses the HuthurPalar Dam on the Kaveri River, situated at Bethri, Madapura. The Kaveri River, which originates in the Coorg district of Karnataka within the Brahmagiri range of the Western Ghats, traverses several areas, including Kirugunda, Harihalli, and Herur, before conjoining with the Hemavathi River. The Hemavathi River originates in the Western Ghats of Karnataka, commencing in the Mudigere taluk of Chikmagalur district. It traverses through Hassan district, where it merges with its principal tributary, the Yagachi River, before ultimately joining the Kaveri River near Krishnarajasagara.

The research includes the Badra River, highlighting locations such as Kolale, Badra, Gorigandi, Jenugadde, Basaravalli, Aldur, and Kolale. The Bhadra River, originating in the Western Ghats, traverses eastward across the southern region of the Deccan Plateau. Throughout its trajectory, it is conjoined by the Somavahini River in the vicinity of Hbbe, Thadabehalla, and Odirayanahalla. Finally, the Tunga River and its related locations, including Jannapura, Jayapura, Kuluru, Tunga, and Honnali, are included in the study. The Tunga River originates in the Western Ghats, notably from a peak called Varaha Parvata near Gangamoola. It traverses two districts in Karnataka: Chikmagalur and Shimoga.

Preparation and examination of Diatom samples

Taylor et al. (2005) delineated their approach for the collection, processing, and analysis of diatom samples. Epiphytic diatoms were gathered from aquatic flora at each sampling location. They removed ten submerged stems, each measuring between 10 and 15 cm in length. The stems were thereafter placed in zip-top bags containing 50 cc of lake water. The diatoms were aggressively detached from the stems. The resultant water, containing the diatoms, was meticulously put into sterilized honey jars filled with 70% ethanol. The final concentration of ethanol was maintained at or below 20% to preserve the collected diatom samples.

Due to the substantial presence of organic detritus in diatom samples, the researchers utilized the hot HCl and KMnO4 method to prepare diatom microscope slides, as outlined by Taylor et al. (2005). The samples were permitted to settle for 24 hours. Marked test tubes were subsequently filled with 2-3 ml of the agitated sample, treated with KMnO4, and allowed to stand for a further 24 hours. Subsequently, 1-2 ml of 32% HCl was introduced according to the material concentration. The specimen was subjected to heating on a hotplate and treated with a solitary drop of hydrogen peroxide to guarantee the thorough digestion of organic material. Following centrifugation, the materials were purified by periodically resuspending them in distilled water. The procedure was executed four times. The diluted diatom samples were meticulously pipetted onto pristine coverslips and affixed to microscope slides with Pleurax (with a refractive index of 1.73).

A Nikon 80i compound light microscope equipped with a 100 1.4 NA oil immersion objective and differential interference contrast (DIC) was utilized to analyze the diatoms. The objective was to identify diatoms at the species level wherever feasible; otherwise, identification was conducted at the genus level. Upon identification, diatom valves were enumerated until 400 were tallied or the entire microscope slide was comprehensively studied, adhering to the methodologies established by Archibald (1966) and Taylor et al. (2007).

Water sampling and laboratory examination

Water samples were obtained from the top 20 cm of the water column utilizing a bottom-weighted polyethylene flask. Prior to utilization, these flasks were scrupulously sanitized in the laboratory employing a regimen of lapoline, 10% HCl, and water samples from each sampling site to guarantee they were devoid of contaminants. This study measured various water quality parameters, including temperature, pH, electrical conductivity (EC), turbidity (T), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), magnesium (Mg2+), chloride (Cl-), nitrate (NO3-), silica, phosphate, sulfate (SO4 2-), dissolved oxygen (DO), chemical oxygen demand (COD), and biological oxygen demand (BOD). The measurement methods and criteria adhered to the rules established by the American Public Health Association (APHA) in 2005.

Statistical analysis

We utilized Canonical Correspondence Analysis (CCA) for our examination. To satisfy the homoscedasticity assumptions, we first turned the parameters into logarithmic form, while the diatom taxonomy data were converted into square root form. We performed a Monte Carlo permutation test using 500 permutations to evaluate the statistical significance of each variable. The data analysis were performed utilizing PAST (version 2.15) software, as detailed in Hammer et al. (2001).

## 3. Results

Water quality analysis

The results of water quality were shows no significant variance was seen among the mean temperatures of the sampled locations, which ranged from 18 to 22 °C across all sites. The pH varied from 6.8 to 7.62, conductivity from 33 to 56, total solids from 13 to 23, alkalinity from 20 to 54, and nutrient contents included phosphate from 0.03 to 0.11, chloride from 3.3 to 22.6, sulphate from 0.3 to 12, silica from 0.14 to 0.28, and sodium from 1.1 to 16, while dissolved oxygen ranged from 3.7 to 6.8. The COD varied from 2.3 and 5.9, but the BOD fluctuated from 2.1 to 5.7 as respectively in Table 1.

Table 1. Physio-chemical parameters analysis from selected Karnataka streams.

| **Parameters** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **S9** | **S10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 20 | 20 | 21 |
| pH | 6.7 | 6.7 | 6.8 | 7 | 7.03 | 7.06 | 7.08 | 7.08 | 7.1 | 7.12 |
| Conductivity(σ) | 22 | 25 | 27 | 28 | 31 | 33 | 34 | 36 | 38 | 43 |
| Turbidity | 2.3 | 2.5 | 2.8 | 3.3 | 3.5 | 3.7 | 3.8 | 4.1 | 4.3 | 4.5 |
| Total Solids | 12 | 14 | 16 | 18 | 17 | 19 | 17 | 18 | 14 | 16 |
| Total Dissolved Solids | 10 | 11 | 12 | 14 | 11 | 17 | 12 | 15 | 12 | 11 |
| Total Suspended solids | 2 | 3 | 4 | 4 | 6 | 2 | 5 | 3 | 2 | 5 |
| Hardness | 6 | 8 | 11 | 13 | 15 | 17 | 19 | 22 | 23 | 25 |
| Alkalinity | 10 | 13 | 15 | 17 | 18 | 18 | 22 | 22 | 29 | 27 |
| Chloride | 3.2 | 3.7 | 4.1 | 4.5 | 4.7 | 5 | 5.3 | 5.7 | 6.4 | 6.9 |
| Sulphide | 0.4 | 0.7 | 0.6 | 0.3 | 0.7 | 0.8 | 1.2 | 0.4 | 1.1 | 0.6 |
| Flouride | 0.17 | 0.08 | 0.14 | 0.31 | 0.09 | 0.06 | 0.22 | 0.18 | 0.06 | 0.38 |
| Sodium | 0.01 | 0.01 | 0.03 | 0.11 | 0.01 | 0.01 | 0.01 | 0.34 | 0.37 | 0.02 |
| Nitrate | 0.02 | 0.04 | 0.03 | 0.12 | 0.04 | 0.05 | 0.03 | 0.35 | 0.41 | 0.06 |
| Phosphate | 0.01 | 0.01 | 0.03 | 0.05 | 0.07 | 0.08 | 0.1 | 0.12 | 0.14 | 0.17 |
| Silica | 0.43 | 0.37 | 0.41 | 0.53 | 0.35 | 0.28 | 0.25 | 3.23 | 3.28 | 0.48 |
| Sulphate | 1.2 | 1.5 | 1.7 | 1.7 | 1.82 | 1.89 | 1.94 | 2.1 | 2.3 | 2.5 |
| Pottasium | 0.05 | 0.05 | 0.08 | 0.14 | 0.09 | 0.11 | 0.12 | 0.16 | 0.06 | 0.15 |
| Magnesium | 0.6 | 0.8 | 0.5 | 1.5 | 0.7 | 0.4 | 0.5 | 2.4 | 3.8 | 1.5 |
| Iron | 0.1 | 0.17 | 0.21 | 0.27 | 0.31 | 0.33 | 0.37 | 0.4 | 0.42 | 0.45 |
| Zinc | 0.02 | 0.03 | 0.03 | 0.05 | 0.05 | 0.06 | 0.08 | 0.08 | 0.1 | 0.12 |
| Dissolved Oxygen | 8.3 | 8.1 | 7.7 | 7.5 | 7.4 | 7.2 | 7 | 6.8 | 6.8 | 6.5 |
| Chemical Oxygen Demand | 3.5 | 3.7 | 3.9 | 4 | 4.1 | 4.2 | 4.2 | 4.4 | 4.4 | 4.6 |
| Biological Oxygen Demand | 3.3 | 3.5 | 3.7 | 3.9 | 4.3 | 4.4 | 4.6 | 4.7 | 4.9 | 4.7 |
| Total Coliform(CFU/100Ml) | 1400 | 1300 | 1400 | 1000 | 1100 | 1200 | 1700 | 1500 | 1100 | 1300 |
| Fecal Coliform(CFU/100Ml) | 800 | 900 | 700 | 600 | 900 | 800 | 1300 | 1100 | 800 | 900 |
| E-coli(CFU/100Ml) | 1100 | 1200 | 1100 | 800 | 700 | 700 | 1200 | 1000 | 700 | 1100 |

Distribution of Diatoms

In this study gathered 87 species of epiphytic diatoms from 20 river sections, encompassing the main river of Karnataka and its tributaries. The sample collections comprised various species, predominantly including between 12 and 22 distinct species. Kuluru (S5) had the highest species richness with 219 species, while Huthur (S20) recorded the lowest with 123 species. The genera with the highest species richness were Eunotia and Gomphonema, each comprising 19 species, followed by Pinnularia, Surirella, and Cymbella, each containing 21 species, respectively. Irrespective of stream habitat conditions, certain taxa were predominant, including Achnanthes biasolettiana, Achnanthidium exigum, Achnanthidium minutissimum, Cocconeis placentula var. euglypta, Cocconeis placentula var. lineata, Cymbella turgidula, Gomphonema angustatum, Gomphonema diminutum, Navicula heimansioides, Oricymba japonica, Planothidium rostratum, Brachysira wyga schii, Gomphonema exilissimum, and Gomphonema lagenula. These species were observed throughout locations, including those impacted by diverse activities. Diatom diversity remained generally high, except in a few places, due to the heterogeneity of microhabitats (Table 2).

Table 2. The Dominant Diatom species present in Karnataka streams (* 1-5%, ** 5-10%, *** 10-20%)

| **Species/Acronyum sites** | **S1** | **S2** | **S3** | **S4** | **S5** | **S6** | **S7** | **S8** | **S9** | **S10** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Achnanthes Biasolettiana* | *** | ** | *** | - | - | - | - | - | *** | ** |
| *Achnanthes Microcephala* | - | - | - | - | - | - | ** | - | - | - |
| *Achnanthidium Exigum* | - | - | - | - | - | - | - | - | - | ** |
| *Achnanthidium Minutissimum* | - | ** | - | ** | - | *** | - | - | - | - |
| *Brachysira Wygaschii* | - | - | - | ** | - | ** | * | * | - | - |
| *Cocconeis placentula v. euglypta* | - | ** | - | - | ** | - | - | - | ** | *** |
| *Cocconeis placentula v. lineata* | - | 15 | 0 | 0 | 10 | - | - | - | - | - |
| *Cymbella Turgidula* | - | - | * | - | * | - | - | *** | - | ** |
| *Gomphonema Angustatum* | - | * | * | - | - | * | - | - | * | - |
| *Gomphonema Diminutum* | - | - | - | - | *** | * | - | - | - | ** |
| *Gomphonema Exilissimum* | - | - | * | - | - | - | * | - | - | - |
| *Gomphonema Lagenula* | ** | * | ** | ** | ** | ** | - | - | - | - |
| *Navicula Heimansioides* | - | - | - | - | - | - | ** | * | * | - |
| *Navicula Subrhynchocephala* | - | - | - | - | - | - | - | - | - | - |
| *Oricymba Japonica* | - | - | *** | * | - | * | - | - | - | * |
| *Planothidium Biporomum* | - | ** | - | - | ** | * | - | * | - | - |
| *planothidium Frequentissimum* | - | - | ** | - | ** | - | - | ** | * | * |
| *Planothidium Rostratum* | - | - | * | - | ** | - | - | * | ** | ** |

Canonical Correspondence Analysis (CCA) was performed to discern patterns among species and places affected by environmental factors. The primary axis, representing 18.2%, and the secondary axis, elucidating 16.0% of the species-environment variation, possessed eigenvalues of 0.79 and 0.69, respectively. The initial axis indicated a gradient in water characteristics that distinguished places according to silica concentrations and dissolved oxygen levels. Furthermore, the extent of habitat characterized by macrophytes rose in conjunction with diatom prevalence. The location of each species on the CCA ordination plane indicated its environmental preference.

Dissolved oxygen content (loading factor: 0.69, p-value: 0.70), water temperature (loading factor: 0.79, p-value: 0.97), sulfate, and chloride (loading factor: 0.60) were significant influences in the initial two components. Other variables exerted minimal influence. The second CCA axis delineated the gradient of water quality, positioning locations and species within the ordination plane. Sites S7, S8, and S15 demonstrated elevated levels of dissolved oxygen, total solids, and pH. These streams predominantly hosted Navicula heimansioides, Cymbella turgidula, and Achnanthidium minutissimum. The locations experienced anthropogenic disruptions, including stream diversion for agricultural and recreational activities. The site placement and species clustering on the right side of the CCA plot were influenced by temperature, turbidity, phosphate, and sulfate concentrations; thus, S1, S4, S6, S14, and S18 are situated in proximity to one another. The species Achnanthidium minutissimum, Achnanthes inflata, Sellaphora bacillam, and Brachysira wygaschii were prevalent in regions with elevated chloride concentrations. Gomphonema angustatum, Achnanthes microcephala, Gomphonema exilissimum, Diploneis subsmithii, Cocconeis placentula var. lineata, and Oricymba japonica. These species are recognized for their preference for silica-rich water, which may explain the elevated amounts of silica S3, S9, S12, and S16 in the designated locations (Figure 2). Figure 3 illustrates the identification of diatom species using a 100X magnification microscope.

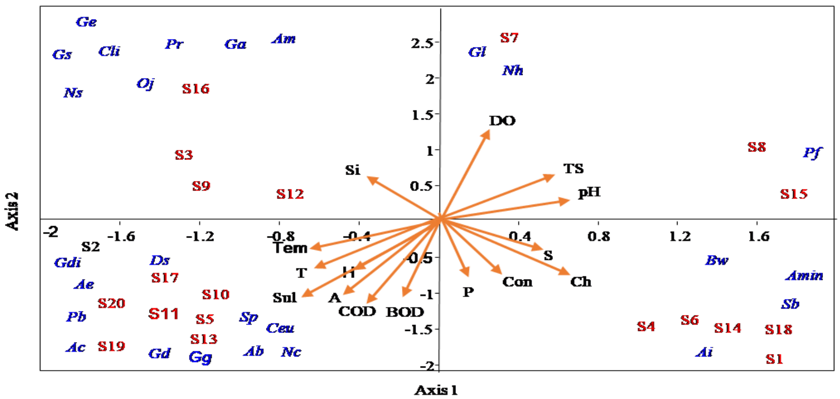


Figure 2: Canonical correspondence analysis (CCA) biplot illustrating the influence of the environmental variables on the diatom community of Karnataka streams.

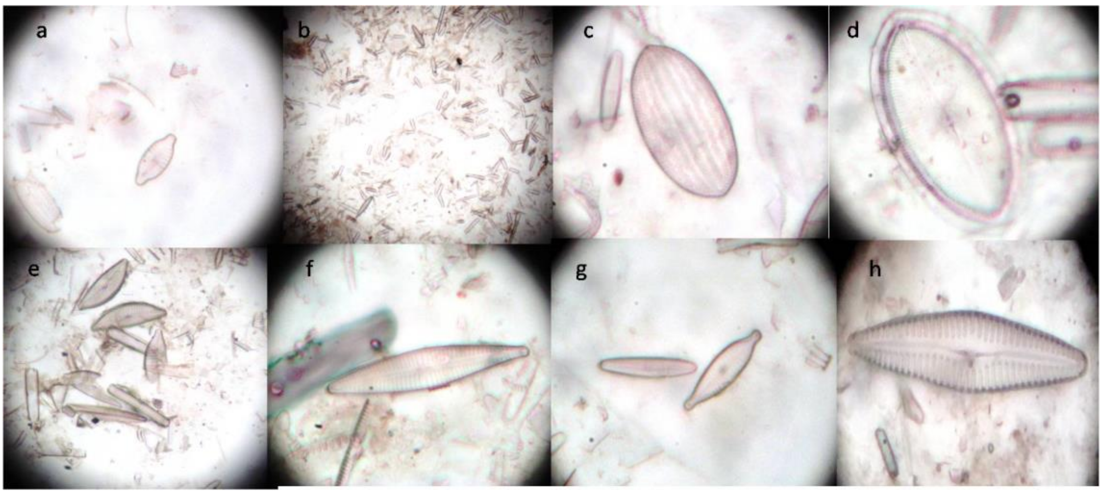


Figure 3: a. Achnanthidiumexigum (Grunow) Czarnecki; b. Achnanthidiumminutissimum (Kutzing) Czarneck; c. Cocconeisplacentula vs euglypta; d. Cocconeisplacentula vs lineate; e. Cymbellaturgidulagrun; f. GomphonemaangustatumKutzingRabenhorst; g. GomphonemalagenulaKutzin; h. Oricymba japonica (Reichelt) Juttner, cox, Krammer and Tuji.

## 4. Discussion

The evaluation of aquatic ecosystem quality depends on monitoring the concentration of water quality indicators in the environment. Nutrients are essential in aquatic environments, serving as the basis for plant growth, as recognized by DWAF 1996, Dallas and Day (2004), Clark and Tilman (2017), and Tromboni and Dodds (2017). Wetland ecosystems, due to their function as nitrogen sinks, are especially vulnerable to nutrient enrichment, as observed by Humphries and Benitez-Nelson (2013). The proliferation of aquatic macrophytes can affect nutrient levels within the environment. Thus, even with seemingly low nutrient concentrations, an aquatic environment may display eutrophic traits, as noted by Kock (2019).

Changes in interisland flow patterns significantly influence diatom distribution in flowing water ecosystems. The quality of river systems and their supporting biota is influenced by streams and minor river networks, as well as the terrain they navigate, as explained by Brown (2000). This study connected the presence and distribution of diatom taxa with in-stream habitat characteristics, revealing a significant prevalence of epiphyton in locations with submerged vegetation. The prevalence of fine and coarse sand affected species distribution, resulting in variations in species composition according to sandy substrate availability. Achnanthidium minutissimum was more abundant in locations intermittently affected by stream water flow, including S4, S6, S14, S15, and S18, which display differing degrees of sandy substrate effect, a trend similarly noted in unstable sandy substrates (Passy and Bode, 2004). In contrast, Oricymba japonica was solely located in areas with reduced sand concentration, such as S16, due to its sensitivity to silt.

Diatoms display distinct distribution choices influenced by water quality; tolerant species endure in disturbed environments, whilst sensitive species are restricted to pristine, undisturbed places (Potapova and Charles, 2005). Particularly, species such as Cocconeis placentula var. euglypta, Planothidium rostratum, and Brachysira wygaschii flourished in regions with elevated nutrient concentrations, including Honnali (S3), Jannapura (S7), and Harihalli (S16), while Navicula heimansioides, Oricymba japonica, and Gomphonema angustatum were also prevalent in these areas. The composition of temperature was correlated with the richness of diatom communities (Leland et al., 2001).

In locations with elevated total solids and pH, such as Jannapura (S7) and Kirugunda (S15), Planothidium frequentissimum, Navicula heimansioides, and Gomphonema lagenula demonstrated significant abundances. The richness of diatom communities was associated with ionic composition (Leland et al., 2001), exhibiting distribution patterns that varied along specific gradients of total dissolved solids (TDS) (Tudor et al., 1991; Stevenson and Pan, 1999). Human disturbances can significantly alter water quality and diatom habitats. Oligotrophic species such as Cocconeis placentula var. lineata, Achnanthidium minutissimum, Gomphonema diminutum, and Navicula heimansioides were observed in both disturbed and minimally damaged locations. Nevertheless, fluctuations in their population show that ostensibly pristine streams may have undergone recent human-induced effects, as noted by Fore and Grafe (2002) and Bellinger et al. (2006). However, N. Palea, a species flourishing in deforested streams and biologically contaminated waters, was discovered in these locations. Alterations in land use and land cover substantially influence algal diversity, detrimentally altering the quality and quantity of freshwater resources (Li et al., 2008; Walsh and Wepener, 2009). Diatom assemblages in streams are generally affected by physical habitat conditions, such as riparian conditions, in stream habitat, and channel morphology (Pan et al., 2006; Veselá and Johansen, 2009), although nutrients and salinity may exert a more significant influence than physical factors (Leland et al., 2001).

Temperature, pH, total solids, dissolved oxygen, and other physicochemical parameters exhibited variability among locations, affected by flow dynamics and the presence of organic matter. This was especially apparent in the sampled sites, with variations in parameters ascribed to in-stream features. Rapids, prevalent in upland rivers, transport organic materials as drift and dissolved particles, which stir throughout their flow, enhancing the water's dissolved oxygen content. Bathra (S6) and Basaravalli (S12) demonstrated elevated concentrations of dissolved oxygen and dissolved solids, indicating comparable circumstances. We examined whether diatom community makeup at each location might explain habitat alterations, aiming to establish the connection between environmental variables and diatom diversity. Dynamic streams with minimum human interference may more effectively maintain the complexity and integrity of lotic systems (Palmer et al., 2005). Moreover, disturbed areas frequently display higher diatom diversity than less damaged sites due to the presence and prevalence of both moderately sensitive and tolerant species (Yu & Lin, 2009). The diversity of macrophytes significantly influences epiphyton diversity, which, while beyond the purview of this study, is affected by environmental conditions and alterations.

## 5. Conclusion

In the present study was identifying the critical elements associated with community variability is a primary objective of stream diatom research; nevertheless, achieving this objective is tough. Our findings illustrated the behavior of stream diatom populations across different scales in response to environmental gradients. Water temperature, pH, turbidity, dissolved oxygen, alkalinity, conductivity, silica, and other essential streamside variables exerted a substantial influence. The study's demonstrated the correlation between diatom biodiversity and environmental parameters in stream conditions. Total Coliform,Fecal Coliform & E.Coli are Important Indicators of water quality streams. The interplay between diatoms and bacterial indicators in Karnataka's water streams can serve as a valuable tool for assessing and managing aquatic health.

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