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Phytoplankton assemblages in the south eastern coastal area of the Bay of Bengal, Bangladesh with special reference to environmental variables

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Abstract
Phytoplankton assemblages in the south eastern coastal area of the Bay of Bengal, Bangladesh was studied from surface water for a period of 12 months (July 2020 to June 2021) in relation to environmental variables like, water temperature, pH, dissolved oxygen, salinity, conductivity, transparency, rainfall, TDS and nutrient contents-including nitrate, nitrite, phosphate and silicate. A total of 137 phytoplankton species were identified whereas, 115 species of diatoms from 44 genera, 15 species of dinoflagellates from 8 genera, 2 species of green algae from 2 genera, 4 species of cyanobacteria from 3 genera and 1 species of silicoflagellate were identified. The highest phytoplankton abundance was found at Shaplapur about 12245 cells/l and the lowest at Saint Martin's Island about 1250 cells/l. Phytoplankton showed complete dominance of diatom genera namely *Asterionella japonica* & *Thalassionema nitzschiodes* in post-monsoon and *Odontella rhombus* in pre-monsoon. Other frequently occurring diatoms were *Coscinodiscus perforatus*, *Actinocyclus normanii, Thalassiothrix fraunfeldii, Ditylum brightwelli, Rhizosolenia alata, Chaetoceros affinis, Thalassionema nitzschoides* etc. respectively. Species diversity was observed to be maximum in post-monsoon (67 species) followed by pre-monsoon (42 species) and monsoon season (28 species). The average annual environmental variables values among the stations were salinity (27.09±2.27 PSU); water temperature (27.22±0.40 ºC); DO (4.78±0.15 mg/l); TDS (21.33±1.93 g/l); Conductivity (41.40±3.49 mS/cm); Transparency (3.09±2.02 ft); Rainfall (87±0.00 mm); NO_3-N (0.38±0.07 mg/l); PO_4-P (0.07±0.01 mg/l); SiO_4 (0.06±0.01 mg/l) respectively. Correlation studies of phytoplankton composition to physicochemical variables indicated significant negative relation with water temperature, salinity and pH but positive relation with nitrate, nitrite, silicate and phosphate of the water body. Nitrate was found to be the limiting factors for phytoplankton growth during pre-monsoon periods whereas, the role of silicate and phosphate remained insignificant in these perspectives.

Keywords: Phytoplankton assemblages, environmental variables, nutrients, Coastal Area

Introduction
The base of the marine food web is phytoplankton which are transferring energy from one trophic level to higher trophic level. Phytoplankton are playing an important role in regulating energy export in marine ecosystems. The abundance, distribution, diversity and growth of plankton composition depend on the availability of inorganic nutrients (Nitrate, Nitrite, Silicate, Phosphate) and hydrological factors of the coastal waters. Comparing to other marine regions, phytoplankton are considerably understudied in the Bay of Bengal [19]. The availability of nutrient & phytoplankton diversity in the marine has a great influence for the functioning of oceanic ecosystem through cycling of nutrient, productivity & carbon export [23]. The potential fertility of coastal waters is depending on availability of nutrients and this nutrient enhances the species composition, abundance and richness rates of primary production [26].

Phytoplankton are contributing about ninety percent of the total marine primary production [49]. The hydrological process is directly influencing the primary productivity and determining the phytoplankton's distribution [12]. Inorganic nutrients are taking part a leading role in phytoplankton abundance, diversity & growth performance [45, 18]. The species composition and abundance of phytoplankton determine the zooplankton diversity which are directly affects the fish production [48].

The variability in primary production influenced the fishery production which has a strong link between phytoplankton and fisheries variability [3, 8]. There are several previous studies which indicated that nitrogen-limitation is a widespread phenomenon in tropical coastal waters of Bay of Bengal [47, 22, 34].

Phytoplankton dynamics has a complex interrelationship among physical, chemical and biological processes [9]. Over the last few decades different authors are interested to study the influencing factors of phytoplankton communities with special relation to physico-chemical parameters [36, 21, 16]. Nutrient relationship engaged with the successional pattern of phytoplankton communities which are helps to understand ecosystem functioning [33, 4]. Different authors have been done their studies about the nutrient dynamics of the Bay of Bengal coastal waters such as [40, 17]. Diatom bloom formation has been recorded along the Orissa coast [52]. To understand the ecosystem dynamics, need the knowledge of primary production, nutrient concentration level with community structure of phytoplankton [5]. Nutrient concentrations in the coastal water column are coming from rivers, industrial & municipal effluents plant, sediment regenerations and atmospheric deposition [50]. N:P ratio always used to predict the species composition, abundance and assemblages of phytoplankton which also helps to understand the fishery productivity and health of the coastal ecosystem [29]. Nitrate or phosphate or both are primary nutrients controlling phytoplankton production. Nitrate is the principal nutrient in limiting phytoplankton growth in South Pacific subtropical realm [14], South China Sea [10], however, phosphorus limited growth occurs in the northwest Mediterranean [60] and East China Sea [68]. Nitrogen and phosphorus may control phytoplankton production in Daya Bay [65], Taiwan Strait [66], and specific areas in the Yellow and East China Sea [32]. Nutrient functionality significantly assessing the diversity of phytoplankton. Proper attention is needed in every aspect of exploration & exploitation of marine plankton as well as fishery production. According to the ecologically important for fishery and other marine product harvesting, extensive research on phytoplankton assemblages in relation to nutrient dynamics are still lacking. Considering these, the present study will be conducted to understand the role of available inorganic nutrients in controlling the abundance and structure of plankton populations as well as for availability of fishery resources along the south eastern coast of Bangladesh. Compared to the other parts of Bay of Bengal the south eastern coast of Bangladesh is comparatively less studied from this perspective.

2. Objective of the Research Project

The specific objectives of the study

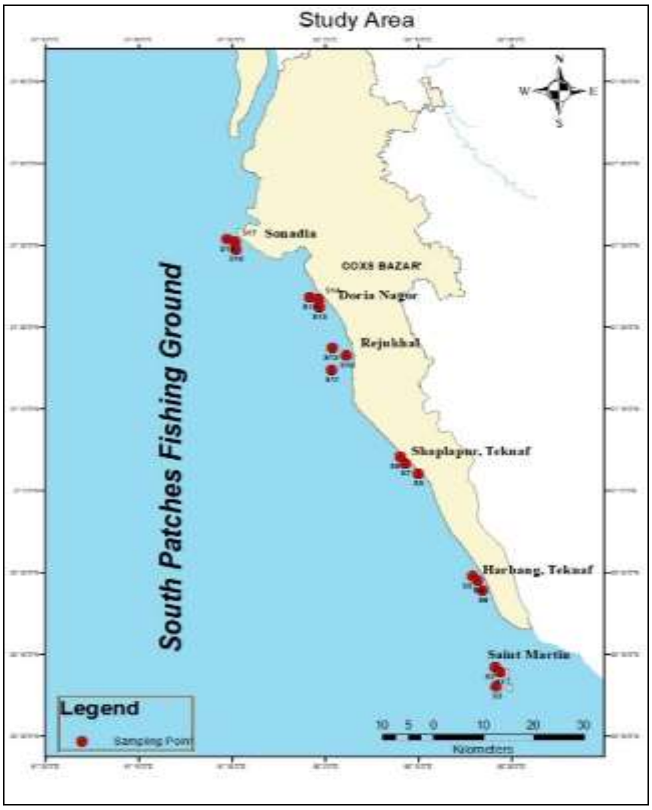
- To determine the environmental variables (Salinity, P^H, DO, Conductivity, Transparency, TDS, Temperature, PO_4-P, NO_3-N, NO_2-N & SiO_3-Si) concentration of the study area
- To identify the phytoplankton composition of the study area

To assess the influence of environmental variables on phytoplankton composition of the study area.

3. Materials and Methods

3.1 Study Area

South eastern coastal area is a unique marine environment, rich in biodiversity and is rightly referred as biologist's paradise which is elongated from Teknaf peninsula to Cox's Bazar. The coast of Cox's Bazar has freshwater influx primarily from the Bakkhali, Matamuhuri, Naf river and other hilly areas mainstream systems, but many other sources also significantly contribute carbon and nutrient to the coast and influence the coastal water quality. There are 10 sampling transects selected namely Saint Martin's Island, Naf River, Teknaf, Shaplapur, Rezukhal, Himsori, Cox's Bazar, Sonadia, Maheshkhali & Bakkhali coastal area (A, B, C, D, E, F, G, H, I, J) for determination of environmental variables & phytoplankton sampling respectively. Three seasons viz: i. monsoon (June- September), ii. Post-monsoon (October-January) and iii. Pre-monsoon (February - May) are observed in this area. As much as about 80% of total rainfall occurs during monsoon period.



3.2 Estimation of Water Analysis

Water samples were collected every month from the Ten stations for a period of one year during July, 2020 to June, 2021. Surface water samples were collected with a sterilized plastic bottle and immediately keep in an ice box and transport to the laboratory for determining the physical and chemical parameters. Water temperature were measured by using Hanna HI98194 multimeter. Salinity was measured by using a hand-held refractometer (Atago hand refractometer, Japan) and YSI ProDSS portable multimeter. Water Transparency was measured insitu condition by using Secchi Disk. Total dissolved solids, Salinity, pH and electrical conductivity were analyzed by using Hanna HI98194 multimeter and YSI portable multimeter and dissolved oxygen (DO) was estimated by the modified Winkler's method [54].

3.3 Nutrients Estimation Method

To determine the abundance and distribution of inorganic nutrients of the south eastern coastal area, surface seawater samples were collected in 1 L pre cleaned polythene bottles at monthly for 1 year. Samples were collected at early morning of the day between 6 a.m. and 9 a.m. 1.5 L capacity based Niskin water sampler was used to collect the water sample and then transferred to the pre cleaned polythene bottles to estimate the nutrients. Collected water samples was immediately keep in icebox and transfer to the testing room for the additional scrutinized. The water samples were filtered applying a Millipore filtering system along whatman membrane filter paper of 0.45 µ porosity. The quantity of the dissolved nutrients of Nitrite-N, Nitrate-N, Phosphate-P, Silicate-Si present in the filter water samples were determined following the standard methods as described by [54] through Shimadzoo-1800 Double Beam Spectrophotometer.

3.4 Enumeration of Phytoplankton

For qualitative analysis of phytoplankton, 1 litre of surface (0.5m depth) seawater samples were taken in transparent bottle and fixed with 2% Lugol's iodine solution. For the quantitative analysis, followed the settling method as detailed [57]. Phytoplankton samples were also taken by towing plankton net which 0.30m open diameter making of bolting silk about 45µm. These samples were preserved in 4 % neutralized formalin and used for qualitative analysis and species level identification. For microscopic investigation, samples were concentrated 5 to10 ml by siphoning out the top layer with a silicon tube enclose with a 10 µm Nytex filter. The required sample concentrates were transferred to a 1 ml capacity Sedgwick-Rafter counter and counted using an Olympus Research Grade Microscope (Model: BX-53) at 100× magnification. Taxonomic identification of the micro phytoplankton was done using appropriate monographs [64, 11, 55, 56, 67, 62, 15, 1, 43, 59, 63, 38, 61].

The total number of phytoplankton present in 1Lwater sample was calculated using the formula

$$N= (n \times v) / V$$

where N = total number of phytoplankton cells in 1 L water (cells/l); n = average number of phytoplankton cells in 1 ml plankton sample; v = volume of plankton concentrates (ml); and V = volume of total water filtered (L).

The Shannon and Weaver [58] formula was used for calculating the species diversity index (H). For calculating the species richness (SR) was followed Gleason [24] method. The evenness index (J') was used the formula of Pielou [41]. The Mc Naughton [35] formula was used for calculating the dominance index. For statistical analysis as like as clustering and principal component analysis (PCA) along with simple correlation were accomplished by applying XLSTAT software.

4. Results

South eastern coastal area of the Bay of Bengal, Bangladesh is eutrophication prone area which directly influence on phytoplankton abundance, distribution and community structure. In dry season due to lower rainfall, high temperature, nutrients availability and high radiation of sun light phytoplankton bloom are occurring frequently in these regions which are concern for coastal aquatic ecosystem. Moreover, the monsoon rain causes major changes in salinity level for 4 months (June–September). The sandy coast along with rough waves resulted in turbid water, therefore reducing phytoplankton growth. The study on environmental variables including inorganic nutrients and plankton assemblages were exhibited clear seasonal trend as influenced by prevailing monsoonal system along the study area. It can be inferred that fish aggregation is mostly influenced by availability of phytoplankton in the south eastern coast of Bangladesh.

4.1 Physico-chemical Parameter Analysis

4.2 Status of Sea Surface Salinity (SSS)

The seasonal variation of observed salinity values (‰) were 31±4.63 (Saint Martin), 24.47±7.02 (Naf River), 28.47±5.97 (Teknaf), 28.69±6.02 (Shamplapur), 26.35±8.41 (Rezukhal), 28.50±6.14 (Himsori), 28.36±6.24 (Cox's Bazar), 26.88±7.09 (Sonadia), 24.73±8.34 (Maheshkhali); 23.35±9.62 (Bakkhali) respectively (Table-2). The maximum salinity was recorded in Saint Martin's Island 35.01±0.44‰ during Pre-monsoon season and the minimum was recorded in Bakkhali 10.16±6.05‰ during Monsoon season.

4.3 Status of Sea Surface Temperature (SST)

The seasonal variation of the coastal water temperature (°C) values were 27.49±1.01 (Saint Martin), 26.22±1.63 (Naf River), 27.30±1.27 (Teknaf), 27.40±0.87 (Shaplapur), 27.06±1.51 (Rezukhal), 27.07±1.60 (Himsori), 26.97±1.53 (Cox's Bazar), 27.56±1.24 (Sonadia), 27.63±1.29 (Maheshkhali); 27.47± 1.47 (Bakkhali) respectively (Table-2). The maximum temperature (28.53°C±2.32°C) was recorded in Rezukhal during pre-monsoon and minimum 24.83°C±2.63°C was recorded at Himsori during post monsoon season.

4.4 Status of Water pH

The seasonal variation of observed pH values was 8.02± 0.14 (Saint Martin), 7.93± 0.11 (Naf River), 7.90± 0.14 (Teknaf), 8.01± 0.13 (Shaplapur), 7.87± 0.20 (Rezukhal), 7.96± 0.14 (Himsori), 7.94± 0.12 (Cox's Bazar), 7.95± 0.08 (Sonadia), 7.88± 0.08 (Maheshkhali) & 7.81±0.21 (Bakkhali) respectively (Table-2). The maximum pH was recorded in Saint Martin's Island 8.13±0.01 during Pre-monsoon season and the minimum was recorded in Bakkhali 7.51±0.06 during Monsoon season.

4.5 Status of Dissolved Oxygen (DO)

The seasonal variation of observed Dissolved Oxygen (mg/l) values were 5.02±0.19 (Saint Martin); 4.67±0.16 (Naf River); 4.51±0.13 (Teknaf); 4.80±0.18 (Shaplapur); 4.57±0.16 (Rezukhal); 4.78±0.06 (Himsori); 4.81±0.11 (Cox's Bazar); 5.00±0.12 (Sonadia); 4.80±0.11 (Maheshkhali) & 4.71±0.26 (Bakkhali) respectively (Table-2). The maximum Dissolved Oxygen was recorded in Saint Martin Island 5.24±0.23 mg/l during post-monsoon season and the minimum was recorded in Rezukhal 4.35±0.27 mg/l during Monsoon season.

4.6 Status of Electric Conductivity

The seasonal variation of observed electric conductivity (mS/cm) values were 48.20± 6.84 (Saint Martin); 37.67±11.61(Naf River); 43.02±9.76 (Teknaf); 43.87±9.31 (Shaplapur); 39.99±12.95 (Rezukhal); 43.66±9.02 (Himsori); 43.25±9.27 (Cox's Bazar); 40.61± 11.07 (Sonadia); 37.66±12.76 (Maheshkhali) & 36.11±14.91 (Bakkhali) respectively (Table-2). The maximum EC was recorded in Saint Martin Island 54.11± 0.40 mS/cm during Pre-monsoon season and the minimum was recorded in Bakkhali 15.42±9.16 mS/cm during Monsoon season.

4.7 Status of Total Dissolved Solids (TDS)

The investigated coastal water TDS (g/l) values were

24.86±2.91 (Saint Martin), 19.78±5.15 (Naf River); 22.49±3.76 (Teknaf); 22.74±3.97 (Shaplapur); 20.38±5.72 (Rezukhal); 22.58±3.57 (Himsori); 22.20±3.65 (Cox's Bazar); 21.13±4.51 (Sonadia); 19.17±5.89 (Maheshkhali) & 18.00±7.28 (Bakkhali) respectively (Table-2). The maximum TDS 27.47±0.25 (g/l) was recorded in Teknaf during pre-monsoon and minimum 7.90±6.02 (g/l) recorded in Bakkhali during monsoon season.

4.8 Status of Water Transparency

The seasonal variation of observed transparency values(ft) was 9.01±3.57 (Saint Martin); 3.55±0.72 (Naf River), 1.85±0.34 (Teknaf); 1.84±0.32 (Shaplapur); 2.62±0.89 (Rezukhal); 2.57±0.85 (Himsori), 2.54±0.82 (Cox's Bazar), 2.40±0.80 (Sonadia); 2.29±0.73 (Maheshkhali) & 2.27±0.77 (Bakkhali) respectively (Table-2). The maximum Transparency was recorded in Saint Martin 13.48±1.30 ft during post-monsoon season and the minimum was recorded in Bakkhali 1.21± 0.52 ft during Monsoon season.

4.9 Status of Rainfall

The seasonal variation of observed rainfall (mm) value was 87.58±94.02 (Table-2). The maximum rainfall was recorded in Teknaf 220.50±77.86 mm during monsoon season and the minimum was recorded in Bakkhali 18.04±19.30 mm during Pre-Monsoon season.

4.10 Nutrients Analysis

Nutrients (NO_3-N, NO_2-N, PO_4-P: SiO_4) are the necessary parameters within the coastal waters that influence the growth, reproduction and metabolic activities of biotic components like phytoplankton.

4.11 Status of NO_3-N

The seasonal variation of observed NO_3-N (mg/l) values were 0.19±0.03 (Saint Martin); 0.41±0.05 (Naf River); 0.37±0.03 (Teknaf); 0.40±0.05 (Shaplapur); 0.41±0.04 (Rezukhal); 0.39±0.03 (Himsori); 0.37±0.03 (Cox's Bazar); 0.38±0.03 (Sonadia); 0.46±0.04 (Maheshkhali) & 0.45±0.05 (Bakkhali) respectively (Table-2). The maximum NO_3-N was recorded in Rezukhal coastal area 0.51± 0.03 mg/l during post-monsoon season and the minimum was recorded in Saint Martin's Island 0.16±0.01 mg/l during pre-monsoon season.

4.12 Status of NO_2-N

The seasonal variation of observed NO_2-N (mg/l) values were 0.06±0.01 (Saint Martin); 0.09±0.03 (Naf River); 0.07±0.01 (Teknaf); 0.08±0.02 (Shaplapur); 0.09±0.02 (Rezukhal); 0.08±0.02 (Himsori); 0.08±0.01 (Cox's Bazar); 0.08±0.01 (Sonadia); 0.09±0.02 (Maheshkhali) & 0.09±0.02 (Bakkhali) respectively (Table-2). The maximum NO_2-N was recorded in Rezukhal coastal area 0.09± 0.03 mg/l during Monsoon season and the minimum was recorded in Saint Martin's Island 0.06±0.01 mg/l during pre-monsoon season.

4.13 Status of PO_4-P

The seasonal variation of observed PO_4-P (mg/l) values were 0.05±0.01 (Saint Martin); 0.08±0.02 (Naf River); 0.06±0.01 (Teknaf); 0.08±0.03 (Shaplapur); 0.08±0.02 (Rezukhal); 0.08±0.02 (Himsori); 0.06±0.01 (Cox's Bazar); 0.07±0.02 (Sonadia); 0.08±0.02 (Maheshkhali) & 0.08±0.01 (Bakkhali) respectively (Table-2). The maximum PO_4-P was recorded in Rezukhal coastal area 0.11± 0.01 mg/l during Monsoon season and the minimum was recorded in Saint Martin's Island 0.03±0.01 mg/l during pre-monsoon season.

4.14 Status of SiO_4

The seasonal variation of observed SiO_4 (mg/l) values were 0.03±0.01 (Saint Martin); 0.06±0.02 (Naf River); 0.06±0.02 (Teknaf); 0.06±0.01 (Shaplapur); 0.07±0.01 (Rezukhal); 0.06±0.01 (Himsori); 0.06±0.01 (Cox's Bazar); 0.06±0.01 (Sonadia); 0.08±0.02 (Maheshkhali) & 0.07±0.02 (Bakkhali) respectively (Table-2). The maximum SiO_4 was recorded in Naf River 0.09± 0.02 mg/l during Monsoon season and the minimum 0.03± 0.01 mg/l in Saint Martin's Island.

5. Phytoplankton Composition

A total of 137 phytoplankton species were identified whereas, 115 species of diatoms from 44 genera, 15 species of dinoflagellates from 8 genera, 2 species of green algae from 2 genera, 4 species of cyanobacteria from 3 genera and 1 species of silicoflagellate were identified (Table-1). The present study revealed that phytoplankton communities were found to vary from stations to stations and season to season due to the influence of environmental variables. The highest phytoplankton abundance was found at Shaplapur, about 12245 cells/l and the lowest at Saint Martin's Island about 1250 cells/l. Phytoplankton showed complete dominance of diatom genera namely *Asterionella japonica* & *Thalassionema nitzschiodes* in post-monsoon and *Odontella rhombus* in pre-monsoon. Other frequently occurring diatoms were *Coscinodiscus perforatus*, *Actinocyclus normanii*, *Thalassiothrix fraunfeldii*, *Ditylum brightwelli*, *Rhizosolenia alata*, *Chaetoceros affinis*, *Thalassionema nitzschoides* etc. respectively. Species diversity was observed to be maximum in post-monsoon (67 species) followed by pre-monsoon (42 species) and monsoon season (28 species). Abundance of bloom forming species *Asterionellopsis glacialis* & *Thalassionema nitzschiodes* was observed at Shaplapur and Rezukhal coastal area during the study period. Suitable environmental conditions in post monsoon contributed towards increasing the number of phytoplankton with reported diversity of 65 species compared to the monsoon season (28 species). High density of diatom species, i.e., *Pseduonitzschia pungens* and *Thalassiothrix frauenfeldii* in post monsoon and *Thalassionema nitzschioides*, *Asterionellopsis glacialis* and *Chaetoceros* sp. in pre-monsoon could be the reason for low silicate concentration due to increase in the uptake rate by diatoms.

6. Discussion

Salinity acts as a vital factor among environmental parameters in distribution of living organisms to the earnest coastal water. Fluctuations in salinity affect fauna of the coastal areas and determine the succession of species and it has a high influence on the marine environment of the Bay of Bengal. The ascertained higher values might be attributed to the low quantity of rainfall, higher rate of evaporation and additionally as a result of neritic water dominance [6]. Observations just like to present study were reported earlier by Palpandi [44] in Vellar estuary. The variability of salinity indicates the upright mixing of the water column due to the nature of the sea-tide seasonally. Salinity demonstrates the negative liaison with phytoplankton biota, whereas Dissolved Oxygen (DO) indicates the symmetry between respiration and photosynthesis and exposed a positive liaison [7]. Salinity acts as a limiting factor in the distribution of living organisms, and its variation caused by dilution and evaporation is most likely to influence the fauna in the intertidal zone [19].

The water temperature is important for its effects on the chemistry and biological activities of organisms in water. Generally, surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters. Less solar radiations with misty sky and moderate rainfall during the Monsoon season may greatly reduce the water temperature [30]. Higher temperature values recorded in the dry season may be because of heat raising temperature of surface water. Low temperature in post monsoon season was due to winter [13].

The pH value depends upon the salinity and temperature of the water and the climatic conditions present in that area. The chemical and biological condition of water also places a role in the control of pH concentrations. The lower pH observed during the month of June to September due to the influence of fresh water, dilution of seawater, low temperature and organic matter decomposition as suggested by Ganesan [20]. Generally, fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, low primary productivity, reduction of salinity and temperature and decomposition of organic materials as stated by Rajasegar [46]. High pH values observed may cause sea water deprivation and high-density phytoplankton effect [42].

Dissolved oxygen (DO) is one of the most important indicators of water quality. Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. Salty water holds less oxygen than fresh water. Anitha [2] has also made similar observations in Thengapattanam estuary and Tamil Selvan *et al*., 2016 has also made similar observations in Adayar estuary.

The conductivity of water is affected by the suspended impurities and also depends up on the number of ions in the water. The present study agrees with earlier reported by Surana [51]. High conductivity during post monsoon might be attributed to low mixing of fresh water input from river. Low value during monsoon season was due to rain and mixing of more fresh water from river. The conductivity values decreased with an increase in rainfall. In the rainy season, the increased volume of water remarkably diluted the water [28].

Total dissolved solids (TDS) include all of the disassociated electrolytes that make up salinity concentrations, as well as other compounds such as dissolved organic matter. The amount of total dissolved solids in sea water was increased by the influence of activities on the land. TDS can be influenced by changes in pH. Changes in the pH will cause some of the solutes to precipitate or will affect the solubility of the suspended matter. TDS value was higher during pre-monsoon and lower during monsoon. The mean values for the total dissolved solids (TDS) were higher in dry season than in the rainy season. The lower values of this parameter suggest that the runoff water only contributes to its dilution in the rainy season [28]. Water with a high total dissolved solids indicated more ionic concentration, which is of inferior palatability and can induce an unfavorable physicochemical reaction in the consumers. Kataria [31] reported that increase in value of TDS indicated organic loading by extraneous sources.

Water transparency is a key factor in ocean ecology as the sun is source of energy for all biological phenomena. Transparency reduction is due to the presence of particles in the water. When light attenuates, it alters or limits the capacity of life of some of the biological communities that live in the sea. Water transparency is approached by Secchi depth. Water transparency serves as an index for the trophic state of a water body. It reflects eutrophication through changes in the phytoplankton abundance; increase in the ambient nutrient status in the water leads to higher phytoplankton biomass that diminishes the propagation of light in the water. The rainfall in Bangladesh varies, depending upon season and location. Rainfall has an important effect on the chemistry and biological activities of organisms in the coastal water.

Distribution of nutrients is principally supported season, tidal conditions, fresh water influx and land runoff, chemical effluents and flushing of chemical employed in the agricultural fields. The most explanation for eutrophication involves the enrichment of water by excess nutrients. This study revealed that the minimum concentrations of nutrients observed during pre-monsoon and maximum concentrations of nutrients observed during post-monsoon. Nitrate is one of the great indicators for determination of water quality which shows the topmost oxidized form of nitrogen. Its plays a vital role in strengthening the aquatic life in coastal ecosystem. The low nitrate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations. The present study agrees earlier reported by Hari Muraleedharan [25] in Thondi coastal water.

Nitrite is also one of the great indicators for determination of water quality. Its plays a vital role in strengthening phytoplankton in marine ecosystem. The nitrite content was fluctuated among the Transects as well as the months. The low nitrite content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations. The present study agrees earlier reported by Hari Muraleedharan [25] in Thondi coastal water.

Phosphate concentration is helpful index of eutrophication within the coastal water. The phosphate content was fluctuated among the Transects as well as change with season. The low phosphate content encountered may be due to the less usage of nitrogen fertilizers and less disposal of wastes around these stations. The present study agrees earlier reported by Hari Muraleedharan [25] in Thondi coastal water. The discovered high Monsoonal phosphate value might be due to the regeneration and release of total phosphorus from bottom mud in to the water column by turbulence and mixing [56]. Similarly, maximum value in Monsoon and minimum value in Pre-Monsoon season were also document from Tranquebar - Nagappattinam coast [53] in Vellar estuary.

Silicon in sea water may be present in suspension, in particles of clay or sand, as a constituent of diatoms, etc., or in solution. Some silicon in solution occurs in the form of silicate. Silicate minerals rapidly release silica to sea water. Biogenic silica is produced by siliceous organisms in the photic layer. Maximum value recorded in Monsoon season due to significant flow of monsoonal fresh water derived from land drainage carrying silicate leached out from rocks and sediment have been exchanged with superimposed water within the coastal environment [34]. The low value of silicate recorded during post-monsoonal season could be attributed to uptake of silicates by phytoplankton for their biological activity [40]. Similar maximum value in Monsoon and minimum in summer season were additionally recorded by Nair [37] in Ashtamudi estuary.

The knowledge of phytoplankton spatial variations of primary production, nutrient concentration and community structure is fundamental for the understanding of ecosystem dynamics. Nutrients play an important role in phytoplankton growth and distribution. Nitrogen availability increased phytoplankton number and growth during post monsoon at Shaplapur & Teknaf coastal water. On the other hand, the result reflects silicate limitation in Cox's Bazar coastal water. High water transparency, moderate salinity, availability of nitrate and comparatively high N: Si: P ratio resulted in high phytoplankton density and diversity during post monsoon season. High dissolved oxygen level indicates high productivity, and in the present study maximum photosynthetic activity was observed in Post monsoon season with increase in dissolved oxygen concentration. In this study, however, phytoplankton population differed quite significantly with the seasons and there was a drastic decrease of the population in monsoon due to water turbidity. Low phytoplankton cell count in monsoon season could be attributed to rough sea conditions leading to upwelling caused conditions of the Bangladesh coast by cyclonic weather. Single species abundance of *Asterionella japonica* & *Asterionellopsis glacialis* were observed from very beginning of post monsoon with a maximum growth rate and create phytoplankton blooming condition consequently. *Odontella* sp. and *Coscinodiscus* sp. appeared as the most abundant species in monsoon season with a maximum growth rate of the total population. Among the other genera sudden appearance of *Skeletonema costatum* was remarkable in the pre monsoon contributing a handsome rate of total population, whereas *Thalassionema nitzschiodes* appeared as 78% of the flora in the month of March 2021

Table 1: Phytoplankton Composition along the study area

SI	Name of Phytoplankton with Taxon
	Class: Bacillariophyceae (Diatom)
1	*Asterionella japonica* Cleve in Cleve & Moller 1882
2	*Asterionellopsis glacialis* (Castracane) Round,1990
3	*Actinocyclus normanii* (Juhl.-Dannf.) Hust 1957
4	*Actinocyclus octonarius* Ehrenberg 1837
5	*Asterolampra marylandica Ehrenberg 1844*
6	*Amphiprora gigantea* var. sulcate (O'Meara) cleve 1894
7	*Biddulphia alternans* (Bailey) Van Heurck 1885
8	*Bacteriastrum shadbolt 1854*
9	*Bacteriastrum hyalinum Lauder 1864*
10	*Bacillaria paxillifer* (O. F. Muller) T.Marsson1901
11	*Cylindrotheca closterium* Reimann & Lewin 1964
12	*Coscinodiscus gigas* Ehrenberg 1841
13	*Coscinodiscus centralis* Ehrenberg 1844
14	*Coscinodiscus eccentricus* Ehrenberg 1841
15	*Coscinodiscus perforatus* Ehrenberg 1844
16	*Coscinodiscus marginatus* Ehrenberg 1843
17	*Coscinodiscus wailesii* Gran et 1937
18	*Coscinodiscus oculus* Ehrenberg 1840
19	*Coscinodiscus radiatus* Ehrenberg 1840
20	*Coscinodiscus sp.* Ehrenberg,1839
21	*Coscinodiscus granii* Gough 1905
22	*Coscinodiscus alchetron* Ehrenberg 1841
23	*Cerataulina pelagica* (Cleve) Hendey,1937
24	*Chaetoceros aequatorialis* Cleve 1901
25	*Chaetoceros wighamii* Brightwell 1856
26	*Chaetoceros curvisetus* Cleve1889
27	*Chaetoceros danicus* Cleve 1889
28	*Chaetoceros decipiens* Cleve 1873
29	*Chaetoceros didymus* Gran & yendo, 1914
30	*Chaetoceros similis* Cleve 1896
31	*Chaetoceros diversus* Cleve 1873
32	*Chaetoceros affinis* Lauder 1864
33	*Chaetoceros brevis* F. Schütt 1895
34	*Chaetoceros eibenii* Grunow 1882
35	*Chaetoceros lauderi* Ralfs ex Lauder 1864
36	*Chaetoceros socialis* H.S. Lauder, 1864
37	*Chaetoceros denticulatus* H.S. Lauder 1864
38	*Chaetoceros lorenzianus* Grunow 1863
39	*Chaeteceros diadema* (Ehrenberg) Gran 1897
40	*Ditylum brightwellii* Grunow in Van Heurck 1885
41	*Diploneis interrupta* (Kutzing) Cleve 1894
42	*Diploneis elliptica* (Kutzing) Cleve 1894
43	*Diploneis ovalis* (Hilse) Cleve 1891
44	*Diploneis sp.* Ehrenberg ex Cleve, 1894
45	*Diploneis weissiflogii* (A.W.F. Schmidt) Cleve 1894
46	*Eucampia zoodiacus* Ehrenberg 1839
47	*Eucampia cornuta* (Cleve) Grunow 1883
48	*Fragilariopsis oceanica* (Cleve) Hasle 1965
49	*Fragilariopsis doliolus* (Wallich) Medlin & PA Sims 1993
50	*Fragilariopsis islandica* Grunow 1880
51	*Gyrosigma acuminatum* (Kutzing) Rabenhorst 1853
52	*Gyrosigma balticum* (Ehrenberg) Rabenhorst 1853
53	*Gyrosigma fasciola* (Ehrenberg) J.W. Griffith & Henfrey 1839
54	*Guinardia delicatula* (Cleve) Hasle 1997

55	*Guinardia flaccida* (Castracane) H. Peragallo 1892
56	*Guinardia striata* (Stolterfoth) Hasle 1996
57	*Hemidiscus hardmannianus* (Greville) Mann, 1907
58	*Hemidiscus cuneiformis* Wallich 1860
59	*Hemiaulus sinensis* Greville, 1865
60	*Hyadolodiscus alchetron*
61	*Lauderia annulata* Cleve 1873
62	*Lauderia pumila* Castracane 1886
63	*Leptocylindrus danicus* Cleve 1889
64	*Leptocylindrus minimus* Gran 1915
65	*Licmophora abbreviata* C. Agardh 1831
66	*Melosira sulcate* (Ehrenberg) Kutzing 1844
67	*Mediopyxis helysia* Kuhn, Hargreaves & Halliger 2006
68	*Merismopedia sp.* Meyen, 1839
69	*Nitzschia sigma* (Kutzing) w. Smith, 1853
70	*Nitzschia seriata* Cleve 1883
71	*Nitzschia lorenziana* Grunow in Cleve & Moller 1879
72	*Nitzschia sigmoidea* (Nitzsch) W.Smith 1853
73	*Nitzschia longissimi* (Brebisson) Ralfs 1861
74	*Navicula clavata* Gregory 1856
75	*Odontella mobiliensis* (Bailey) Grunow 1884
76	*Odontella sinensis* (Greville) Grunow 1884
77	*Odontella regia* (M. Schultze) Simonsen 1974
78	*Odontella alchetron*
79	*Odontella rhombus* (Ehrenberg) Kutzing 1849
80	*Odontella aurita* (Lyngbye) C. Agardh 1832
81	*Pleurosigma angulatum* Smith, 1852
82	*Pleurosigma diversestriatum* F.Meister 1934
83	*Pleurosigma elongatum* W. Smith 1852
84	*Pleurosigma directum* Grunow in Grunow & Cleve 1880
85	*Pleurosigma normanii* Ralfs in Pritchard 1861
86	*Paralia sulcata* (Ehrenberg) Cleve 1873
87	*Proboscia alata* (Brightwell) Sundstrom 1986
88	*Proboscia indica* (H. Peragallo) Hernandez-Becerril 1995
89	*Podosira glacialis* (Grunow) Cleve 1896
90	*Podosira stelligera* (Bailey) A. Mann 1907
91	*Planktoniella sol* (Wallich) Schütt 1892
92	*Pseduonitzschia pungens* Hasle 1993
93	*Rhizosolenia curvata* Zacharias 1905
94	*Rhizosolenia robusta* G. Norman ex Ralfs 1861
95	*Rhizosolenia setigera* Brightwell 1858
96	*Rhizosolenia alata* Brightwell 1858
97	*Rhizosolenia bergonii* H. Peragallo 1892
98	*Rhizosolenia formosa* H. Peragallo 1888
99	*Rhizosolenia imbricata* Brightwell 1858
100	*Rhizosolenia* styliformis T. Brightwell 1858
101	*Stephanopyxis palmeriana* (Greville) Grunow 1884
102	*Synedra Formosa* Hantzsch 1863
103	*Skeletonema costatum* (Greville) Cleve 1873
104	*Thalassionema nitzschioides* Mereschkowsky, 1902
105	*Triceratium favus* Ehrenberg 1839
106	*Triceratium robertsianum* Greville 1863
107	*Triceratium formosum* Brightwell 1856
108	*Thalassiosira decipiens* (Grunow ex Van Heurck) Jorgensen 1905
109	*Thalassiosira pseudonana* Hasle & Heimdal 1970
110	*Thalassiosira lacustris* (Grunow)Hasle, 1977
111	*Thalassiosira sp.*
112	*Thalassiosira eccentrica* (Ehrenberg) Cleve 1904
113	*Thalassiosira rotula* Meunier, 1910
114	*Thalassiothrix frauenfeldii* (Grunow) Jorgensen 1900
115	*Thalassiothrix longissima* Cleve & Grunow 1880
Class: Diyanopyceae	
116	*Ceratium azoricum* Cleve, 1900
117	*Ceratium furca* (Ehrenberg) Lachmann 1858
118	*Ceratium macroceros* (Ehrenberg) Vanhoffen 1897
119	*Ceratium tripos* (O.F. muller) Nitzsch, 1817
120	*Dynophysis caudate* Saville-Kent 1881
121	*Noctiluca miliaris* Suriray 1816
122	*Noctiluca scntillans* Kofoid & Swezy, 1921
123	*Ornithocercus steinii* Schutt 1900
124	*Procentrum gracile* Schutt, 1895
125	*Procentrum micans* Ehrenberg 1834
126	*Pyrocystis lunula* (F.Schutt) F. Schutt in Engler & Prantl 1896
127	*Pyrocystis fusiformis* CW Thomson1876
128	*Pyrophacus steinii* Schiller 1935
GREEN ALGAE	

129	*Chlorella marina* Butcher 1952
130	*Pediastrum* sp.Meyen, 1829
Cyanobacteria (BGA)	
131	*Microcystis* sp. Lemmermann 1907
132	*Trichodesmium erythraeum* Ehrenberg 1830
133	*Oscillatoria princeps* Vaucher ex Gomont, 1822
Silicoflagellates	
134	*Dictyocha* sp. Ehrenberg 1837

Table 2: Seasonal variation of Physico-chemical Parameters of the Study Area (2020-2021 FY)

Transect	Monsoon	Post monsoon	Pre-monsoon	Avg.	STD	Monsoon	Post monsoon	Pre monsoon	Avg.	STD	Monsoon	Post monsoon	Pre monsoon	Avg.	STD	Monsoon	Post monsoon	Pre monsoon	Avg.	STD
	Salinity	Salinity	Salinity			Temp.	Temp.	Temp.			DO	DO	DO			p^H	p^H	p^H		
A	24.64	33.77	35.01	31.14	4.63	28.45	26.10	27.92	27.49	1.01	4.77	5.05	5.24	5.02	0.19	7.83	8.11	8.13	8.02	0.14
B	16.46	23.46	33.51	24.47	7.00	24.70	25.48	28.48	26.22	1.63	4.56	4.89	4.55	4.67	0.16	7.78	7.96	8.05	7.93	0.11
C	20.10	31.69	33.63	28.47	5.97	28.00	25.52	28.37	27.30	1.27	4.40	4.69	4.44	4.51	0.13	7.89	7.74	8.08	7.90	0.14
D	20.23	32.15	33.7	28.69	6.02	27.77	26.20	28.245	27.40	0.87	4.57	5.00	4.825	4.80	0.18	7.81	8.11	8.06	8.00	0.13
E	14.46	31.92	32.67	26.35	8.41	27.65	24.99	28.53	27.06	1.51	4.35	4.65	4.73	4.57	0.16	7.59	8.07	7.95	7.87	0.20
F	19.90	31.75	33.86	28.50	6.14	28.03	24.82	28.37	27.07	1.60	4.71	4.80	4.84	4.78	0.06	7.76	8.07	8.04	7.96	0.14
G	19.63	31.58	33.86	28.36	6.24	27.81	24.83	28.27	26.97	1.53	4.65	4.86	4.90	4.81	0.11	7.77	8.06	7.98	7.94	0.12
H	16.97	30.52	33.13	26.88	7.09	28.65	25.84	28.20	27.56	1.24	4.83	5.09	5.08	5.00	0.12	7.84	7.98	8.03	7.95	0.08
I	13.30	27.93	32.96	24.73	8.34	28.73	25.82	28.34	27.63	1.29	4.65	4.89	4.85	4.80	0.11	7.78	7.88	7.98	7.88	0.08
J	10.16	27.02	32.86	23.35	9.62	28.63	25.40	28.37	27.47	1.47	4.43	4.95	4.98	4.79	0.26	7.51	7.95	7.97	7.81	0.21

Table 2: Cont…

Trnascet	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD
	TDS	TDS	TDS			Conductivity	Conductivity	Conductivity			Transparency	Transparency	Transparency			Rainfall	Rainfall	Rainfall		
A	20.80	26.31	27.47	24.86	2.91	38.62	51.89	54.105	48.20	6.84	4.73	13.48	8.82	9.01	3.57	220.50	24.25	18	87.58	94.02
B	13.96	18.91	26.48	19.78	5.15	24.02	36.62	52.39	37.67	11.61	4.38	3.63	2.63	3.55	0.72	220.50	24.25	18	87.58	94.02
C	17.37	23.81	26.29	22.49	3.76	29.37	48.05	51.62	43.02	9.76	1.44	2.28	1.81	1.85	0.34	220.50	24.25	18	87.58	94.02
D	17.27	24.37	26.58	22.74	3.97	30.90	48.38	52.33	43.87	9.31	1.45	2.24	1.84	1.84	0.32	220.50	24.25	18	87.58	94.02
E	12.29	24.38	24.48	20.38	5.72	21.68	48.79	49.50	39.99	12.95	1.45	3.61	2.80	2.62	0.89	220.50	24.25	18	87.58	94.02
F	17.57	24.50	25.67	22.58	3.57	30.95	49.15	50.89	43.66	9.02	1.39	3.37	2.94	2.57	0.85	220.50	24.25	18	87.58	94.02
G	17.16	23.76	25.69	22.20	3.65	30.20	48.73	50.83	43.25	9.27	1.42	3.36	2.85	2.54	0.82	220.50	24.25	18	87.58	94.02
H	14.81	23.58	25.01	21.13	4.51	25.00	47.40	49.43	40.61	11.07	1.30	3.17	2.73	2.40	0.80	220.50	24.25	18	87.58	94.02
I	11.09	21.44	24.98	19.17	5.89	20.00	43.24	49.73	37.66	12.76	1.29	3.02	2.57	2.29	0.73	220.50	24.25	18	87.58	94.02
J	7.91	21.29	24.81	18.00	7.28	15.40	43.03	49.90	36.11	14.91	1.21	2.98	2.63	2.27	0.77	220.50	24.25	18	87.58	94.02

N.B: Transect-A (Saint Martin's Island); Transect- B (Naf River); Transect-C (Teknaf); Transect-D (Shamplapur); Transect-E (Rezukhal) Transect-F (Himsori); Transect-G (Cox's Bazar), Transect-H (Sonadia); Transect-I (Maheshkhali); Transect-J (Bakkhali)

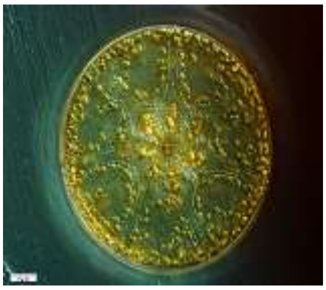
Table 2: Cont…

Trnascet	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD	Monsoon	Post monsoon	Pre monsoon	avg	STD
	NO_3-N	NO_3-N	NO_3-N			NO_2-N	NO_2-N	NO_2-N			PO_4-P	PO_4-P	PO_4-P			SiO_4	SiO_4	SiO_4		
A	0.18	0.23	0.16	0.19	0.03	0.07	0.06	0.04	0.06	0.01	0.06	0.04	0.03	0.05	0.01	0.04	0.03	0.04	0.03	0.01
B	0.42	0.47	0.34	0.41	0.05	0.12	0.08	0.05	0.09	0.03	0.11	0.08	0.06	0.08	0.02	0.09	0.06	0.050833	0.06	0.02
C	0.34	0.41	0.35	0.37	0.03	0.09	0.07	0.059	0.07	0.01	0.08	0.06	0.05	0.06	0.01	0.06	0.04	0.08	0.06	0.02
D	0.34	0.45	0.39	0.40	0.05	0.10	0.08	0.065	0.08	0.02	0.09	0.11	0.049	0.08	0.03	0.06	0.04	0.08	0.06	0.01
E	0.42	0.45	0.35	0.41	0.04	0.12	0.09	0.07	0.09	0.02	0.10	0.08	0.06	0.08	0.02	0.08	0.05	0.08	0.07	0.01
F	0.38	0.44	0.36	0.39	0.03	0.11	0.07	0.07	0.08	0.02	0.10	0.08	0.05	0.08	0.02	0.07	0.05	0.08	0.06	0.01
G	0.34	0.40	0.36	0.37	0.03	0.09	0.08	0.06	0.08	0.01	0.08	0.06	0.05	0.06	0.01	0.06	0.04	0.075833	0.06	0.01
H	0.36	0.42	0.35	0.38	0.03	0.09	0.08	0.06	0.08	0.01	0.09	0.07	0.06	0.07	0.02	0.06	0.04	0.08	0.06	0.01
I	0.44	0.51	0.43	0.46	0.04	0.11	0.09	0.07	0.09	0.02	0.11	0.06	0.06	0.08	0.02	0.08	0.05	0.09	0.08	0.02
J	0.44	0.52	0.3975	0.45	0.05	0.12	0.09	0.07	0.09	0.02	0.10	0.08	0.06	0.08	0.01	0.08	0.05	0.08	0.07	0.02

Table 3: Annual average environmental variables value (2020-2021 FY)

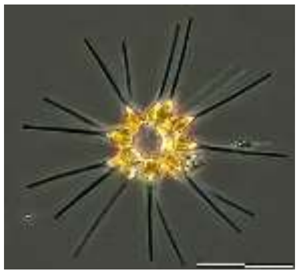
SI	Parameter	Unit	Transects Data										Avg.	SD
			A	B	C	D	E	F	G	H	I	J		
1	Salinity	PSU	31.14	24.47	28.47	28.69	26.35	28.5	28.36	26.88	24.73	23.35	27.09	2.27
2	Temperature	°C	27.49	26.22	27.3	27.4	27.06	27.07	26.97	27.56	27.63	27.47	27.22	0.40
3	DO	mg/l	5.02	4.67	4.51	4.8	4.57	4.78	4.81	5	4.8	4.79	4.775	0.15
4	PH	-	8.02	7.93	7.9	8	7.87	7.96	7.94	7.95	7.88	7.81	7.926	0.06
5	TDS	g/l	24.86	19.78	22.49	22.74	20.38	22.58	22.2	21.13	19.17	18	21.333	1.93
6	Conductivity	mS/cm	48.2	37.67	43.02	43.87	39.99	43.66	43.25	40.61	37.66	36.11	41.40	3.49
7	Transparency	Ft	9.01	3.55	1.85	1.84	2.62	2.57	2.54	2.4	2.29	2.27	3.094	2.02
8	Rainfall	Mm	87.58	87.58	87.58	87.58	87.58	87.58	87.58	87.58	87.58	87.58	87.58	0.00
9	NO_3-N	mg/l	0.19	0.41	0.37	0.4	0.41	0.39	0.37	0.38	0.46	0.45	0.38	0.07
10	NO_2-N	mg/l	0.06	0.09	0.07	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.081	0.01
11	PO_4-P	mg/l	0.05	0.08	0.06	0.08	0.08	0.08	0.06	0.07	0.08	0.08	0.072	0.01
12	SiO_4	mg/l	0.03	0.06	0.06	0.06	0.07	0.06	0.06	0.06	0.08	0.07	0.061	0.01

N.B: Transect-A (Saint Martin's Island); Transect- B (Naf River); Transect-C (Teknaf); Transect-D (Shamplapur); Transect-E (Rezukhal) Transect-F (Himsori); Transect-G (Cox's Bazar), Transect-H (Sonadia); Transect-I (Maheshkhali); Transect-J (Bakkhali)


1. *Asterolampra marylandica*


2. *Actinocyclus octonarius*


3. *Coscinodiscus oculus*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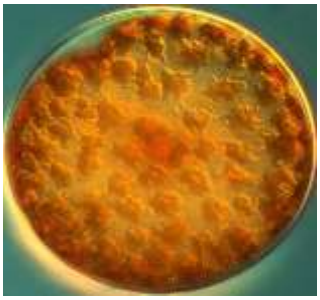
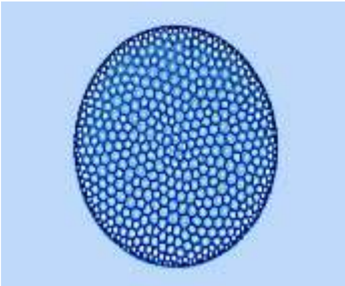
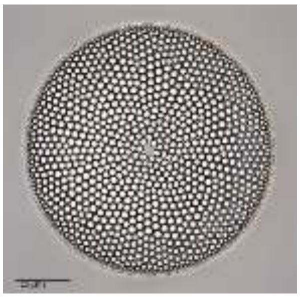
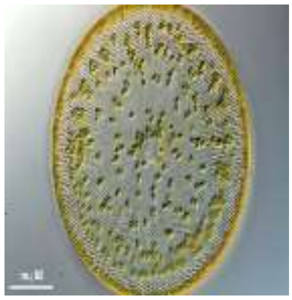
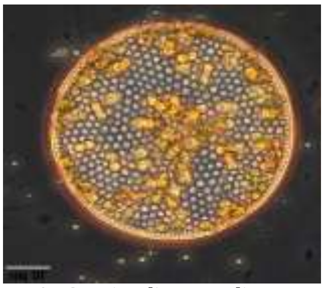

5. *Coscinodiscus centralis*

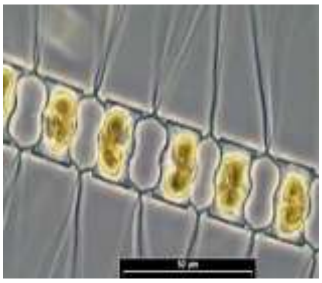

6. *Coscinodiscus marginatus*

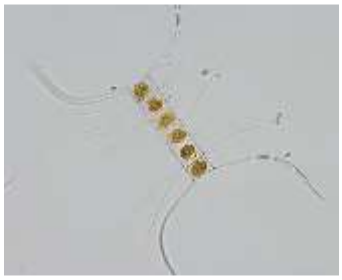

7. *Coscinodiscus perforatus*


8. *Coscinodiscus wailesii*


9. *Coscinodiscus radiatus*

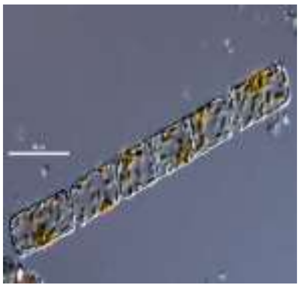

10. *Coscinodiscus granii*


11. *Chaetoceros brevis*


12. *Chaetoceros affinis*


13. *Chaetoceros decipiens*


14. *Ditylum brightwellii*

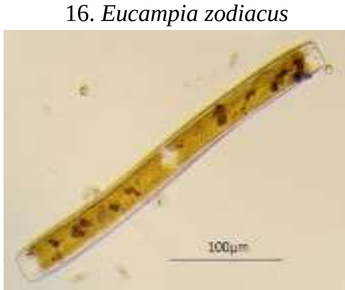

15. *Chaetoceros pelagica*


16. *Eucampia zodiacus*


17. *Ceratium macroceros*


18. *Ceratium furca*

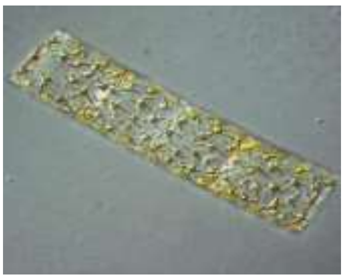

19. *Ceratium tripos*



20. *Fragilariopsis oceanica*

Fig 2: Image of Marine Phytoplankton


21. *Guinardia delicatula*


22. *Guinardia flaccida*


23. *Guinardia striata*


24. *Gyrosigma acuminatum*

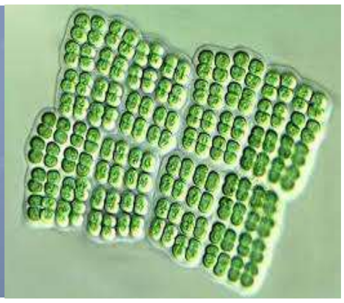

25. *Gyrosigma balticum*


26. *Hemidiscus cuneiformis*


27. *Lauderia annulata*


28. *Licmophora abbreviata*

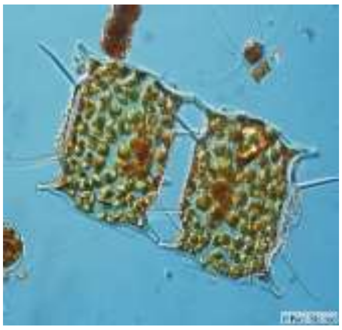

29. *Mediopyxis helysia*

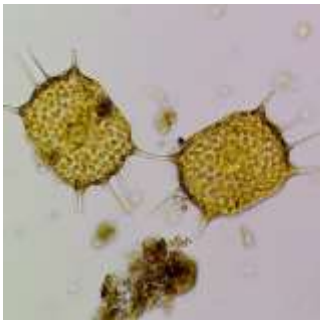

30. *Merismopedia sp.*

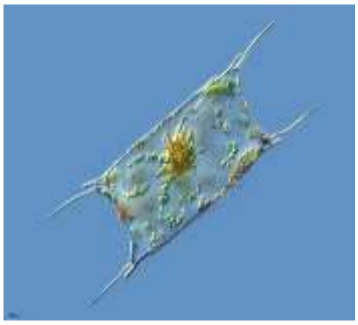

31. *Navicula clavata*


32. *Nitzschia sigma*

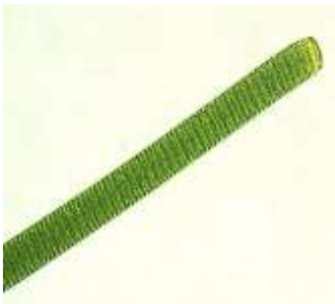

33. *Nitzschia longissimi*


34. *Odontella alchetron*


35. *Odontella mobiliensis*


36. *Odontella sinensis*


37. *Odontella steinii*

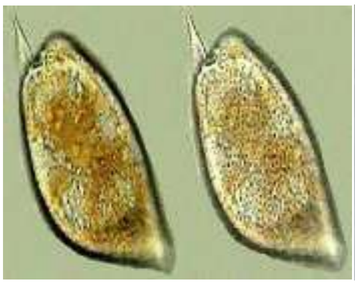

38. *Oscillatoria princeps*

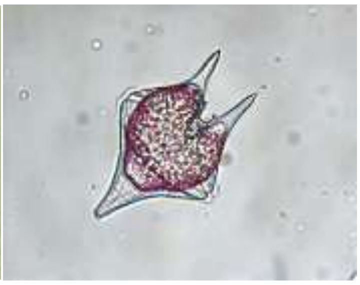

39. *Pleurosigma angulatum*


40. *Planktoniella sol*

Fig 3: Image of Marine Phytoplankton


41. *Procentrum gracile*

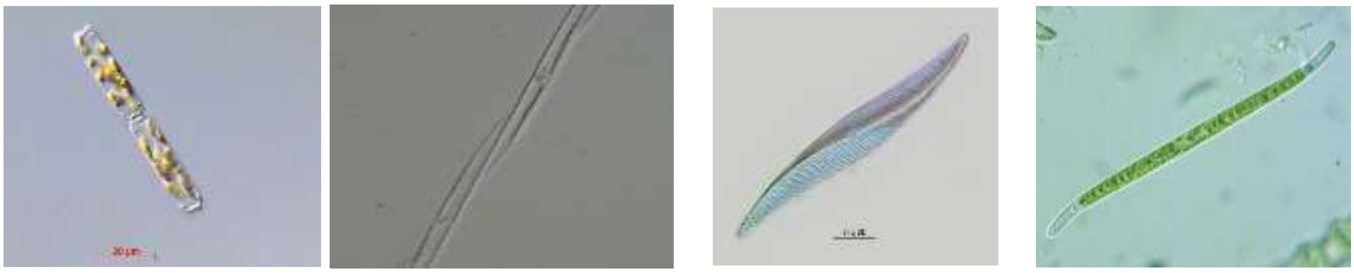

42. *Procentrum micans*


43. *Protoperidinium conicum*


44. *Pleurosigma diverse-striatum*

45. *Proboscia alata* 46. *Pyrocystis fusiformis* 47. *Pyrocystis lunula* 48. *Pyrophacus horologium*

49. *Thalassiosira lacustris* 50. *Thalassiosira sp.* 51. *Thalassiosira rotula* 52. *Odontella aurita*



53. *Leptocylindrus danicus* 54. *Pseudonitzschia pungens* 55. *Pleurosigma decorum* 56. *Nitzschia lorenziana*

57. *Noctiluca scintillans* 58. *Chaetoceros similis* 59. *Chaetoceros curvisetus* 60. *Ceratium azoricum*

Fig 4: Image of Marine Phytoplankton

7. Conclusion

The phytoplankton assemblages in the south eastern coastal ecosystem of the Bay of Bengal, Bangladesh were characterized by high species richness and abundance. The community was dominated by diatoms during the post monsoon season. Freshwater discharge makes the coastal water turbid, light limited, and less productive during certain period. Nutrient stoichiometry played an important role in the distribution of planktonic population spatially and temporally. A distinct seasonal nutrient limitation on phytoplankton growth was evident. However, sufficient attention has been given to the Cox's Bazar coast with regard to water quality analysis and its relationship with the density and diversity of phytoplankton. Hence, the present study will provide a baseline information on hydrology, photosynthetic efficiency and phytoplankton community distribution along the coast; further investigation on phytoplankton dynamics can provide clear insight about the specific type of food chain and a plankton model can be developed for future reference.

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