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Checklist of Phytoplankton Availability at Selected Sites of Gulf of Khambhat, Gujarat, India

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ABSTRACT

A study was carried out in the selected sites of two districts Anand and Bharuch to know the diversity of Phytoplankton in the mangroves' habitats. Phytoplankton samples were collected bi-monthly from the depth of 1-2 ft below the water level from January to December 2021 from three perennial sites VGM (Vadgam) TTM (Tadatalav) KJM (Kantiyajal). Samples were collected using a plankton net with a mesh size of 20 mesh made up of bolting silk. Among the temporal distribution of phytoplankton at VGM, Bacillariophyta members were recorded as the highest species composition represented by 50% of all taxa followed by Chlorophyta with 30% whereas Cyanobacteria and Dinophyta members with 10% each. At TTM Chlorophyta accounts for the highest distribution of families at TTM with 45% followed by Bacillariophyta, Cyanobacteria with 22% and the least with 11% of Dinophyta. The mangroves and estuarine water in KJM show a great diversity of phytoplankton with the taxa Bacillariophyceae recording the highest taxa with 37%. Chlorophyta is the second-highest taxa with a representation of 36% followed by Cyanobacteria accounting for 18% and Dinophyta accounting for 9% among all the taxa. A total of 33 phytoplankton species were identified amongst which Bacillariophyta was the most dominating among the four classes found at VGM, which can be an indicator of good water quality at selected sites. The observed phytoplankton diversity is one of the indicators of rich biodiversity. These findings have major impacts on our understanding of marine phytoplankton diversity. The new data and hypotheses contribute to a better understanding of the diversification of Phytoplankton in the ocean. Understanding and assessing diversity might be essential for understanding and predicting the impact of environmental factors on this major compartment.

Keywords Biodiversity, Phytoplankton, Mangrove ecosystem.

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INTRODUCTION

Mangrove is a big tropical evergreen tree/forest that develops along the shorelines and on muddy tidal flats. Mangroves develop aerial roots from their stems that become entangled in the mud and form a tangled network that supports the tree root system (Encyclopedia 2014). These roots also serve as a

foundation for the deposit of silt and other material transported by the tides or water discharge, resulting in the formation of land that is eventually overrun by other plants (Encyclopedia 2014). As a result, mangrove forests are nutrient-dense and serve as a haven for fish, crabs, and other marine creatures. Mangroves are more important in coastal locations than in inland or estuarine settings because tsunamis, cyclones, and wind are the first to strike the shore. In this setting, mangroves protect coastlines from tsunamis, tidal waves, cyclones, and flash floods, as well as acting as a windbreak. Different depositional coastal characteristics interact with tidal waves on a regular basis. Sand dunes are a type of depositional structures that help to protect land-based ecosystems such as mangroves (Sapkale 2014). Simultaneously, these two factors lessen the severity of coastal disasters.

Both phytoplankton and zooplankton populations have been employed to monitor coastal water quality and as pollution bio-indicators with effectiveness (Parmar *et al*. 2016, Fossi *et at*. 2018, Hemraj *et al*. 2017). They are the first biological components from which energy is transported up the food chain to higher creatures (Ananthan *et al*. 2004, Tiwari *et al*. 2006). To understand the state of an estuarine environment, data on phytoplankton quantity, distribution, and species composition are required. In the maritime environment, they are a significant source of energy. These planktons start the marine food chain by feeding primary consumers like zooplankton, shellfish, finfish, and other small fish (Ananthan *et al*. 2004, Tas and Gonulol 2007). According to Nugraha (2021), plankton in mangrove ecosystems contributes between 20 and 50% of overall fish production.

Physical and chemical factors have a greater impact on planktonic communities in mangrove waters than in coastal waters, resulting in seasonal fluctuations in planktonic species composition and density (Vajravelu *et al*. 2018). As a result, planktonic communities, as well as their periodic shifts in abundance and composition, play a significant role in the mangrove ecosystem. To comprehend harmful changes in the environment, data on species diversity, richness, evenness, and dominance evaluation on the biological component of the ecosystem is required (Borja *et al*. 2016).

Plankton composition is a good way to assess the ecological integrity of aquatic habitats in terms of fish development and production. The autotrophic components of the plankton community that dwell suspended in open water and have a minimal capacity to resist the passage of water currents are known as phytoplankton (Jonah *et al*. 2020). They are chlorophyll-containing eukaryotic or prokaryotic photosynthetic plankton that can be found as single cells, chains, colonies, or filamentous forms. They provide the primary live feed for a variety of aquatic organisms, including zooplankton, crustacean larvae, mollusks, and herbivorous fishes, and they represent the foundation of the food web in deep waters. They are also capable of synthesizing organic compounds and releasing oxygen into the water body (Boyd 2020). However, because phytoplanktons are sensitive to changes in water quality, they are also classified as hydrobionts that serve as environmental indicators (Mitrofanova 2008, Brettum and Anderson 2005). Water quality is determined by available plankton, according to Olasehinde and Abeke (2012) and Kutama *et al*. (2014), since it provides more information about the current environment; changes in water quality parameters than nutrient concentrations (Medupin 2011). Studies show that phytoplankton density and variety are biological indicators of environmental health, water quality, and eutrophication levels (Shekhar *et al*. 2008, Uttah *et al*. 2013).

Tropical wetlands have played an important role in a wide range of ecological niches on all continents, containing a considerable percentage of the world's biological diversity for humans. Wetlands, like rainforests and coral reefs, are among the world's most productive ecosystems. The bulk of the floating plants in the oceans is phytoplankton, which is a type of unicellular microscopic algae. Fish biological wealth is directly linked to the density of phytoplankton populations in each aquatic environment and provides a vital link in the food chain. They are the primary producers in the food chain and may be found at the bottom of the tropics in the freshwater ecosystem's food chain.

Both phytoplankton and zooplankton are essential components of the aquatic food web (Rahman 2021). Only a little amount of scientific attention has

been dedicated to phytoplankton populations in the Gulf of Khambhat's coastal waters up to this point.

MATERIALS AND METHODS

Study area

The plankton analysis was conducted in three locations in Gujarat, namely Vadgam, Tadatalav, and Kantiyajal, all of which are located in the Gulf of Khambhat. Vadgam and Tadatalav are in Gujarat's Khambhat taluka of Anand district, while Kantiyajal is in Gujarat's Bharuch district.

Vadgam (VGM) is around 35 kilometers west of Anand. The location's latitude and longitude are 22°19'04"N and 72°22'45"E, respectively. It is at a height of 19 meters above sea level.

Tadatalav (TTM) is situated 40 kilometers west of Anand. The location's latitude and longitude are 22°15'18"N and 72°27'11"E, respectively. The elevation of Tadatalav is 19 meters above sea level.

Kantiyajal (KJM) village falls in the Hansot tehsil and Bharuch district of Gujarat. Kanityajal is 60 kilometers from Bharuch, the district headquarters. The location's latitude and longitude are 21°28'38"N and 72°39'25"E, respectively. It is located 22 km above sea level. Study area maps were prepared with the help of Quantum GIS Software. Study area map is shown in Fig. 1.

METHODOLOGY

Phytoplankton samples were collected bimonthly from January to December 2021 from all three sites i.e. VGM, TTM, KJM. Samples were collected using a plankton net with a mesh size of 20 mesh made up of bolting silk. At Each station, a total of 50 L of the sample was collected, which was condensed to 30 ml using the plankton net (George *et al*. 2015). Samples were then preserved in 4% formalin and brought to the laboratory for further analysis. For phytoplankton analysis LABOMED STC - HL light microscope was used. A checklist of phytoplankton was prepared. Taxonomic studies of phytoplankton were carried out by using standard references (Joshi *et al*. 2018, Gopinathan *et al*. 2007, Bellinger and Sigee 2010, Taylor *et al*. 2007).

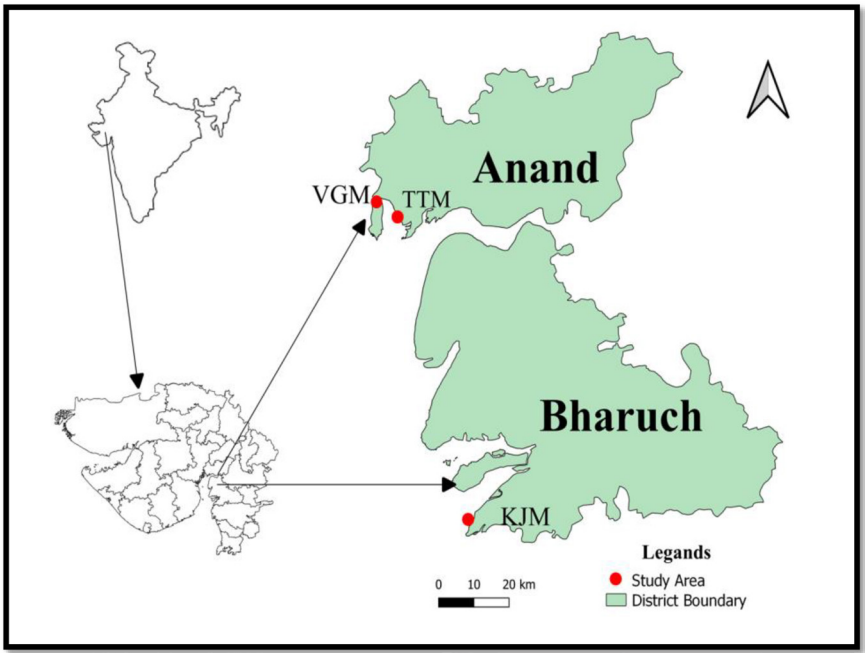

Fig. 1. Map showing study area.

RESULTS AND DISCUSSION

Estuarine water or mangrove water receives water from both sea and river making it a diverse ecosystem where saline water and freshwater get mixed. Thus, it frequently undergoes mixing and flushing of water which leads to variation in the quality and health of the ecosystem. These variations can be studied by analyzing the physico chemical parameters of the water and by studying the population of phytoplankton residing in the ecosystem or analyzing the species of phytoplankton found in that particular ecosystem.

The presence of phytoplankton in the aquatic ecosystem indicates the health of that particular ecosystem. The more the number and variety of phytoplankton present in the water, the better is the quality of water. They are the producers of the aquatic ecosystem and play important role in maintaining the ecological balance as well as the interaction between different trophic levels (George *et al*. 2012). The composition of phytoplankton varies with season (Jouenne *et al*. 2007). The factors like light, temperature, nutrient availability can also affect the composition of phytoplankton in an ecosystem. Khattak *et al*. (2005) concluded that the biomass, relative abundance, species composition, temporal and spatial distribution of phytoplankton are an expression of environmental health and biological integrity of a particular water body. The distribution of phytoplankton was variable in all three respective sites. The highest phytoplankton was recorded in taxa Bacillariophyta at VGM and KJM while at TTM the highest recorded taxa were Chlorophyta. Phytoplankton recorded at sampling sites is depicted in Plate 1.

Vadgam (VGM)

VGM is rich in the diversity of phytoplankton. Among the temporal distribution of phytoplankton at VGM, Bacillariophyceae was recorded for the highest species composition represented by 50% of all taxa. The families of taxa Bacillariophyta included Family: Naviculaceae, Family: Nitzschiaceae, Family: Coscinodiscaceae, Family: Pinnulariaceae, Family: Skeletonemaceae. The taxa with the lowest recorded distribution at VGM are Cyanobacteria and Dinophyceae with 10% each. Chlorophyceae is represented by 30% of the total taxa. The taxa of Chlorophyta recorded the existence of five families and the taxa of Cyanobacteria and Dinophyceae recorded 2 families each respectively. Waghmare and Kulkarni (2015) carried out a similar kind of study in the Lendi River, Maharashtra and reported around 20 genera of phytoplankton including diatoms, blue-

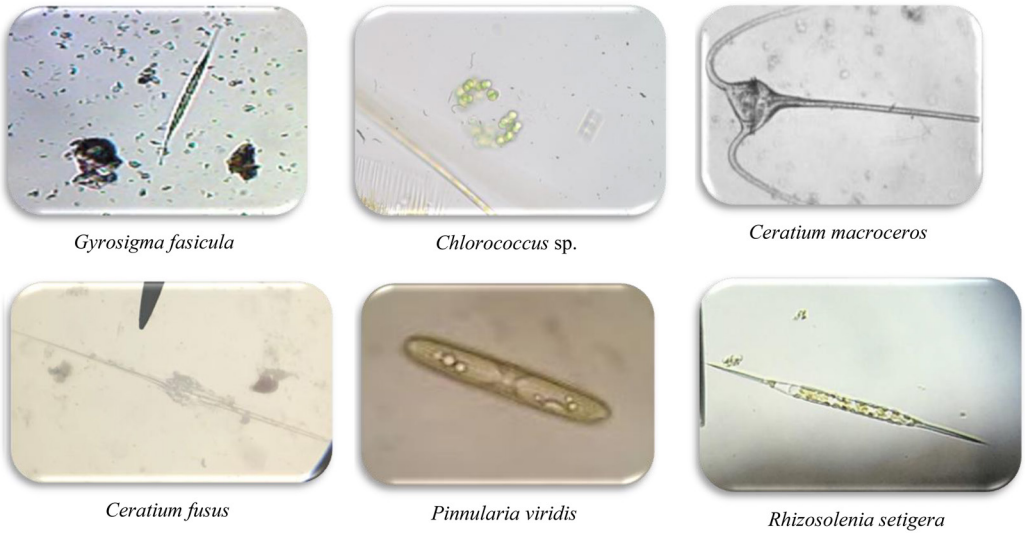

Plate 1. Phytoplankton species found at sampling sites.

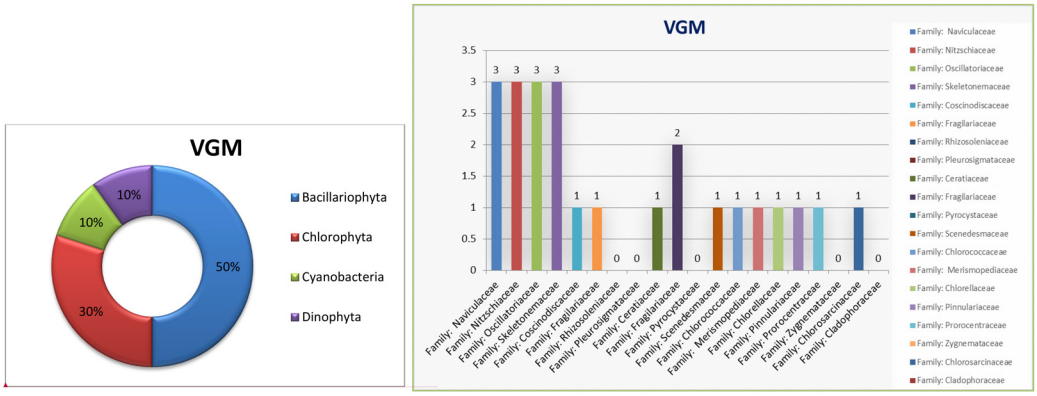

Fig. 2. Species composition of VGM.

green algae, green algae. The percentage distribution of each taxas and the respective families and their species have been shown in Fig. 2.

Tadatalav (TTM)

TTM showed a range of diversity in the phytoplankton species (Fig. 3). Chlorophyta accounts for the highest distribution of families at TTM with 45% and included the presence of Family: Zygnemataceae, Family: Scenedesmaceae, Family: Chlorellaceae, Family: Cladophoraceae, Family: Chlorosarcinaceae respectively. Taxa of Bacillariophyta record 22% of distribution and Cyanobacteria and Dinophyceae record 22% and 11% respectively. The Bacillariophyta records presence of species from 2 families namely Family: Naviculaceae, Family: Nitzschiaceaerespectively. Chlorophyta is the second most important and largest taxa after Bacillariophyta (George *et al.* 2012). The percentage distribution of each taxons and the respective families and their species have been shown in Fig. 3.

Kantiyajal (KJM)

KJM is situated in the Bharuch district of Gujarat and receives water from the Narmada river. The mangroves and estuarine water in KJM show a great diversity of phytoplankton (Fig. 4) with the taxa Bacillariophyta recording the highest taxa with 37%. Chlorophyta is the second-highest taxa with a representation of 36% followed by Cyanobacteria accounting for 18% and Dinophyta accounting for 9% among all the taxa. Bacillariophyta being the highest

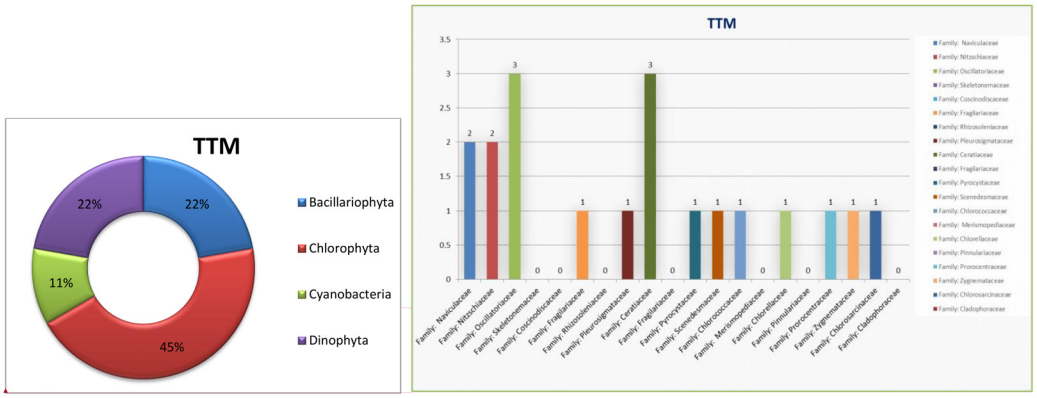

Fig. 3. Species composition of TTM.

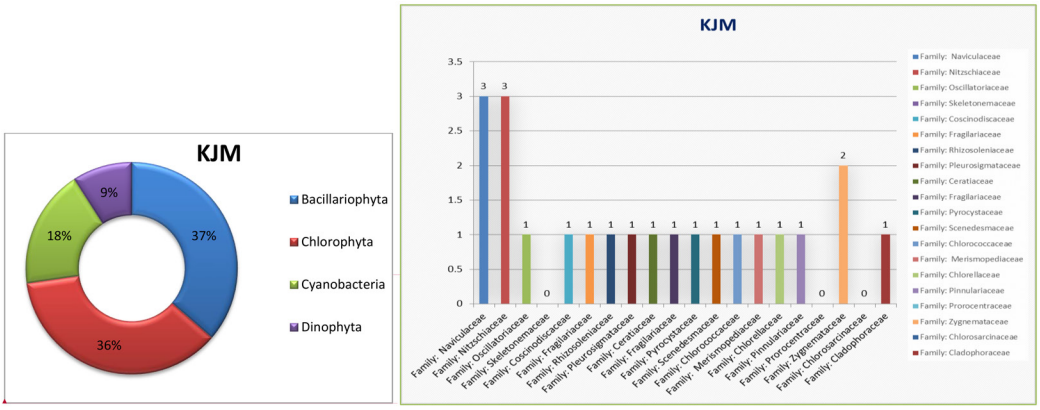

Fig. 4. Species composition of KJM.

recorded taxa plays important role in maintaining the health of the estuarine. The Bacillariophyta shows the presence of species from four families namely *Family: Naviculaceae, Family: Nitzschiaceae, Family: Coscinodiscaceae, Family: Pinnulariaceae*. The species of Cyanobacteria are mostly confined to the regions of freshwater. The percentage distribution of the taxa and the families and their species recorded at KJM is shown in Fig. 4.

CONCLUSION

A total of 33 species of plankton were identified Bacillariophyta division was the most dominating among the four divisions, which is an indicator of good water quality at selected sites. The observed plankton diversity is one of the indicators of rich biodiversity. These findings have major impacts on our understanding of marine phytoplankton diversity. The new data and hypotheses contribute to a better understanding of the diversification of Phytoplankton in the ocean. Understanding and assessing diversity may be essential for understanding and predicting the impact of environmental forcing on this major compartment.

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REFERENCES

Ananthan GA, Sampathkumar P, Soundarapandian P, Kannan L (2005) Observation on environmental characteristics of Ariyankuppam estuary and Veerampattinam coast of Pondicherry, India. *Aqua Biol* 19: 67-72.

Bellinger EG, Sigee DC (2010) A key to the more frequently occurring freshwater algae. Freshwater algae, pp 137-244.

Borja A, Elliott M, Andersen JH, Berg T, Carstensen J, Halpern BS, Rodriguez-Ezpeleta N (2016) Overview of integrative assessment of marine systems: The ecosystem approach in practice. *Front Marine Sci*, pp 20.

Boyd CE (2020) Microorganisms and Water Quality. In Water Quality. Springer, Cham, pp 233-267.

Brettum P, Andersen T (2005) The use of phytoplankton as indicators of water quality (No. SNO 4818–2004). – Norwegian Institute for Water Research (NIVA), Oslo, Norway.

Brooks DA, Baca MW, Lo YT (1999) Tidal circulation and residence time in a macrotidal estuary: Cobscook Bay, Maine. *Estuarine, Coastal Shelf Sci* 49(5): 647-665.

Bruce LC, Hamilton D, Imberger J, Gal G, Gophen M, Zohary T, Hambright KD (2006) A numerical simulation of the role of zooplankton in C, N and P cycling in Lake Kinneret, Israel. *Ecol Modell* 193(3-4): 412-436. https://doi.org/10.1016/j. ecolmodel.2005.09.008.

Dunbar FN, Webber MK (2003) The phytoplankton distribution in Kingston Harbor, Jamaica. *Bull Marine Sci* 73(2): 343-359.

Fossi MC, Pedà C, Compa M, Tsangaris C, Alomar C, Claro F, Baini M (2018) Bioindicators for monitoring marine litter ingestion and its impacts on Mediterranean biodiversity. *Environm Pollution* 237: 1023-1040.

George B, Kumar JN, Kumar RN (2012) Study on the influence of hydro-chemical parameters on phytoplankton distribution along Tapi estuarine area of Gulf of Khambhat, India. *The Egypt J Aquatic Res* 38(3): 157-170.

Gopinathan CP, Rajagopalan M, Kaladharan P, Prema D (2007) Training Manual on Phytoplankton Identification/Taxonomy.

Hemraj DA, Hossain MA, Ye Q, Qin JG, Leterme SC (2017) Plankton bioindicators of environmental conditions in coastal

lagoons. *Estuarine, Coastal and Shelf Sci* 184: 102-114.
Hendey N (1957) III—Marine Diatoms from Some West African Ports. *J Royal Microscopical Soc* 77 (1-2): 28-85.
Hudson JJ, Taylor WD (1996) Measuring regeneration of dissolved phosphorus in planktonic communities. *Limnol.Oceanogr*. 41(7): 1560–1565. https://doi.org/ 10.4319/lo.1996.41.7.1560.
Hudson JJ, Taylor WD, Schindler DW (1999) *Planktonic nutrient* 461: 1998–2000.
Jonah UE, Etteokon SE (2020) Preliminary study on the diversity of plankton flora and water quality of a tropical mangrove estuarine system, AkwaIbom State, Niger Delta Area, Nigeria. *Afr J Environ Natural Sci Res* 3(6): 34-45.
Joshi A, Desai AY, Bhatt AJ, Kardani HK, Yusufzai SI, Khileri RA (2018) A Guide to the Marine Phytoplankton of Marine National Park, Gujarat, College of Fisheries Science, Junagadh Agricultural University, India. ISBN: 978-93-5300-352-4.
Jouenne F, Lefebvre S, Véron B, Lagadeuc Y (2007) Phytoplankton community structure and primary production in small intertidal estuarine-bay ecosystem (eastern English Channel, France). *Marine Biol* 151(3): 805-825.
Kannan L, Vasantha K (1992) Microphytoplankton of the Pitchavaram mangals, southeast coast of India: Species composition and population density. In The Ecology of Mangrove and Related Ecosystems. Springer, Dordrecht, pp 77-86.
Kathiresan K (2000) A review of studies on Pichavaram mangrove, southeast India. *Hydrobiologia* 430(1): 185-205.
Khattak TM, Noorzaman Bhatti, Ghulam Murtaza (2005) Evaluation of Algae from the Effluent of Dandot Cement Company, Dandot Pak. *J Appl Sci Environ Mgt* 9(1): 147-149.
Krishnamoorthy P, Subramanian P (1999) Organisation of commercially supporting meroplankton in Palk Bay and Gulf of Mannar biosphere reserve areas, southeast coast of India.
Kutama RM, Abubakar MM, Balarabe ML (2014) The plankton as indicators of water quality in Kusalla Reservoir: A shallow man made lake. *IOSR J Phar Biol Sci* 9(3): 12-15.
Lalli C, Parsons T (1997) Biological oceanography: An introduction. Elsevier.
Lehman JT, Sandgren CD (1985) Species-specific rates of growth and grazing loss among freshwater algae. *Limnol. Oceanogr* 30: 34–46. https://doi.org/10.4319/ lo.1985.30.1.0034.
Mani P (1992) Natural phytoplankton communities in Pichavaram mangroves.
Medupin CECILIA (2011) Phytoplankton community and their impact on water quality: An analysis of Hollingsworth Lake, UK. *J Appl Sci Environm Manag* 15(2): In press
Mitrofanova E (2008) Indicative significance of phytoplankton for estimation of large river state near cities and settlements (Ob and Tom Rivers as a case study. Russia). In Geophysical Research Abstracts, pp 10.
Narmada, Rtevo (2015) An evaluation of phytoplankton assemblage in relation to environmental variables of Narmada Estuarine Region of Gulf of Khambhat, Gujarat, India. *Appl Ecol Environ Res* 13(1): 115-123.
Nugraha YA, Susanto HA, Simanjuntak CP, Wildan DM (2021) Mangrove ecosystem related to fisheries productivity in the coastal area of Karawang Regency, West Java, Indonesia. In IOP Conference Series: Earth and Environmental Science (Vol. 800, No. 1, p. 012016). IOP Publishing.
Olasehinde KF, Abeke AA (2012) Limnological features of Ikere Gorge Reservoir, Iseyin south-western Nigeria: Plankton composition and abundance. *J Biol Environ Sci* 2(6): 20-31.
Parmar TK, Rawtani D, Agrawal YK (2016) Bioindicators: The natural indicator of environmental pollution. Front life Sci 9(2): 110-118.
Pinel-Alloul B, Downing JA, Perusse M, Codin-Blumer G (1988) Spatial heterogeneity in freshwater zooplankton: Variation with body size, depth and scale. *Ecol Soc Am* 69: 1393-1400.
Rahman MH Diversity and Density of Plankton in the Sundarban Mangrove Forest, Estuarine Area, Bangladesh.
Robertson AI, Blaber SJM (1993) Plankton, epibenthos and fish communities. *Coastal Estuarine Studies*, pp 173-180.
Sapkale JB (2014) Degradation of coastal sand dunes in Mithmumbari and Kunkeshwar of Devgad Coasts, Maharashtra. *Int J Innov Res Sci, Engg Technol* (*IJIRSET*). 3(9): 16097-16103.
Sterner RW (2009) Encyclopedia of Inland Waters. *Encycl Inl Waters*, pp 678–688.
Tas B, Gonulol A (2007) An ecologic and taxonomic study on phytoplankton of a shallow lake, Turkey. *J Environm Biol* 28(2): 439.
Taylor JC, Harding WR, Archibald CGM (2007) Methods manual for the collection, preparation and analysis of diatom samples. WRC Report No TT 281/07. Water Research Commission, Pretoria, pp 11-23.
Urabe J, Nakanishi M, Kawabata K (1995) Contribution of metazoan plankton to the cycling of nitrogen and phosphorus in Lake Biwa. *Limnol Oceanogr*. 40(2): 232–241. https://doi.org/10.4319/lo.1995.40.2.0232.
Uttah EC, Ogbeche J, Ogban E, Iboh CI, Ajang R (2013) Risk factors of hookworm infection in a tourist destination in Cross River State, Nigeria. *Global J Bio-Sci Biotechnol* 2(1): 135-141.
Vajravelu M, Martin Y, Ayyappan S, Mayakrishnan M (2018) Seasonal influence of physico-chemical parameters on phytoplankton diversity, community structure and abundance at Parangipettai coastal waters, Bay of Bengal, South East Coast of India. *Oceanologia* 60(2): 114-127.
Waghmare BD, Kulkarni AN (2015) An assessment of phytoplankton population and seasonal variation in Lendiriver, district Nanded, Maharashtra, India. *Int J Sci Res* 4(12): 936-940.
Wang PF, Martin J, Morrison G (1999) Water quality and eutrophication in Tampa Bay, Florida. *Estuarine, Coastal Shelf Sci* 49(1): 1-20.
Webber M, Edwards-Myers E, Campbell C, Webber D (2005) Phytoplankton and zooplankton as indicators of water quality in Discovery Bay, Jamaica. *Hydrobiologia* 545(1): 177-193.