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"EFFECTS OF CLIMATE CHANGE ON PHYTOPLANKTON DIVERSITY AND COMMUNITY STRUCTURE IN MURUGAMATHA TANK,A FRESHWATER TANKTANK, SHIMOGA DISTRICT, KARNATAKA STATE"

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ABSTRACT

Phytoplankton diversity and community structure have been significantly altered as a result of climate change in the freshwater environment of Murugamatha Tank, which is located in the Shimoga District of Karnataka. These changes have been broad and complex in nature. Temperatures are increasing and precipitation patterns are shifting as a consequence of climate change, which is causing significant changes to occur in the chemical and physical environment of the tank. These changes are forcing the tank to undergo significant modifications. Both the availability of nutrients and the temperature stratification of the water column are very important for the development and dispersion of phytoplankton; these changes have an effect on both of these factors. The end result is a change in the variety of phytoplankton species, with some species of phytoplankton successfully adapting to the shifting environment while others completely disappearing. Considering that phytoplankton are the main producers, this shift in the species makeup of the aquatic food web has an impact on the whole aquatic food structure. It is possible that the ecological equilibrium of the tank will be further disrupted when some species become prominent as a result of changes in the structure of the phytoplankton community. This, in turn, may lead to the blooming of toxic algae. The Murugamatha Tank is an essential resource for the preservation of local biodiversity and for human use; hence, it is of the utmost importance to comprehend these alterations for the sake of conservation and management.

Keywords: *Environmental, phytoplankton diversity, climate change*

INTRODUCTION

The modern-day epidemic of environmental pollution is not immune to the ecosystems that are found in water. As a consequence of this, it is of the highest significance to protect and keep an eye on the ecology of freshwater. Phytoplankton are vital to the process of biosynthesis of organic matter in aquatic environments. This process is responsible for the provision of nutrition for all aquatic organisms in some fashion. Research on plankton may be beneficial to any body of water since it not only enables us to get a better understanding of the underlying ecology and economics of the lake, but it also offers a dependable tool for assessing the quality of the water. Anachronistic urban planning and design A broad variety of pollutants are being produced as a consequence of the increasing industrialization and the reckless use of synthetic chemicals in farming. These pollutants are having a detrimental effect on aquatic ecosystems, causing them to become less healthy and putting the existence of aquatic animals in jeopardy. When a certain planktonic population becomes dominant in a body of water, blooms will eventually appear as a result of this explosion. The bloom-forming blue-green algae that are often seen are distinct from other types of algae in that they always include gas vacuoles. These gas vacuoles have the potential to offer the algae positive buoyancy in certain circumstances.

Through the socio-economic advantages that they provide, marine ecosystems play an important part in the upkeep of human health and well-being. Fisheries are responsible for providing at least twenty percent of the animal protein that is eaten by almost half of the world's population. An further method by which marine ecosystems regulate the temperature of the Earth is via the process of absorbing and storing carbon dioxide from the atmosphere. Consequently, it is of the utmost importance to protect biodiversity in order to offer resilience against future climate change and adverse environmental conditions. It is difficult to identify particular patterns of decline in local ecosystems, despite the fact that human activities are the leading driver of biodiversity loss on a global scale. On the contrary, it seems that ecosystems are going through a tremendous rearrangement as dominating species are being replaced at a rapid rate. If you are on land, you may not notice these movements as much as you do when you are in the water.

It is anticipated that the loss of biodiversity would be caused by anthropogenic climate change, which, in conjunction with human pressures on habitat, will subsequently lead to a deterioration in ecological stability. Both the functioning and the structure of marine ecosystems are impacted as a consequence of this. Ocean warming, changes in nutrient availability as a result of changed circulation or stratification, and other pressures such as ocean acidification and deoxygenation are anticipated to be the driving forces behind the rearrangement of communities. There are a number of factors that contribute to the difficulty of predicting future changes to marine ecosystems. These factors include the relative scarcity of consistent and repeated sampling, the inherent variability in community composition over daily to interannual scales, and the lack of knowledge regarding how future climate change and other anthropogenic stressors may alter biodiversity. In light of the fact that it is anticipated that future oceans would be around two to four degrees Celsius warmer, more acidic, and have a lower concentration of oxygen, species will either be forced to adapt to their environment, move to regions that are comparable to their current environment, or run the danger of extinction. The marine ecosystem as a whole is at risk of experiencing a loss of biodiversity, which will have ramifications for the ocean's capacity to control temperature and provide food, in addition to other vital ecosystem functions and processes such as the generation of biomass and the preservation of water quality.

Climate-driven Abiotic Changes in Marine Ecosystems

- **Increased atmospheric CO2 and ocean acidification**

Carbon dioxide (CO_2) levels in the atmosphere rose from around 280 parts per million vapor in preindustrial times to over 384 parts per million vapor in 2007. This growth rate is quite worrisome since it is at least ten times greater than what has been seen in previous centuries. Carbonic acid (H_2CO_3) is formed when dissolved CO_2 combines with molecules of H_2O. This acid then dissociates into bicarbonate (HCO_3^-), releasing a proton H^+ and lowering pH levels. Ocean intake mitigates the effects of rising atmospheric CO_2 levels, although diffusion into water has a significant influence on C chemistry. A reduction in the concentration of carbonate ions (CO_3^{2-}), which increases the solubility of calcium carbonate ($CaCO_3$), is caused by a series of chemical events collectively known as ocean acidification. The pH of surface waters has dropped about 0.1 units due to ocean acidification in the last 200 years, reaching an average of 8.1 now.

If CO_2 concentrations reach 750 ppm in 2100, the pH could drop another 0.3 units, which would be outside the natural range seen in the previous 20 million years.

- **Rising ocean temperatures and global warming**

Higher air and sea temperatures of 0.4 to 0.8 °C have been recorded during the last hundred years. As we near the end of this century, global circulation models indicate that certain parts of the world's oceans would experience warmer temperatures, with an extra 3°C on top of the current mean sea surface temperature (SST) of 18°C, reaching 21.5°C. The euphotic zone's nutrition supply diminishes when sea surface temperature rises, which improves water column stratification. In addition, it causes changes to the underwater light regime. A possible freshening of mean sea surface salinity, along with rising temperatures, is predicted by global circulation models. This might be due to a balance between greater evaporation from low-latitude ocean surfaces and higher precipitation and ice-melt in the poles.

Phytoplankton Responses to Hydroclimatic Changes

Calcification: Research on the effects of elevated CO_2 and low pH on marine phytoplankton growth and production rates is limited in comparison to that on the effects of warming. This is due, in part, to the complexity of the chemical reactions that contribute to ocean acidification, making them difficult to replicate in a controlled laboratory setting. Here are some broad explanations of the mechanisms: Ocean acidification reduces the concentration of carbonate ions (CO_3^{2-}), which increases the solubility of calcium carbonate ($CaCO_3$). As a result, aragonite, the metastable form of $CaCO_3$, is less accessible to creatures like coccolithophores, corals, foraminifers, and mollusks that rely on it for skeleton construction. Because of the important function that calcithophosores' calcite precipitation plays in alkalinity flux to the deep ocean (the inorganic carbon pump), these organisms have attracted a lot of interest. For example, it has been shown that two of the most common calcified phytoplankton species in the ocean, Emiliania huxleyi and Gephyrocapsa oceanic, exhibit deformities of their $CaCO_3$ skeletons and smaller cell sizes when exposed to elevated CO_2 levels in monocultures. Consistent with this, mesocosm investigations have shown that when exposed to high CO_2, E. huxleyi calcify cation decreases and organic carbon is lost from the water column at an accelerated rate.

Interactive effects on phytoplankton: Community composition, acclimation, and growth circumstances are three factors that influence the ecophysiological reactions of marine phytoplankton to acidification. Physiological assumptions about phytoplankton are very questionable because to the interaction impacts of rising CO_2 and warming-related changes, such as changes in mean irradiance exposure, nutrient inputs, sinking rates, and organic carbon exportation from the euphotic zone. For example, it has been shown via experimentation that when temperature and irradiance are coupled with CO_2 levels, it improves photosynthesis in Emiliania huxleyi, independent of the irradiance regime, and that when CO_2 and light are combined, it reduces calcification. Contrarily, diatoms were less abundant and photosynthesis rates dropped in naturally occurring phytoplankton communities that were subjected to increasing light and CO_2. Recent studies have shown that important parameters regulating phytoplankton primary production and community composition have a synergistic effect that may affect ocean carbon cycles and higher trophic levels.

OBJECTIVE

1. Examine Phytoplankton Responses to Hydroclimatic Variations

2. Future phytoplankton diversity in a climate that is changing.

Material and Methods

Study Site

The influence of climatic change on the diversity of phytoplankton in the Murugamatha tank, which is a freshwater tank located in the Shimoga district of Karnataka state. This tank contains both urban and rural areas and accounts for around 4.8% of the entire geographical area of the city, which is approximately 640 square kilometers as of the present day. The current examination was carried out in the tanks that are situated at 12°54' 0" North and 77°29' 0" East. These tanks are situated in the urban area of the Murugamatha tank and the Freshwater tank, respectively. Rainwater is the primary source of water for the tanks, which are used extensively for irrigation, farming, fish aquaculture, and other related applications. However, due to its high elevation of 900 meters (3,000 feet) above sea level, Shimoga normally has a temperature that is more mild throughout the year. This is the case even if there are occasional heat waves that may make summertime fairly miserable. During the summer, temperatures seldom go over 36 degrees Celsius (97 degrees Fahrenheit), while during the winter, they barely ever go below 14 degrees Celsius (57 degrees Fahrenheit).

When the monsoon season was in full swing in 2017, samples were taken from two tanks: the Murugamatha tank and the Freshwater tank. A net with a mesh size of 25 micrometers was employed to collect phytoplankton samples from a volume of 25 liters of habitat water. These samples were collected from a depth of around 10 to 12 centimeters below the surface. After the samples were gathered, they were placed in plastic bottles that had a capacity of one liter. Immediately after the surface water was removed from the centrifuge tube, the samples that were collected were centrifuged in order to concentrate them and bring their volume up to one hundred milliliters. After being transferred to a new bottle, the plankton population was swiftly preserved in Lugol's Iodine solution, labeled, and then taken to the laboratory for subsequent tests. This was done quite quickly. Before the microscopy, each of the samples was thoroughly combined. Through the utilization of a wide-mouth graduated pipette, one milliliter of the agitated material was introduced into a Sedge-wick Rafter counting cell. The quantity of plankton was determined by counting the number of plankton that were present in each microfield focus.

Results and Discussion

The results of the freshwater and Murugamatha tank produced phytoplankton data. the data was collected from both tanks. According to the calculated diversity, the percentage composition and quantity of the phytoplankton in both tanks are taken into consideration.

Table 1: Freshwater and Murugamatha tank phytoplankton species (November 2017).

Group	Murugamatha tank	% Composition	Freshwater tank (Organisms/m1)	% Composition
Chlorophyceae	956	86.12	493	76.55

Euglenophyceae	10	0.90	08	1.24
Bacillariophyceae	65	5.85	46	7.14
Cyanophyceae	79	7.11	81	12.57
Charophyceae	Nil	Nil	15	2.32
Dinophyceae	Nil	Nil	01	0.15

Table 2: Murugamatha and Freshwater tank phytoplankton abundance and composition (November 2017).

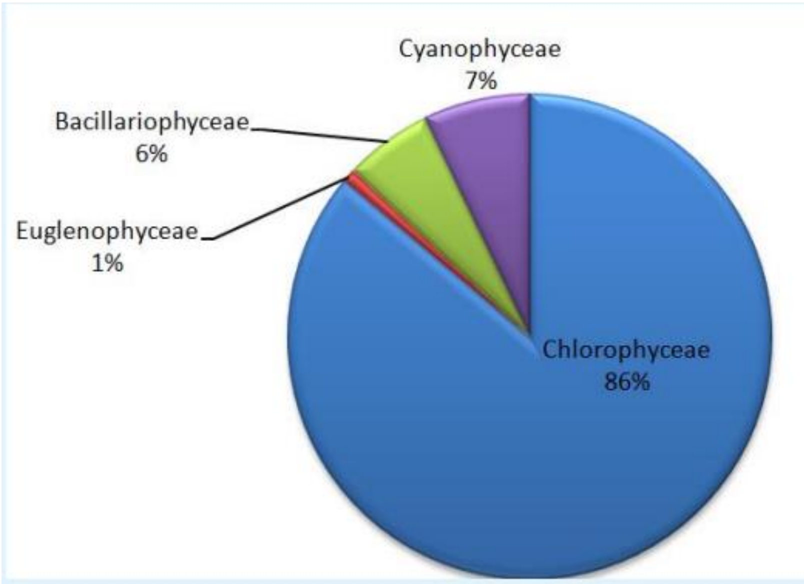
Nine Diversity Indices of Phytoplankton	Murugamatha tank	Freshwater tank
Taxa_S	4	6
Individuals	1110	644
Dominance_D	0.7503	0.6077
Shannon_H	0.5253	0.8059
Simpson_1-D	0.2497	0.3923
Evenness_e^H/S	0.4227	0.3731
Menhinick	0.1201	0.2364
Margalef	0.4278	0.7731
Equitability J	0.3789	0.4498
Fisher alpha	0.5220	0.9149
Berger-Parker	0.8613	0.7655

There are 1110 organisms per milliliter of phytoplankton in the Murugamatha tank, whereas there are 628 organisms per milliliter in the Freshwater tank. This information is based on the species distribution pattern. To calculate diversity indices, the concentration of the algae was determined by counting the number of organisms that were present per milliliter. There were 37 distinct species of algae that were discovered, and they were classified into the following six families: Dinophyceae, Cholrophyceae, Euglenophyceae, Bacillariophyceae, Cyanophyceae, and Charophyceae. Within the Chlorophyceae family, the species that were found in the greatest abundance in both aquariums were Pediastrum simplex, Elakatothrix sp., Volvox sp., Selenastrum sp., Phytoconis sp., and Pleurotaenium sp. Phacus sp., Bacillariophyceae dominated by Diatoms sp., Cyanophyceae dominated by Merismopedia sp., and Cyanophyceae dominated by Anabaenopsis circularis were the Euglenophyceae groups that were determined to be the most prevalent in both tanks.

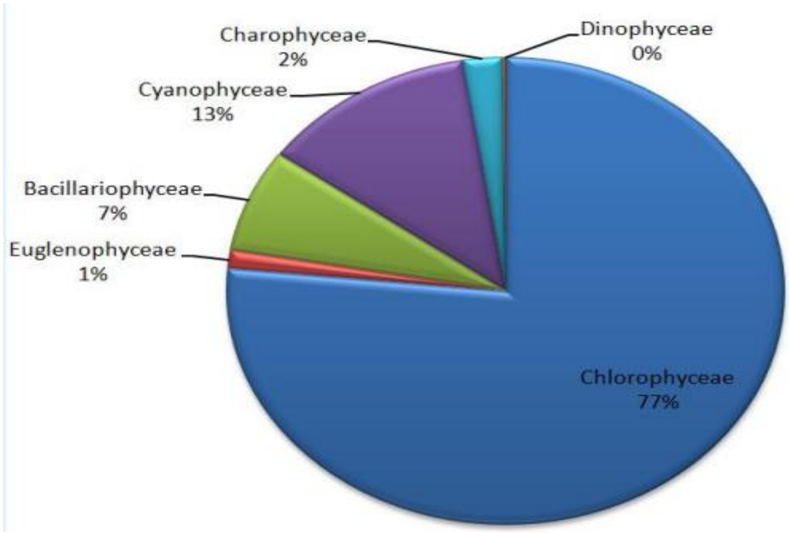
Within the scope of this study, the families Euglenophyceae and Dinophyceae were not well represented in comparison to other taxonomic groups. The predominance of Euglenophyceae and Dinophyceae was shown to have a negative correlation with the members of the Chlorophyceae family. When it came to the aquatic organisms, chlorophyceae made up the great majority in both the Murugamatha tank (956 organisms/ml, which is equivalent to 86.12% of the total) and the Freshwater tank (493 organisms/ml, which is equivalent to 76.5% of the total). Charophyceae and Dinophyceae were not present in either the Murugamatha tank or the freshwater tank containing any plants. It is estimated that Dinophyceae represented for around 0.15 percent of the total, whereas Charophyceae contributed for 2.32 percent.

Chlorophyceae made up 22 of the 29 species of phytoplankton that were discovered in the Murugamatha tank. Euglenophyceae made up one of the species, Bacillariophyceae made up two, and Cyanophyceae made up four of the species. The Chlorophyceae accounted for 86.12% of the phytoplankton in November 2017, followed by the Euglenophyceae with a percentage of 0.90 percent, Bacillariophyceae with a percentage of 5.85 percent, and Cyanophyceae with a percentage of 7.11%. Twenty-four of the phytoplankton in the freshwater tank were classified as cyanophyceae, one was classified as dinophyceae, two were classified as bacillariophyceae, five were classified as cyanophyceae, and one was classified as euglenophyceae. The following is a breakdown of the phytoplankton taxa in November 2017, according to the present study: Chlorophyceae (76.55%), Euglenophyceae (1.24%), Bacillariophyceae (7.14%), Cyanophyceae (12.57%), Charophyceae (2.32%), and Dinophyceae (0.15%).

In relation to the percentage composition of phytoplankton species in the Murugamatha tank and the Freshwater tank respectively. On the third graph, the relative quantities of phytoplankton that are present in the freshwater tank and the Murugamatha tank are shown.



Graph 1: November 2017 Murugamatha tank phytoplankton species percentage.



Graph 2: Freshwater tank phytoplankton species percentage November 2017

For this data set, we used the "PAST" tool, which produces nine diversity indices: Dominance D, Shannon H, Simpson, Evenness, Menhinick, Margalef, Equitability J, Fisher alpha, and Berger-Parker. Index value decreases as variety rises.

The numerical significance of the most numerous species may be easily measured using the dominance index. According to the current study's Dominance index, the planktonic species concentration is greatest in the Murugamatha tank (0.75) and lowest in the Freshwater tank (0.60).

Depicted by the Shannon and Weiner index is the entropy. It is a measure of diversity that takes both the total number of people and the total number of taxa into consideration. A body of water's contamination condition may also be ascertained using this index. A range of 0 to 4 is considered normal. Water with an index value of 3 or above is considered clean, according to Wilham and Dorris; moderate contamination is indicated by values between 1 and 3, and severely contaminated by values below 1. On this scale, the Murugamatha tank has a contamination level of 0.52, whereas the Freshwater tank has a level of 0.80. One common method for quantifying habitat biodiversity is the Simpson's index. Not all species are distributed uniformly, as per Simpson's index. The numbers fall anywhere between 0.71 and 0.96. Results for the Murugamatha tank (0.24) and the Freshwater tank (0.39), according to the current research, for Simpson's index. Species evenness is defined as the diversity index, according to Pielou's evenness index, which assesses the degree to which a community is diverse.

In the Murugamatha tank, the evenness was 0.42, whereas in the Freshwater tank, it was 0.37. Two indices that quantify species richness in ecosystems are Menhinick's and Margalef's. In the Murugamatha tank, Menhinick's index is 0.12, whereas in the freshwater tank, it reaches a maximum of 0.23. The Murugamatha tank has a low Menhinick's index of 0.42 while the freshwater tank has a high score of 0.77. The degree to which individuals are distributed evenly throughout the taxa in question may be gauged using the Equitability index. On a scale from 0 to 1, where 1 represents perfect equality, we find equitability. According to the current research, the Murugamatha tank has an index of 0.37 and the Freshwater tank has an index of 0.44. One mathematical way to find out how diverse a population is is to use Fisher's alpha index. The first mathematical description of the link between species and individuals was provided by this work. The Murugamatha tank has an extremely low index of 0.52 whereas the Freshwater tank has the highest value of 0.91. What this means is that the freshwater tank was home to a wide variety of animals. The number of individuals in the dominating taxon divided by the total number of individuals (n) is the Berger-Parker dominance index. The Murugamatha tank has the highest values at 0.86, while the Freshwater tank has the lowest values at 0.76.

CONCLUSION

In aquatic environments, phytoplankton is crucial. Freshwater tank are significant to the social ecology of their area. The tank in human-dominated regions are threatened by anthropogenic activities including bathing, washing clothing, cleaning animals and cars, dumping solid waste, etc. Such activities deplete aquatic biodiversity, particularly plankton. The research area is semiarid, which is prone to high temperatures and little rainfall. Water bodies are threatened by little rainfall, high temperatures, and increasing human activity in the study region. Several water bodies have disappeared from the study area during the previous 50 years. We performed thorough field surveys in the study area and found 21 species from various families. Seasonal changes and water flow may boost or reduce species diversity during summer and monsoon seasons. However, several studies show considerable species diversity in different lake habitats. Water shortage reduces species diversity in the studied area. Human activity is the principal cause of aquatic biodiversity decline. For improved water ecosystem management, people should be taught about water bodies' value and usage. The Murugamatha tank ecology in a semiarid zone was studied to determine phytoplankton diversity. Researchers studying semiarid environments may use it as a baseline data source.

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