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Periphytic Algae of Achankovil River in Pandalam Municipality, Kerala

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***Abstract*:** The present investigation focuses on the periphytic algae in the riparian microhabitats of the Achankovil River in Pandalam, Kerala, India. The study was conducted from December 2021 to December 2022 across six fixed sampling locations (PN1, PN2, PN3, PN4, PN5, and PN6). Monthly samples were collected from periphyton-colonized plants at each station, preserved, and identified according to standard procedures. The study identified 61 algal genera across five classes: Cyanophyceae, Euglenophyceae, Chlorophyceae, Charophyceae, and Bacillariophyceae. The number of taxa in each class was Cyanophyceae (5), Euglenophyceae (4), Chlorophyceae (11), Charophyceae (16), and Bacillariophyceae (25). The genus *Cosmarium* was the most frequently occurring with 7 species, followed by *Nitzschia* (6 species), *Pinnularia* (5 species), and *Navicula* (4 species). The highest number of algal genera was observed at PN2 (17), while the lowest was at PN5 (8).

***Keywords*:** Achankovil river, Anthropogenic pollution, Phytoplankton diversity, Western Ghats forest

The world is experiencing drastic environmental effects from climate change, prompting researchers worldwide to investigate the consequences. Natural disasters not only endanger human lives but also cause irreversible changes and biodiversity loss, negatively affecting the quality of ecosystem services. Rich biodiversity indicates the safety and pristine nature of the Earth, but climate change, ecosystem degradation due to overuse and pollution, and the emergence of invasive species threaten biodiversity (Hannah and Lovejoy 2019). In August 2018, Kerala faced a major flood, resulting in significant loss of life and irreparable biodiversity loss, as well as the mixing of different water ecosystems (Pramanick et al 2021). The excess flow from three major rivers-the Pampa, Manimala, and Achankovil-severely affected the Pathanamthitta and Alappuzha districts. Enormous amounts of particulate matter and dissolved and undissolved solvents flowed through the rivers and adjacent streams, devastating micro- and macrohabitats. Riparian microhabitats along the rivers, including small streams, ponds, oxbow lakes, marshes, and wetlands, are crucial transitional regions between land and water (Rajbongshi and Das 2016). These areas are known for their rich algal biodiversity (Ramey and Richardson 2017). Aquatic macrophytes in such habitats can help improve water quality by removing excess nutrients and as substratum for the attachment of phytoplankton (Ngente and Mishra 2024). Micro-algae have the potential to effectively remove organic loadings from wastewater (Rasheed et al 2022).

The Achankovil River, one of the major west-flowing rivers in peninsular India, flows through the Kerala districts of Kollam, Pathanamthitta, and Alappuzha. This 128-kilometer river originates from the streams of Pasukidamedu in the southwestern ghats and flows through several important towns in the Pathanamthitta district, including Pandalam, and joins the Pampa River at Veeyapuram in the Alappuzha district. The Pandalam area is enriched with unique micro and macroflora, and many endemic plants of Kerala exist there (Krishnan and Harikrishnan 2017). Throughout its course, the river has developed numerous small and large water microhabitats, some of which are seasonal flood plains while others are ephemeral areas. The river and surrounding areas were severely affected by ecosystem changes, habitat loss, and species loss during the flood. The riverine bodies in the district are rich in fish and other biological species. Swapna (2009) recorded 52 fish species in the river. A new checklist with a record of 35 species of ichthyofauna in the Achankovil basin was prepared by Vishnu et al (2023). Phytoplankton in the water bodies are significant contributors of oxygen and play an essential role in maintaining the balance between living species. Previous algal enumerations in the river have focused only on its lotic systems with little attention given to the riparian phytoplankton and periphytic flora (Krishnan et al 2020, Krishnan and Dhar 2021). Therefore, present study was conducted on epiphytic in the flood-affected Achankovil River in Pandalam Municipality.

Table 1. Identified Periphyton of Achankovil River at Pandalam, Kerala

Name of class	Scientific name
Cyanophyceae	
	Anabaena cylindrica Lemmermann
	Arthrospira platensis (C.B.Rao) Desikachary
	Lyngbya sp.1
	Oscillatoria formosa Bory ex Gomont
	Rivularia sp.1
Euglenophyceae	
	Euglena caudata E. Hubner
	Euglena acus
	Phacus sp.1
	Phacus acuminatus
Chlorophyceae	
	Chlorococcum humicola (Nageli) Rabenhorst
	Coelastrum microporum Nageli
	Crucigeniella crucifera (Wolle) Komárek
	Dictyochloropsis sp.1
	Oedogonium sp.1
	Oocystis lacustris Chodat
	Radiococcus nimbatus (De Wildeman) Schmidle
	Scenedesmus denticulatus Lagerheim
	Scenedesmus ellipticus Corda
	Scenedesmus quadricauda (Turpin) Brébisson
	Spirogyra sp. 1
Charophyceae	
	Closterium navicula (Brebisson) Lütkemüller
	Closterium parvulum Nageli
	Cosmarium didymoprotupsum West & G.S.West
	Cosmarium hammeri Reinsch
	Cosmarium impressulum Elfving
	Cosmarium obsoletum (Hantzsch) Reinsch
	Cosmarium quadrum P.Lundell
	Cosmarium subprotumidum Nordstedt
	Cosmarium subtumidum Nordstedt
	Euastrum binale F. *C*rassum Joshua
	Euastrum denticulatum F.Gay
	Euastrum pulchellum Brébisson
	Micrasterias laticeps Nordstedt
	Pleurotaenium archeri Delponte
	Pleurotaenium ehrenbergii (Ralfs) De Bary
	Pleurotaenium trabecula Nageli
Bacillariophyceae	
	Achnanthidium minutissimum (Kutzing) Czarnecki
	Amphora inariensis Krammer
	Amphora sp.1
	Aulacoseira granulata (Ehrenberg) Simonsen
	Cyclotella meneghiniana Kutzing
	Cymbella sp.1
	Diadesmis confervacea Kutzing
	Frustulia rhomboides (Ehrenberg) De Toni
	Gomphonema affine Kutzing
	Gomphonema lagenula Kutzing
	Gomphonema olivaceum (Hornemann) Ehrenberg
	Gomphonema venusta Passy, Kociolek & Lowe
	Navicula lanceolata (C.Agardh) Kutzing, nom. illeg.
	Navicula sp.1
	Nitzschia agnita Hustedt
	Nitzschia clausii Hantzsch
	Nitzschia desertorum Hustedt
	Pinnularia divergens W.Smith
	Pinnularia gibba (Ehrenberg) Ehrenberg
	Pinnularia rectangularis Y.Liu, Kociolek & Q.-X.Wang
	Pinnularia sp.1
	Pinnularia viridis (Nitzsch) Ehrenberg
	Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot
	Sellaphora pupula (Kutzing) Mereschkovsky
	Synedra sp.1

Cont....

*sp.-species

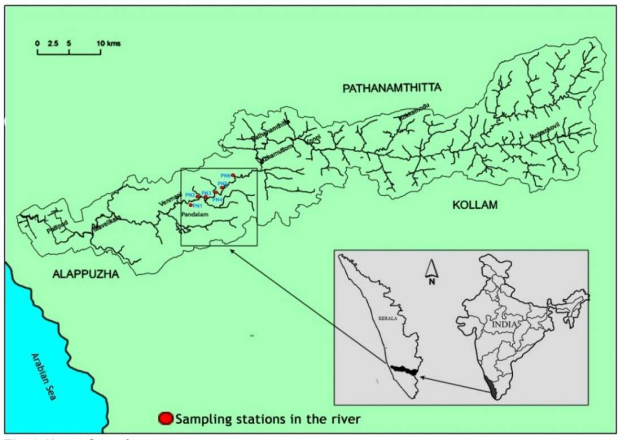

Fig. 1. Map of study area

MATERIAL AND METHODS

Pandalam Municipality covers a total area of 28.72 km² and, situated between 9.2250° N latitude and 76.670° E

longitude. Selected six vulnerable wards for sampling, establishing a total of six sampling stations (one in each ward). The stations were designated as PN (Pandalam Station Number), specifically PN1 (9 ^{0} 15'73"N and 76 ^{0}73'23"E), PN2 (9°13'28"N and 76°40'15"E), PN3 (9^{0} 22'95"N and 76^{0} 66'81"E), PN4 (9 ^{0}23'68"N and 76 ^{0}66'23"E), PN5 (9 ^{0} 23'55"N and 76 ^{0}67'48"E), and PN6 (9 ^{0}22'44"N and 76^{0} 69'09"E) (Figure 1). This study primarily aims to conduct a taxonomic analysis of different classes of periphytic microalgae in the river.

Sampling in the riverine lentic water bodies: Between December 2021 and December 2022, sample collections were conducted between 9 a.m. and 10 a.m. from the riverine water bodies of the Achankovil River at each of the fixed stations. Periphytons were collected from the leaves of colonization-supporting submerged plants such as *Hydrilla, Nymphaea*, and various grasses. The thin film of algae that developed on the surface of these plants was stripped and preserved in 100 ml of double-distilled water in pre-sterilized plastic bottles. All collected water samples were preserved in Lugol's iodine following standard procedures (Alan et al 2021). Periphytons were identified using a compound microscope (MX21i Clinical) at 100X magnification. Photographs were taken with an Olympus BX 40 camera attached to a stereomicroscope, obtained on a payment basis outside the institution. Identification was done using

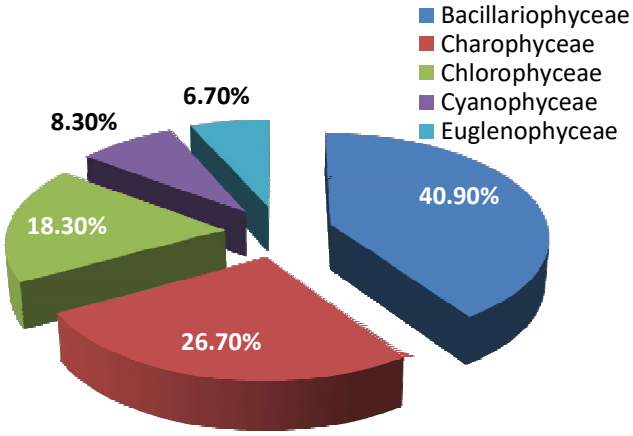

Fig. 2. Percentage wise distribution of different classes of Epiphytic algae

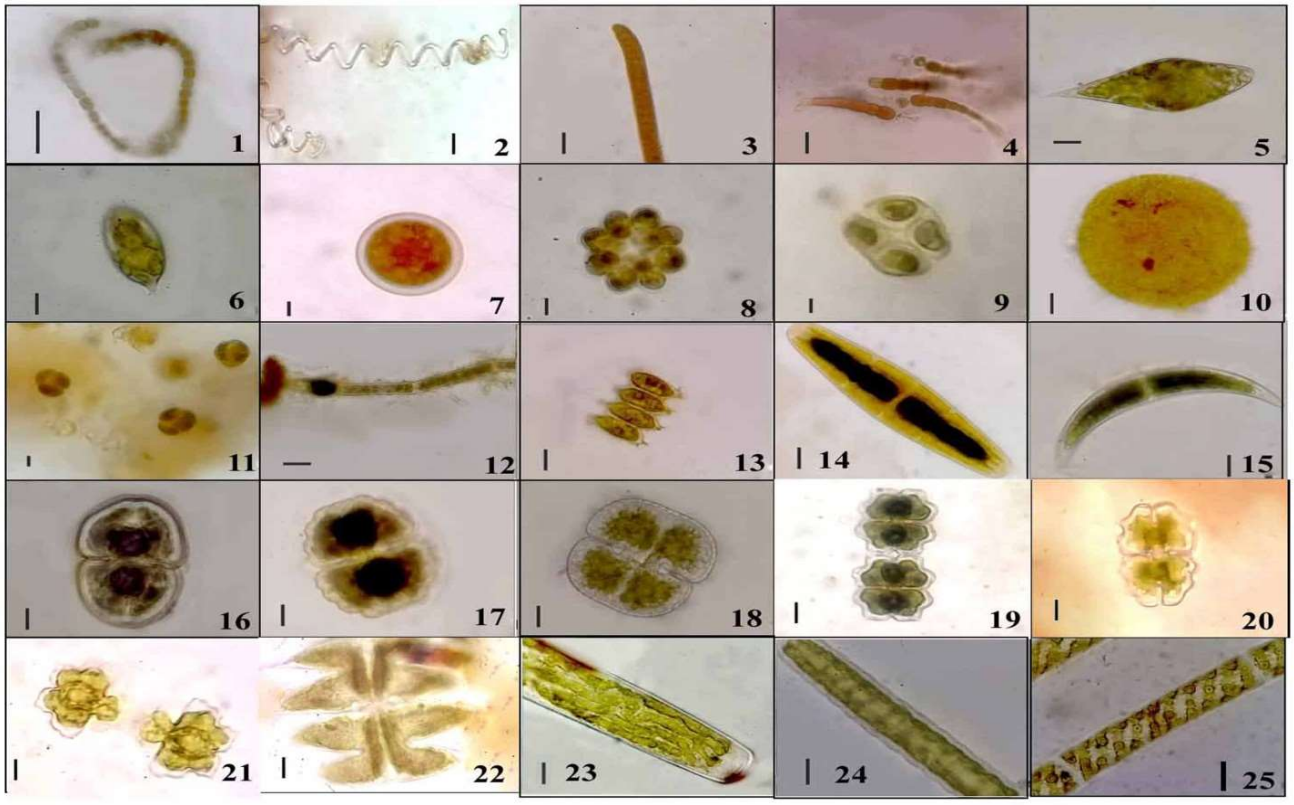

Plate 1. (1) *Anabaena cylindrica,* (2) *Arthrospira platensis,* (3) *Oscillatoria formosa,* (4) *Rivularia* sp., (5) *Euglena caudata,* (6) *Phacus sp,* (7) *Chlorococcum humicola,* (8) *Coelastrum microporum,* (9) *Crucigenia crucifera,* (10) *Dictyochloropsis* sp., (11) *Radiococcus nimbatus,* (12) *Oedogonium* sp., (13) *Scenedesmus denticulatus,* (14) *Closterium navicula* (15), *Closterium parvulum,* (16) *Cosmarium hammeri,* (17) *Cosmarium subprotumidum,* (18) *Cosmarium quadrum,* (19) *Euastrum binale,* (20) *Euastrum denticulatum,* (21) *Euastrum pulchellum,* (22) *Micrasterias laticeps,* (23) *Pleurotaenium archeri,* (24) *Pleurotaenium trabecula,* (25) *Spirogyra* sp. [Scale bars, Fig. 1-25: 10 µm]

standard keys for Cyanophyceae (Komarek and Anagnostidis 2014), Green algae (Karlson et al 2020, Guiry and Guiry 2023), and Diatoms (Bellinger and Sigee 2015, Spaulding et al 2021). The phytoplankton were separated into classes. They were classified according to the Round (1973) system. The samples were deposited in the Botany Laboratory at NSS College, Pandalam, Kerala.

RESULTS AND DISCUSSION

The flood-affected riverine areas of Pandalam exhibited rich algal diversity. This study documented 61 algal taxa from ephemeral to perennial lentic water habitats of the river, with 50 identified to the species level. The identified taxa belong to 61 genera under five classes: Cyanophyceae (5), Euglenophyceae (4), Chlorophyceae (11), Charophyceae (16), and Bacillariophyceae (25). Krishnan et al (2020) indicated the dominance of Chlorophyceae, while Charophyta and Bacillariophyta were dominant in the microalgae of rivers in Pathanamthitta (Harikrishnan 2010). The results corroborated these findings, with Bacillariophyceae being the dominant class (25 genera). The genus *Cosmarium* (Desmidaceae) was the most dominant, with seven species, followed by the diatoms *Pinnularia* and *Gomphonema*, each with four species. *Scenedesmus quadricauda* was present at all stations. The percentage distribution of different classes was 40.9% Bacillariophyceae followed by Chlorophyceae (26.7%) and Charophyceae (18.3%) (Figure 2). The highest number of algal genera was

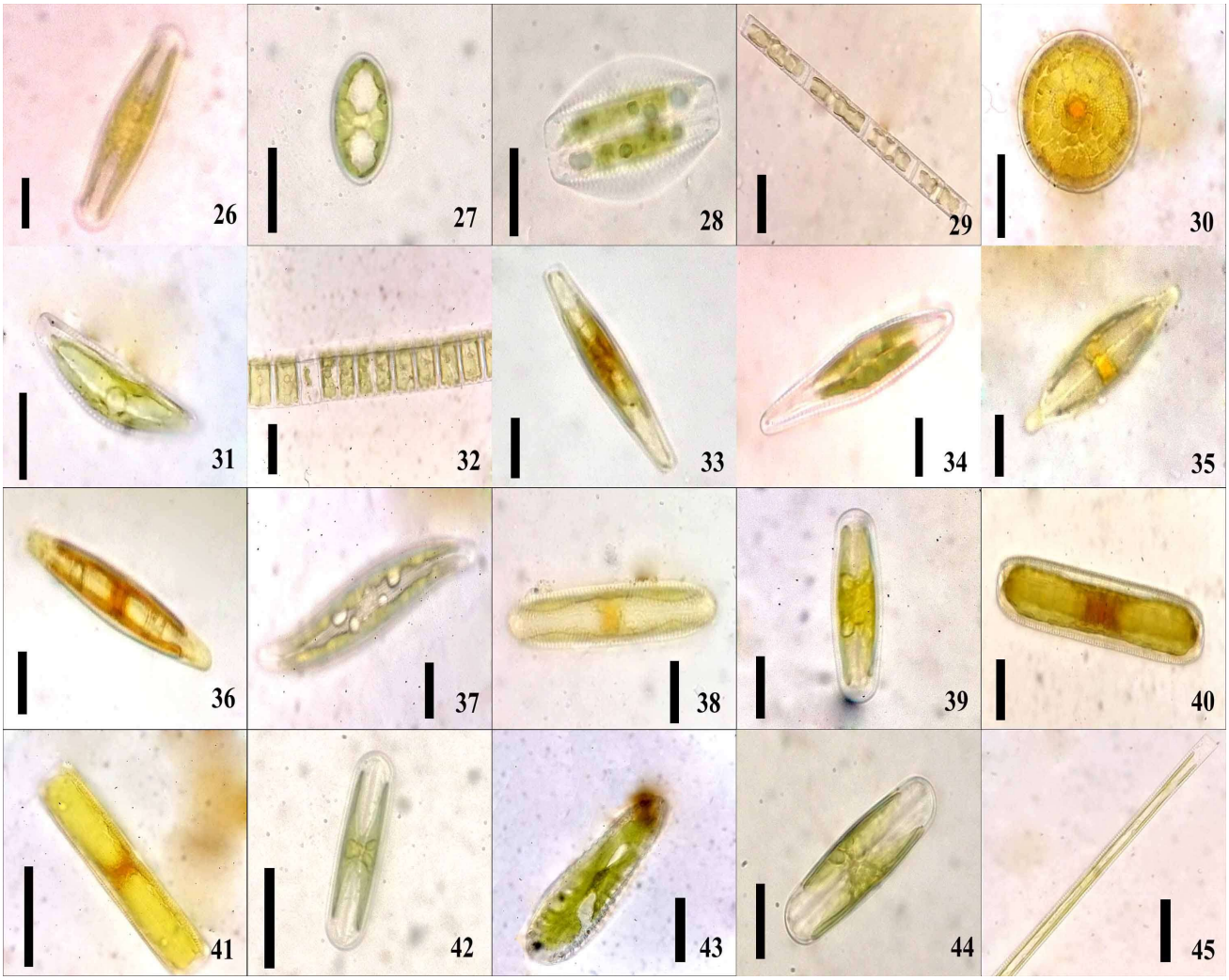

Plate 2. (26) *Achnanthidium minutissimum,* (27) *Amphora inariensis,* (28*) Amphora* sp.*,* (29) *Aulacoseira granulata,* (30) *Cyclotella meneghiniana,* (31) *Cymbella* sp., (32) *Diadesmis confervacea,* (33) *Frustulia rhomboides,* (34) *Gomphonema affine,* (35) *Gomphonema lagenula,* (36) *Navicula lanceolata,* (37) *Nitzschia clausii,* (38) *Pinnularia divergens,* (39) *Pinnularia gibba,* (40) *Pinnularia rectangularis,* (41) *Pinnularia* sp., (42) *Pinnularia viridis,* (43) *Rhoicosphenia abbreviata,* (44) *Sellaphora pupula,* (45) *Synedra* sp. [Scale bars, Fig. 25-45: 10 µm]

at PN2 (17), and the lowest at PN5 (8 taxa). The high density of taxa at PN2 could be due to the presence of large riparian lentic water habitats, which allowed for multiple representative samples. In contrast, PN5 had fewer colonization-supporting submerged plants due to the presence of small rocks and mud-filled shores and was severely affected by landslides, leading to fewer periphytic algae samples.

In two pre-monsoon studies at Achankovil Pandalam, Chlorophyceae and Bacillariophyceae were dominant (Harikrishnan 2010, Krishnan et al 2020). The increased number of Euglenophytes at PN6 could be attributed to human contaminants increasing nitrate availability. This station is near the pilgrimage area of Pandalam Valiyakoikal Palace, heavily used by Sabarimala pilgrims for sanitary purposes. Kumar et al (2018) concluded that, higher number of Euglenophytes indicates decaying organic contaminants. Presence of pollution-tolerant *Scenedesmus* at this station indicates water degradation due to pollution (Paul and Sreekumar 2008).

Among the five classes of algae identified, most were dwellers in oligotrophic habitats, with desmids and diatoms being more numerous. Their predominance indicates good water quality (Thomas and Paul 2015). The dominance of diatoms and desmids in high-altitude oligotrophic lakes in Kerala has been documented by Krishnan (2012). Bacillariophyceae and Chlorophyceae were dominant in many rivers (Tas and Gonulol 2007).

CONCLUSION

This investigation reveals that the riparian lentic microhabitats of the Achankovil River in Pandalam Municipality are rich in periphyton biodiversity. Flood events have disturbed the community structure, leading to the mixing of waters and the presence of pollution indicators and flagellated forms at some stations. Additionally, anthropogenic influences at certain locations show a slight trend towards eutrophication, although the water is not highly contaminated. Strict measures should be implemented to protect the biodiversity-rich water bodies of Pandalam Municipality, especially the Achankovil River. The river is heavily used during the pilgrimage season, and care should be taken to prevent habitat and species loss during flood events, as Pandalam is flood-prone.

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