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# Plankton Community Structure and Productivity Patterns in Kadalundi Estuary, South West Coast of India

Ashique P. A.[1] and Joseph Antony Jerald I*[2]

[1-2] P. G. and Research Department of Zoology, Jamal Mohamed College (Autonomous), (Affiliated to Bharathidasan University), Tiruchirappalli - 620 020, Tamil Nadu, India

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## Abstract

In addition to being an essential primary producer in aquatic ecosystems and the base of the food chain, phytoplankton plays a significant role in the processes of the material cycle and energy conversion. Despite making up just 0.2% of primary producer biomass, phytoplankton are accountable for 50% of worldwide net primary production. We have measured the phytoplankton abundance, biomass, and primary production at 10 sites along the southwest coast of India during the study period and examined nutritional elements such as calcium, magnesium, sodium, and carbonate. We have used the functional biogeography approach to examine the correlation between primary production, export production, and phytoplankton population size distributions throughout a large latitudinal range. Ecosystem production is an engrossing example of an environmental gradient with an interesting relationship to diversity and variation. The species richness of an ecosystem may have a direct and indirect impact on primary production. The exact processes behind the varying productivity-diversity connections remains poorly understood (PDR). The focus of this study was to learn about how different environmental factors affect the phytoplankton community composition and C fixing capacity in Kadalundi Estuary.

***Key words*:** Phytoplankton, Species distribution, Abundance, Kadalundi, Diversity

Salinity and pH are two potential key elements that may control an estuarine phytoplankton community and biomass. An estuary's salinity is a dynamic phenomenon that is primarily controlled by local rainfall, river discharge, and tidal amplitude. The phytoplankton communities in an undisturbed estuary are very diverse and show a complex pattern of distribution along the salinity gradient. This is because they have evolved to be able to live in a wide range of salinities. The metabolism of aquatic systems is highly reliant on the long-term structure and behaviour of phytoplankton groups. Aquatic ecosystems are significantly affected by temporal fluctuation and phytoplankton species composition because of interactions between physical, chemical, and biological processes. Favourable subaquatic conditions and habitat features for different species are discontinuous since the bulk of pelagic systems are so susceptible to environmental changes. This is another way of saying that the community structure is often unstable and basic because the system is frequently chaotic [1].

The species composition, abundance, biomass, and diversity of phytoplankton communities are often influenced by the abiotic resources like biogenic structure, pH, sunlight, etc of aquatic habitats [2]. One such well-known element that regulates primary producer communities is salinity [1]. Researchers have shown that in very saline lake systems, salinity may alter the composition of the phytoplankton community. So, salinity is an important part of lake systems because it causes changes in where phytoplankton populations live [2]. Many kinds of phytoplankton in lakes prefer water with a little different salinity than the rest of the lake. Previous studies have shown that lakes with salinities below 50 have a disproportionately large cyanophyte biomass, whereas lakes with salinities over 50 have a greater biomass of eukaryotic algae such as Chlorophyta, Bacillariophyta, and Dinophyceae. Phytoplankton diversity, biomass, and primary production are often thought to be limited by salinity [3].

Phytoplankton and the zooplankton that rely on it may be affected by an increase in salinity gradients in lake systems because of the potential for widespread changes in the functional categories of microbial communities. According to Brucet, alterations in functional groups will reduce water quality by making it harder for zooplankton to exert top-down control on phytoplankton [4]. High salinity levels generate high nutrient levels, which may enhance phytoplankton development despite the fact that they reduce phytoplankton population and activity. Salinities between 1 and 35 in saltwater lakes had less of an effect on phytoplankton abundance than freshwater lakes of the same salinity, as reported by Yue [5]. Saltwater lakes with salinities between 1 and 35 had a more pronounced moderate impact of fertilisers. The results are the same as those found in other lake systems, which show that phytoplankton populations are more diverse where there is more salt in the water [6]. Plateau Lake systems are typically assumed to be relatively unpolluted since they are remote and have suffered less human disturbance than other lake systems. Therefore,

***Correspondence to:** Joseph Antony Jerald I, E-mail: jeraldij@gmail.com; Tel: +91 9895823046

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researchers have paid them comparatively little attention. Indeed, air pollutants such as acid rain and nitrogen deposition have had an increasing influence on remote high-altitude lake systems during the last several decades. Lake ecosystems are especially vulnerable to changes in the environment because of their basic trophic structure and harsh weather conditions [7].

Even little changes may have a major effect on ecological communities in plateau lake systems [8]. Many of the Qinghai-Tibet Plateau's 1,055 lakes are salty, despite the plateau's high elevation of an average of 4,500 metres above sea level. It is well known that the lakes of the Qinghai-Tibet Plateau are exceptionally numerous, widely dispersed, and adaptable to a wide range of climatic conditions. As a result, studies of lake ecosystem responses to external disturbances along a variety of environmental gradients would greatly benefit from focusing on these lake systems. Since the 1990s, increasing human activity has put many strains on the aquatic ecosystems of the Qinghai-Tibet Plateau’s Lake systems. That's why there are 53–346 times as many nutrients in the lakes of the plateau as there would be in lakes at sea level [9]. Phytoplankton species local to lakes experiencing extreme environmental stress require a greater quantity of nutrients to sustain their various life activities than do those native to lakes experiencing less severe environmental stress. Phytoplankton respond differently to rising nutrient concentrations over a wide range of environmental gradients. We hypothesised that phytoplankton communities would be able to adapt to challenging environments by making use of nutritional gradients and other environmental factors. To test our idea, we focused on two main areas: (i) figuring out what causes phytoplankton communities to be different in different places, and (ii) seeing how different phytoplankton communities respond to changes in nutrients along environmental gradients.

## MATERIALS AND METHODS

*Study area*

One of the four main rivers that pass through the Malappuram district of the Indian state of Kerala is the Kadalundi River (Kadalundipuzha). 10 sites from the south west coast of India were taken. Kadalundi Bridge, Balathiruthi Road, Kadav Balathiruthi, Cheruthiruthy Bridge, Herose Nagar Road, Kottakadav Bridge, Thazhe, Thachira, Athanikkal Olipuram Kadav and Olipuram Kadav Bridge. At the site, freshwater samples were collected.

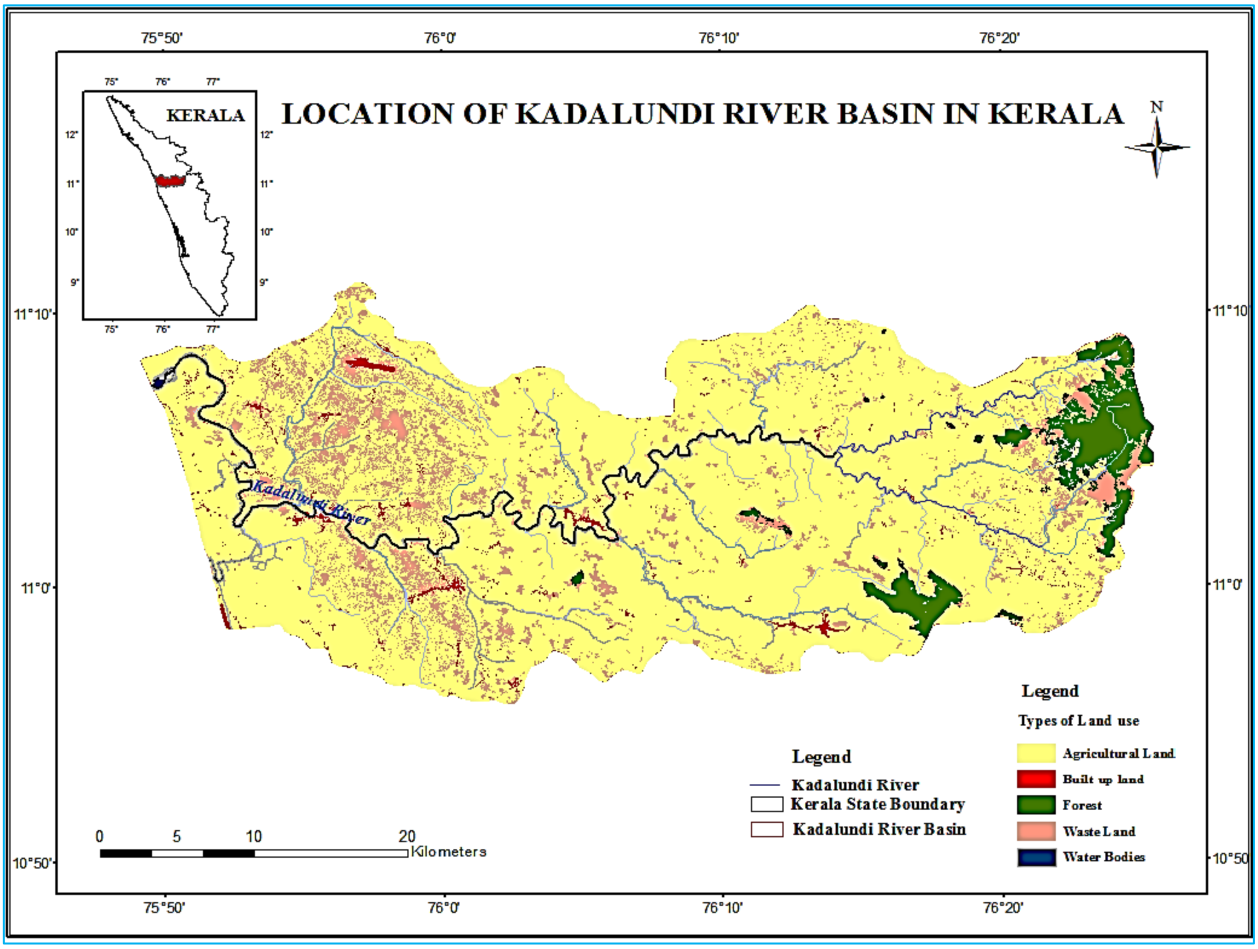


Fig 1 Study area

*Sampling and analysis*

A 20-liter Nalgene bottle was used to collect the surface water sample, and subsequently, a 5-liter Niskin container was used to collect discrete water samples. An autosal was used to determine the salinity of the water. A Metrohm auto titration instrument was used to measure pH. Merck India Ltd.'s 99.5% pure sodium chloride was used to adjust the salinity levels. NaCl, the chemical symbol for the main component of sea salt, was used to refer to this treatment. The salinity of the freshwater was changed by adding a large amount of NaCl that had been dissolved in the same water. Instead of the gradual disintegration of NaCl crystals, abrupt salinity changes were allowed on the basis that this is how salinity changes in natural systems (the arrival of a tidal front with a large salinity gradient). The incubation tests were performed with transparent vials under daylight conditions.

*Filtration and extraction*

After incubating the samples for five days, 500 mL of the sample was filtered out. Tissue paper was put on the filters to absorb the moisture. The tubes had 4 mL of 90% acetone dispensed. Ultrasonification of materials can disrupt cells and facilitate the removal of pigment. Finally, the tubes spent the night in the freezer. After the slurry was well mixed by vortexing and was filtered using a nylon HPLC syringe cartridge filter.

## RESULTS AND DISCUSSION

No significant change in pH was observed during the study. After analysing the total trace metal concentrations in the freshwater sample, it was discovered that all of the physiologically important metals were in the area of nm. values. Both the total biomass and the communities of phytoplankton are affected by the presence of salt. The total biomass gradually declined as the salinity of the salt-manipulated waters rose from 12 to 16 percent NaCl. A lutein signal was not detected by HPLC in any of the salt-treated samples. Green algae, originally found in freshwater, were shown to be very sensitive to even small changes in salinity [10]. As the salinity of the freshwater rose, there was a big change in the phytoplankton population. Salt-tolerant cyanobacteria completely replaced the green algal species.

*Total biomass and phytoplankton community structure as a function of pH*

The pH of an environment may have an effect on the total biomass and the communities of phytoplankton. Chlorophyll concentration (total biomass) in freshwater systems is related to the pH. The highest concentration of Chl-a was found at a pH of 8.15, after rising steadily from an acidic to a neutral pH range. This conclusion is quite different from what was seen when salinity was manipulated, and the cyanobacteria were found to have constantly dominated the colony. Green algae in freshwater systems seem to have changed over time so that they can live in a wide pH range. This is because the water and riverbed mud don't have much of a buffering effect. The green algae appear to be fairly tolerant of pH changes and may be more resistant to either anthropogenic or natural pH changes. More research is being done to figure out how salinity, pH, and other biogeochemical factors affect the formation of the phytoplankton population [11-12].

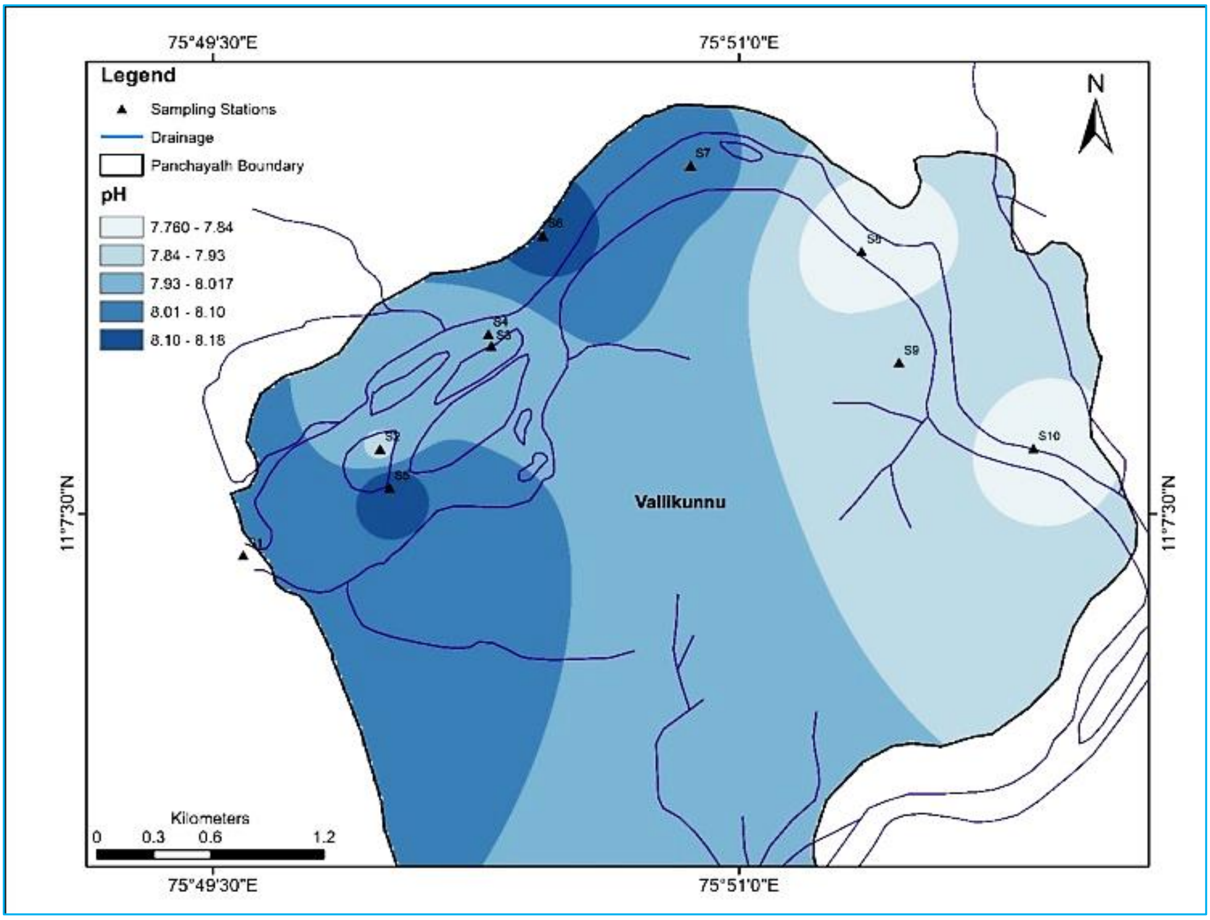


Fig 2 pH gradient of the study area

Phytoplankton community shows characteristic change along the salinity gradients [13]. The results corroborated with previous research showing a negative relationship between salinity and phytoplankton abundance. Aspects of phytoplankton community variation over salinity gradients were investigated. The salinity of the water in plateau lake systems has a significant impact on the physiological activities of phytoplankton. The osmotic pressure of phytoplanktonic cells may be altered by an increase in salt in aquatic settings, reducing their capacity to absorb ions. In spite of the fact that different types of phytoplankton have different capacities for osmotic adjustment to fluctuations in salinity. This explains why there aren't many phytoplankton and how much biomass there is in salty lake environments. Most species of phytoplankton, in particular, perish at high salinities because their cells cannot withstand the increased osmotic pressure. Salinity did not operate as a barrier in these plateau lake systems, despite the fact that they included a wide variety of phytoplankton communities. Since these diatoms are found in very saline conditions independent of environmental variables that promote variety in the phytoplankton community composition of plateau lake systems, it is important that they be able to satisfy additional screening requirements [14]. As an example, fertilizers have a negative impact on phytoplankton populations in both freshwater and saltwater lakes.

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.

Phytoplankton's metabolic rate is inversely proportional to cell size [15]. As temperatures went down along gradients of altitude, phytoplankton populations gradually changed size, with bigger individuals getting smaller to save energy.

## CONCLUSION

According to this study, the key factor affecting the biomass and abundance of phytoplankton communities was found to be salt. Although salinity was present, the dominant phytoplankton species barely noticed it. Bacillariophyta were dominated the phytoplankton community from the start. Comparatively to low-altitude lake systems, high-altitude lake systems exhibited smaller-sized individual phytoplankton species as a result of variations in the nutritional quality. Results showed that the phytoplankton community's reaction to nutrients varied over salinity gradients. High levels of salt in lakes generally suppress phytoplankton growth, but nutrients (mostly TN) have reversed this effect. As a result of its inhibitory effect on the development of dominant algal species, TN may encourage the growth of sensitive algal species and decrease the distance between each species in salty lake systems. The opposite is true for TN, which may help dominant algae species in saline lake systems while making it more challenging for more sensitive algal species to thrive. To account for the diverse phytoplankton reaction patterns along environmental gradients, it is necessary to establish individualised response planning approaches for various lake systems against the backdrop of rising N imports. The focus of this study was to learn about how different environmental factors affect the phytoplankton community composition and C fixing capacity in plateau lake systems.

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