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Ecological structure and productivity patterns of Plankton Communities in the Kadalundi Estuary, Southwest coast of India

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Abstract
Phytoplankton is not only an important primary producer in aquatic ecosystems and the base of the food chain, but it also plays a big part in the material cycle and energy conversion. Phytoplankton only make up 0.2% of the biomass of primary producers, but they are responsible for 50% of the world's net primary production. We have taken measurements of the phytoplankton's abundance, biomass, and primary production at 10 different locations along India's southwest coast. We assessed the number of phytoplankton, its biomass, and its primary production at 10 sites along the southwest coast of India during the research period. We also looked at the nutritional elements such as calcium, magnesium, salt, and carbonate. A unique representation of an environmental gradient with a fascinating connection to variety and variation is ecosystem production. Primary output may be impacted both directly and indirectly by an ecosystem's species diversity. Little is known about the precise mechanisms underlying the disparate productivity-diversity relationships (PDR). This study sought to understand the effects of various environmental conditions on the C-fixing capacity and phytoplankton community composition in the Kadalundi Estuary.

Keywords: Phytoplankton, species distribution, abundance, Kadalundi, diversity

Introduction

Salinity and pH are two potential significant variables that may control the biomass and community of estuarine phytoplankton. An estuary's salinity is a dynamic phenomenon that is primarily impacted by local rainfall, river discharge, and tidal amplitude. The phytoplankton communities in an undisturbed estuary are very diverse and show a complicated distribution pattern along the salinity gradient. The reason for this is that they have adapted to survive in a variety of salinities. The long-term structure and behaviour of phytoplankton groups are crucial to the metabolism of aquatic systems. Because of interactions between physical, chemical, and biological processes, temporal fluctuation and the species composition of phytoplankton have a significant impact on aquatic ecosystems. Because the majority of pelagic systems are so vulnerable to environmental changes, favourable subaquatic conditions and habitat features for various species are discontinuous. This is another way of saying that because the system is usually chaotic, the community structure is frequently unstable and basic [1]. The abiotic resources of aquatic environments, such as biogenic structure, pH, sunlight, etc., frequently affect the species composition, abundance, biomass, and diversity of phytoplankton communities [2]. Salinity is one such well-known factor that controls primary producer communities [1]. Studies have demonstrated that salinity may change the phytoplankton community's composition in extremely salinized lake systems. Because it alters the habitats of phytoplankton populations, salinity plays a significant role in lake systems [2]. Numerous types of phytoplankton in lakes favour water that is slightly salinized differently than the rest of the lake. According to earlier research, lakes with salinities below 50 have a disproportionately high biomass of cyanophytes, while lakes with salinities above 50 have a higher biomass of eukaryotic algae, including Dinophyceae, Bacillariophyta, and Chlorophyta. Salinity is frequently assumed to be a limiting factor in phytoplankton diversity, biomass, and primary production [3]. An increase in salinity gradients in lake systems may have an impact on phytoplankton and the zooplankton that depend on it due to the possibility of broad shifts in the functional categories of microbial communities. Changes in functional groups, according to Bruce, will lower the quality of the water by making it more difficult for zooplankton to exert top-down control over phytoplankton [4]. Even though high salinity levels decrease phytoplankton population and activity, they also produce high nutrient levels, which may promote phytoplankton development. Yue found that freshwater lakes with the same salinity had a greater impact on phytoplankton abundance than saltwater lakes with salinities between 1 and 35 [5]. Saltwater lakes with salinities ranging from 1 to 35 exhibited a more significant moderate effect of fertilizers. The results are the same as those from other lake systems, which show that there are more types of phytoplankton in saltier water [6]. People usually think that Plateau Lake systems are not very polluted because they are far away and have not been disturbed by people as much as other lake systems. Researchers have thus devoted minimal attention to them. In fact, acid rain and nitrogen deposition are two examples of air pollutants that have had more and more of an effect on remote high-altitude lake systems over the past few decades. Lake ecosystems are very sensitive to changes in the environment because of their simple food chain and harsh weather [7]. Small changes can have a big effect on ecological communities in plateau lake systems [8]. Despite the Qinghai-Tibet Plateau's high elevation—an average of 4,500 meters above sea level—many of its 1,055 lakes are salty. It is commonly known that the lakes on the Qinghai-Tibet Plateau are incredibly numerous, widely spaced, and climate-adaptable. Therefore, concentrating on these lake systems would be extremely beneficial for research on how lake ecosystems react to external disturbances across a range of environmental gradients.

The aquatic ecosystems of the lake systems on the Qinghai-Tibet Plateau have been under a lot of stress since the 1990s due to growing human activity. Because of this, the lakes on the plateau contain 53–346 times as many nutrients as lakes at sea level [9]. Compared to phytoplankton species found in lakes with less severe environmental stress, those found in lakes with significant environmental stress need more nutrients to support their diverse life activities. Over a broad spectrum of environmental gradients, phytoplankton react to increasing nutrient concentrations in diverse ways. We postulated that phytoplankton communities could utilize nutritional gradients and other environmental elements to adapt to harsh conditions. We concentrated on two primary areas to test our hypothesis: (i) determining the factors that lead to distinct phytoplankton communities in various locations, and (ii) observing the responses of various phytoplankton communities to nutritional changes along environmental gradients.

Materials and Methods

1. Study area

The Kadalundi River (Kadalundipuzha) is one of the four principal rivers that flow through the Malappuram district of the Indian state of Kerala. Ten locations from India's southwest coast were selected; Herose Nagar Road, Kottakadav Bridge, Thazhe thachira, Athanikkal, Olipuram Kadav, Kadalundi Bridge, Balathiruthi Road, Balathiruthi Kadav, Cheruthiruthy Bridge, and Olipuram Kadav Bridge. Samples of freshwater were taken at the location.

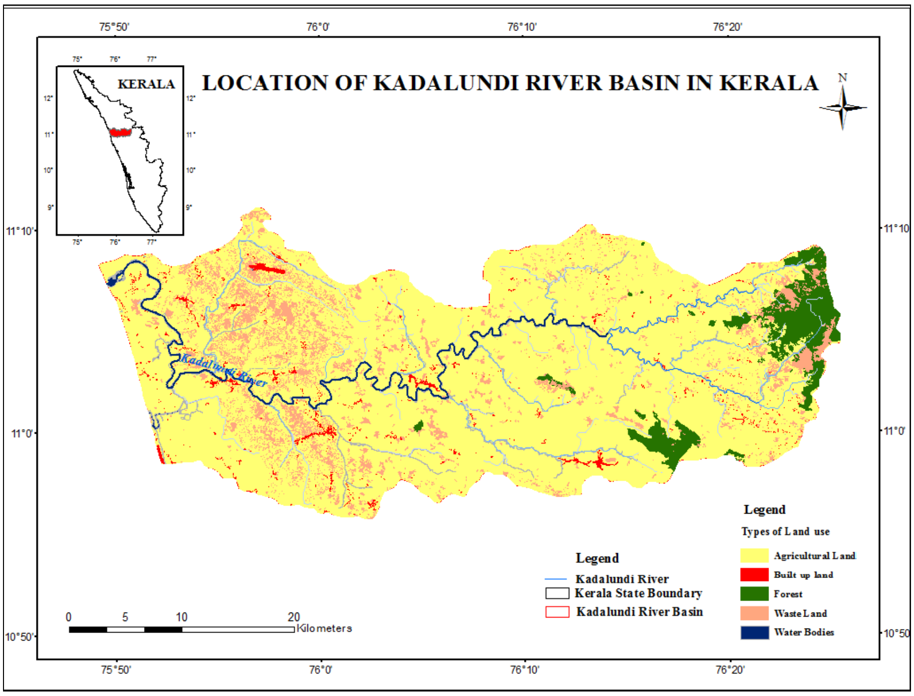

Fig 1: Study area

2. Sampling and analysis

The surface water sample was taken in a 20-liter Nalgene bottle, and separate water samples were then taken in a 5-liter Niskin container. The water's salinity was assessed using an autosal. The pH was measured using a Metrohm auto titration device. The salinity levels were adjusted using 99.5% pure sodium chloride from Merck India Ltd. This treatment was denoted by the chemical symbol NaCl, which stands for the primary ingredient in sea salt. A significant amount of NaCl that had been dissolved in the same water was added to the freshwater to alter its salinity. Since this is how salinity changes in natural systems (the arrival of a tidal front with a large salinity gradient), abrupt salinity changes were permitted in place of the gradual disintegration of NaCl crystals. Transparent vials were used for the incubation tests, which were conducted in daylight.

3. Filtration and extraction

500 mL of the sample was filtered out following five days of incubation. The filters were covered with tissue paper to absorb the moisture. Four millilitres of 90% acetone were poured into each tube. Materials can be ultrasonified to break up cells and make pigment removal easier. At last, the tubes were placed in the freezer for the night. A nylon HPLC syringe cartridge filter was used to filter the slurry after it had been thoroughly mixed by vortexing.

Results and Discussion

Throughout the study, there was no discernible change in pH. All of the physiologically significant metals were found to be within the range of nm values after the total trace metal concentrations in the freshwater sample were analysed. The presence of salt has an impact on both the communities of phytoplankton and the total biomass. As the salinity of the salt-manipulated waters increased from 12 to 16 percent NaCl, the overall biomass progressively decreased. None of the salt-treated samples had a lutein signal that could be identified by HPLC. Originally found in freshwater, green algae have been demonstrated to be extremely sensitive to even slight variations in salinity [10]. The phytoplankton population changed significantly as the freshwater's salinity increased. The green algal species were totally supplanted by salttolerant cyanobacteria. The relationship between pH and total biomass and phytoplankton community structure. The overall biomass and phytoplankton communities may be impacted by an environment's pH. In freshwater systems, the concentration of chlorophyll (total biomass) is correlated with pH. After gradually increasing from an acidic to a neutral pH range, the maximum concentration of Chl-a was discovered at a pH of 8.15. When salinity was changed, the cyanobacteria were found to have consistently dominated the colony, which is a significant departure from this conclusion. It appears that green algae in freshwater systems have evolved over time to be able to survive in a broad pH range. This is because there isn't much of a buffering effect from the water and riverbed mud. The green algae might be more resilient to anthropogenic or natural pH fluctuations because they seem to be reasonably tolerant of them. The effects of pH, salinity, and other biogeochemical variables on the development of the phytoplankton population are being investigated further [11-12]. Along the salinity gradients, the phytoplankton community exhibits distinctive changes [13]. The findings supported earlier studies that found a negative correlation between phytoplankton abundance and salinity.

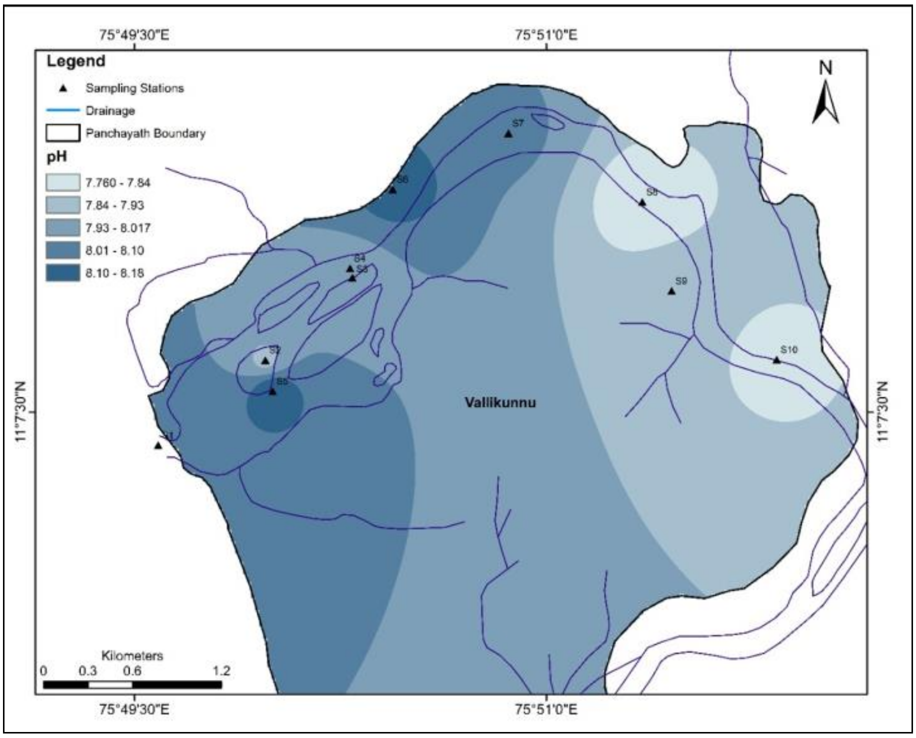

Fig 2: pH Gradient of the Study area

We looked into how the phytoplankton community changed across salinity gradients. The physiological activities of phytoplankton in plateau lake systems are significantly impacted by the water's salinity. An increase in salt in aquatic environments may change the osmotic pressure of phytoplanktonic cells, decreasing their ability to absorb ions. despite the fact that distinct phytoplankton species have varying capacities for osmotic adaptation to salinity variations. This explains the high biomass and low phytoplankton in salty lake environments. Because their cells are unable to tolerate the elevated osmotic pressure, the majority of phytoplankton species, in particular, die at high salinities. Even though these plateau lake systems contained a diverse range of phytoplankton communities, salinity did not act as a barrier.

It is crucial that these diatoms meet extra screening criteria because they are found in extremely saline environments regardless of environmental factors that encourage diversity in the phytoplankton community composition of plateau lake systems [14]. For instance, in both freshwater and saltwater lakes, fertilizers negatively affect phytoplankton populations. This demonstrates that saline lake phytoplankton are more sensitive to variations in nitrogen levels than their freshwater and saltwater counterparts. Nonetheless, because of the significant constraints that salinity has on phytoplankton abundance and biomass, nutrients may have a little impact and would not be able to change the spatial distribution patterns of phytoplankton in plateau lake systems. Phytoplankton species that have adapted to live at low trophic levels are often smaller, which might explain why they contribute to low BA ratios. The metabolic rate of phytoplankton and cell size are inversely correlated [15]. Phytoplankton populations progressively changed size as temperatures decreased along elevation gradients, with larger individuals becoming smaller to conserve energy.

Conclusion

This study found that salt was the primary factor influencing the biomass and abundance of phytoplankton communities. The dominant phytoplankton species hardly noticed the salinity, despite its existence. From the beginning, Bacillariophyta dominated the phytoplankton community. Because of differences in the nutritional quality, individual phytoplankton species in high-altitude lake systems were smaller than those in low-altitude lake systems. The phytoplankton community's response to nutrients varied across salinity gradients, according to the results. Generally speaking, high salt concentrations in lakes inhibit phytoplankton growth; however, nutrients, primarily TN, have the opposite effect. In salty lake systems, TN may promote the growth of sensitive algal species and reduce the distance between each species due to its inhibitory effect on the development of dominant algal species. In contrast, TN may favour dominant algae species in saline lake systems while hindering the growth of more delicate algal species. In light of increasing N imports, customized response planning strategies for different lake systems are required to take into consideration the varied phytoplankton reaction patterns along environmental gradients. This study sought to understand the effects of various environmental factors on the C-fixing capacity and phytoplankton community composition in plateau lake systems.

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Conflict of Interest
The authors declare that there is no conflict of interest.

References
1. Reynolds CS. Ecology of phytoplankton. Cambridge University Press, 2006.
2. Jakobsen HH, Blanda E, Staehr PA, Hojgard JK, Rayner TA, Pedersen MF, *et al*. Development of phytoplankton communities: Implications of nutrient injections on phytoplankton composition, pH and ecosystem production. Journal of Experimental Marine Biology and Ecology,2015:473:81–89.
3. Seekell DA, Lapierre JF, Ask J, Bergström ÅK, Deininger A, Rodríguez P, *et al*. The influence of dissolved organic carbon on primary production in northern lakes. Limnology and Oceanography,2015:60:1276–1285.
4. Gusha MN C, Dalu T, Wasserman RJ, Mcquaid CD. Zooplankton grazing pressure is insufficient for primary producer control under elevated warming and nutrient levels. Science of the Total Environment,2019:651:410–418.
5. Al-Said T, Al-Ghunaim A, Rao DVS, Al-Yamani F, Al-Rifaie K, Al-Baz A. *et al*. Salinity-driven decadal changes in phytoplankton community in the NW Arabian Gulf of Kuwait. Environmental Monitoring and Assessment, 2017, 189(6).
6. Costa RS, Molozzi J, Hepp LU, Rocha RM, Barbosa JE L. *et al*. Diversity partitioning of a phytoplankton community in semiarid salterns. Marine and Freshwater Research,2016:67:238.
7. Zhong ZP, Liu Y, Miao L, Wang F, Chu LM, Wang JL. *et al*. Prokaryotic community structure driven by salinity and ionic concentrations in plateau lakes of the Tibetan Plateau. Applied and Environmental Microbiology,2016:82:1846–1858.
8. Brucet S, Boix D, Gascon S, Sala J, Quintana XD, Badosa A. *et al*. Species richness of crustacean zooplankton and trophic structure of brackish lagoons in contrasting climate zones: north temperate Denmark and Mediterranean Catalonia (Spain). Ecography,2009:32:692–702.
9. Yue LY, Kong WD, Ji MK, Liu JB, Morgan-Kiss RM. Community response of microbial primary producers to salinity is primarily driven by nutrients in lakes. Science of the Total Environment,2019:696:134001.
10. Lozupone CA, Knight R. Global patterns in bacterial diversity. Proceedings of the National Academy of Sciences,2007:104:11436–11440.
11. Adrian R, O'Reilly CM, Zagarese H, Baines SB, Hessen DO, Keller W. *et al*. Lakes as sentinels of climate change. Limnology and Oceanography,2009:54(6):2283–2297. https://doi.org/10.4319/lo.2009.54.6_part_2.2283
12. Tolotti M, Manca M, Angeli N, Morabito G, Thaler B, Rott E, *et al*. Phytoplankton and zooplankton associations in a set of alpine high-altitude lakes: geographic distribution and ecology. Hydrobiologia,2006:562:99–122.
13. Wu Y, Wang SR, Ni ZK, Li H, May L, Pu J. *et al*. Emerging water pollution in the world's least disturbed lakes on the Qinghai-Tibetan Plateau. Science of the Total Environment, 2020.
14. Olofsson M, Hagan JG, Karlson B, Gamfeldt L. Large seasonal and spatial variation in nano- and microphytoplankton diversity along a Baltic Sea–North Sea salinity gradient. Scientific Reports,2020:10(1):176 66. https://doi.org/10.1038/s41598-020-74428-8
15. Glazier DS. How metabolic rate relates to cell size. Biology,2022:11(8):1106. https://doi.org/10.3390/biology11081106]-]000000