Isolaion and identification of marine diatoms from RK beach water samples

Abstract

Diatoms are well- known group that can be found in marine water, freshwater, soils and damp shells. Almost all of the diatoms live pelagically in open water, some of them live as face flicks at the water deposition interface. Diatoms are exclusively important in abysses, where they are estimated to contribute up to 45% of the total oceanic primary product. Spatial distribution of marine phytoplankton species is confined both horizontally and vertically. Diatoms are in total 12 species, among them, the *Climacosphenia lengthen* was maximum recorded followed by *Skeletonema sp.* observed as alternate dominante species in this study area. In the present study overall 12 different species were constantly observed in the RK beach water. Among the 12 species similar species *Nitzschia sigma, Climacosphenia lengthen, Pleurosigma directum, Chaetoceros compressus, Asterionella japonica, Arachnoidiscus sp, Tabellaria sp, Hemidiscus sp, Coscinodiscus centralis, Rhizosolenia curvata, Skeletonema sp and Ditylum brightwelli. found the* water sample analysis of Physico- chemical parameters were and species diversity were studied in the current research study.

Key words: Water physiochemical analysis, Diatoms, RK Beach, 12 species

Introduction

Over the earth, there are quiet different variety of living forms are existed. It includes lots of unicellular forms & complex advanced multicellular organisms. According to a research study bacteria & blue green algae are evolved first, about3.5 billion times ago. Later complex organisms are evolved. Algae are first time identified by Antonia van Leunwenhoek in 1700'S. The word algae were derived from the Latin which means **"**See cream**"**, which include marine as well as fresh water samples. The algae simply define as "chlorophyll bearing living organisms" in which accurate leaves stem & roots are absent. Study of algae is called 'algology' or 'phycology'. There are wide variety of algae are identified, which includes unicellular and multi-cellular forms. Algae are grown widely and they may be suitable to grow on ice, Saline water, Soil and over fresh water. Some algae live in Symbiotic association, they may be attach to substratum or may be free floating. The algal forms are social or unicellular. These are autotrophic, which are members of BGA (Cyanophyceae) and they are prokaryotic while other members are Eukaryotic. They play veritably important part in primary productivity in submarine food chains (Prescott 1954).F.E. Fristch (1934),"Father of algae", publish a book " Structure & Reproduction in Algae " in which he classified algae into 11 classes in which Bacillariophyta is one of the most important class, which include bitsy algae called Diatom. The diatoms are discovered by an unknown Englishman. And his work was published his work in Royal society of London in "Philosophical deals." In reactionary record, centric diatoms were, recorded from Jurassic strata of the Mesozoic period (Toshiharu, 1985). Bacillariophyta word comes from Latin ward bacillus means 'rod' or ' little stick ' & phyta means factory (Sanet Janse van et.al. 2006). The diatoms are unicellular or social, they're oceanographic or planktonic (Aditi Kale et.al. 2015). The size of diatom is between 2-200 µm, occasionally they may be more µm long. 2 Diatoms means two cells (halves), which may be called as frustules or faucets which give seductive structural achromatic variety, on which their identification is grounded. The Diatom cell is made up of silica, which

is special character of diatom. These cell walls are composed of largely patterned & perforated silica(Han du Buf et.al. 2002) & due to this unique pattern structure, they look veritably beautiful under microscope & hence they're called as “jewels of Sea” or “opals of ocean” (Cox 1996)

Materials and Methodology

Collection of samples

The water samples were collected from RK beach area every month for a one year (January to December, 2019). The sub surface water samples were collected using clean sterile glass container for nutrient analysis. The collected water samples were properly closed and kept in an ice-cold box and transported **saftly** to the laboratory for further analysis. The planktonic diatoms were collected from the surface waters of the study area by towing plankton net (mouth diameter 0.35 m) made of bolting silk cloth (No.35mesh size 48/µm) for 20 minutes. The samples were preserved in 4 % neutralized formalin and used for qualitative analysis. For quantitative analysis of diatoms, the settling method described by Sukhanova (1978) and Sridhar et al ., 2006.

Estimation of Physico-chemical parameters in a water samples

Rainfall data of RK beach the State of Karnataka was obtained from the Meteorological Department of Vishakapatnam. Physico-chemical parameters were studied such as air temperature, surface water temperature, salinity, pH, dissolved oxygen, nitrite, nitrate, reactive silicate, inorganic phosphate and total phosphorus. Salinity was estimated with the help of a refractometer (Agato, Japan) and pH was

measured by pH pen (pHep, Henna instrument Pvt. Ltd., Portugal). For the estimation of dissolved oxygen, Winkler's titration method was followed (**APHA 1995**) (Vernon, 1960). For the nutrients analysis, water samples were filtered through the millipore unit. Dissolved inorganic phosphate, nitrite, nitrate and reactive silicate were estimated by adopting the methods described Strickland and Parsons, (1972) and Grasshoff (1983).

Diatom mounting media

Diatom samples with water sample were placed in sterilized plastic container. In the laboratory all the contents, including the samples, were transferred into Erlenmayer flasks with 30% H2O2 and left for 24 h to start the oxidation process slowly (as described in Letáková et al., 2016). The samples with hydrogen peroxide were then boiled until the volume decreased by two thirds, and a few milligrams of K2Cr2O7 and 1 ml of concentrated HCL were added into the hot liquid. All the chemicals were washed out through careful rinsing with distilled water until the final pH was neutral. Clean diatom samples were mounted in Naphrax (two slides per sample). Diatoms were investigated by light microscopy using a Olympus microscope firstly qualitatively and then semi quantitatively (Rimet and Bouchez, 2012a). Identifications were carried out using **Krammer and Lange-Bertalot** (1996 and 2017) and nomenclature was unified using Algae base

Diversity indices of diatoms communities on sample spot

The diatoms community diversity indices of all the phytoplankton communities were recorded based on the following characteristics. For instance, the diversity indices such as diversity index described by Shannon-Weiner (1949); Species richness index described by

Simpson (1949) and evenness index described by Pielou's (1975) and species Dominance were calculated by the following formula Shannon- Weiner species diversity index (H'):

The phytoplankton community species diversity index (H') of individual study area was calculated by the formula

$$H = -\sum_{i=1}^{S} p_i \log_b p_i$$

Where

H' = Species diversity, pi = Proportion of species i, and S is the number of species so that S i=1 pi = 1, and b is the base of the logarithm. It is most common to use natural logarithms (and then we mark index as H0), but b = 2 has theoretical justification. The default is to use natural logarithms.

i. Simpson species richness Index (D'):

bird's species richness (D') of the different study areas were calculated by following formula

$$D' = \frac{1}{\sum (Pi)2}$$

Where;

$$\mathbf{Pi} = \frac{\mathbf{ni}}{\mathbf{N}},$$

n_i = the number of individuals in species i, i^2 etc

N = the total number of isolates in each study area.

ii. Pielou's species evenness index (J'):

The evenness index is also high important to determine diatoms diversity indices. The evenness measure (J') Pielou's evenness was calculated by the following formula described by Pielou's (1975)

Here, $$\textbf{Pielou's evenness, J'} = \frac{H'}{H'\max}$$

H' = Shannon-Wiener diversity index

H' max = the maximum value of diversity for the number of species present.

Result and Discussion

The marine environment is a complex system mainly influenced by a variety of physical, chemical and biological processes. One of the basic goals of ecology is to understand the factors which play their role in the distribution pattern of organisms (Underwood, 1979). Coastal waters are heavily impacted by nutrients and inorganic and organic carbon inputs from rivers and other sources. They also intensively exchange nutrients, with the open sea across marginal boundaries (Thomas *et al.* 2004). Environmental conditions also play an important role in promoting the occurrence and abundance of commercially exploitable marine resources (Ivlev, 1966). Likely, in the near shore waters, back waters and estuaries, they exhibit considerable seasonal variations on physico-chemical parameters depending on the local conditions of rainfall, tidal actions, various abiotic and biotic processes and quantum of fresh water input also influcing the nutrient cycle of different coastal environments (Choudury and Panigraphy, 1991). Palk bay is a one the most important marine biodiversity hot

spots in India (Sulochana and Muniyandi, 2005). So for many researchers have investigated the hydrographic parameters of Thondi coastal waters (Meeran *et al.,* 2011; and Santhosh Kumar and Perumal, 2011). In the present investigation an attempt has been made to study the physicochemical parameters of the seawater of Thondi coastal water for a period of one year from January to December, 2008. During the study period, annual rain fall recorded was 1317.6 mm, whereas the average monthly rainfall recorded was 109.8 mm. During the study period, the maximum rain fall (451.40 mm) was registered in the month of October, at the same time, minimum rainfall (12.20 mm) was recorded in the month of August. There was no rainfall during the months of February and May (Table 1). However, the seasonal variation on rain fall was highly fluctuated during the study period and it ranged 19.40 to 301.33mm. The maximum rain fall (301.33 mm) was recorded during the monsoon season, whereas the minimum rain fall (19.40 mm) was noticed during the premonsoon season.

Temperature

Atmospheric temperature

Temperature is one of the important factors in any aquatic environments affecting on biological processes. Every species has its maximal, optimal and minimal temperature requirement for their growth and development. Generally, the surface water temperature is considered as a major environmental parameter controlling the abundance and distribution of bacteria in the aquatic environment (West and Lee, 1984). For instance, Santhosh Kumar and Perumal (2011) have also reported that, this fact from Munaikadu coast, Thondi coast and Ayyampattinam costal area of Palk Bay region **repsectively**, the maximum temperature was also recorded during the summer season (May) and minimum during the monsoon season (November and December). In accordance with these, in the present study also it was found that, the surface water temperature (SWT) of source seawater and atmospheric temperature (AT) were maximum during the month of May

(Summer) and it was minimum temperature was also recorded during the Monsoon period (November). Thee fluctuation was may be the reason of high solar radiation, warming and freshwater input during the monsoon season. The monthly variation in atmospheric temperature recorded during the study period is given in (Table 1). Atmospheric temperature varied from 23 ± 0.47 to 32 ± 0.00°C during the study period. Minimum atmospheric temperature of 23 ± 0.47°C was recorded in the month of November and maximum atmospheric temperature of 32 ± 0.00°C was recorded in the month of May. The seasonal changes on atmospheric temperature was in the order of 24 ± 0.82; 27 ± 2.16; 28 ± 0.94 and 30 ± 1.70ºC, respectively during monsoon, premonsoon, postmonsoon and summer seasons.

Surface water temperature

The lowest surface water temperature of 22°C was recorded in the months of October and November respectively, whereas, the highest temperature of 31°C was recorded in the month of May **(Table 1)**. However, the average surface water temperature was recorded as 27.4°C. The seasonal variation of surface water temperature was fluctuated, between 29 and 22°C. The highest seasonal surface water temperature (29 ± 1.25°C) was observed during the summer period and the lowest temperature recorded (22 ± 0.47°C) was during the monsoon season (Fig.1). The surface water temperature positively correlatied with atmospheric temperature (r = 0.944).

Hydrogen ion concentration (pH)

In accordance to the present study, Ganesan (1992) evidenced that the seawater of Gulf of Mannar region of water sample had low pH during monsoon season, and also inferred that it may be dilution of seawater due to the fresh water influx. **Thus** the alkaline nature of seawater in the present study may be due to regular penetration and influence of neritic water. Thus semi diurnal tides favour regular reflux and flow of neritic water. In the present study ,The pH of the source water showed a meager variation during the study period

and it varied from 7.1 to 8.4 during January to December 2008. For instance, the highest pH of 8.4 ± 0.05 was recorded during the month of May, whereas the lowest pH of 7.1 ± 0.04 was recorded in the month of October (Table 1).The hydrogen ion concentration was seasonally varied from 7.2 ± 0.08 to 8.1 ± 0.24. The maximum pH of 8.1 ± 0.24 was recorded during the summer season and the minimum pH of 7.2 ± 0.08 was registered during the monsoon season (Fig.2). The hydrogen ion concentration (pH) showed positive correlation with atmospheric and surface water temperature (r = 0.717; 0.842) during the study period. Similarly Ananthan *et al.* (1994) reported that the higher value of seawater pH during summer at Pondicherry coast and pointed out that it may be due to the uptake of CO_2 by the photosynthesizing organisms. Similarly, Sridhar *et al.* (2008) observed the narrow range of pH in Munikadu coastal waters, they observed the maximum pH of 8.2 in the month of May during the summer and minimum pH of 7.0 during the post monsoon season. The values obtained in the present study are comparable with the values reported by earlier workers. In recently, Meeran *et al.* (2011) and Santhosh Kumar and Perumal, (2011) reported that the maximum pH value was noted during the summer and minimum pH value during the monsoon season.

Salinity

In support to the result of present study, Meeran *et al.* (2011) recorded minimum salinity of 13.18 psu during the month of October and signified that it inferred because of heavy rainfall and large quantity of fresh water inflow in to the sea and the maximum salinity (35.6psu) was noted during the summer season (i.e, in the month of May). The monthly variation in salinity of the water samples is provided in Fig.2. Salinity showed much variation during the study area, it varied from 27 to 33 ppt with an average of 30 ± 1.50 ppt. Result inferred that the source water had lowest salinity of 27 ±0.47 ppt recorded in the month of October, but the highest salinity of 33 ± 0.00 ppt was recorded in the month of May. Likely, the seasonal variation in salinity was observed with moderate changes during the study period. The

maximum salinity of 32 ± 0.94 ppt was recorded during the summer season, whereas the minimum salinity of 28 ± 0.82 ppt was recorded during the monsoon season. A postively correlation was obtained in salinity between atmospheric, surface water temperature and pH (r = 0.815; 0.887 and r = 0.787). In support to the result of present study, Meeran *et al.* (2011) recorded minimum salinity of 13.18 psu during the month of October and signified that it inferred because of heavy rainfall and large quantity of fresh water inflow in to the sea and the maximum salinity (35.6psu) was noted during the summer season (i.e, in the month of May)Moreover, Santhosh Kumar and Perumal (2011) have described the seasonal variation of salinity in Ayyampattinam near Thondi coast, the maximum salinity was observed 35 ppt in the month of May, 2008.

Dissolved Oxygen (DO)

The dissolved oxygen concentration of the source water showed significant monthly variation during the study period. It ranged from 5.27 to 7.82 ml/L. At the same time the average dissolved oxygen concentration recorded was 6.21 ± 0.79 ml/L. The maximum dissolved oxygen concentration of 7.82 ± 0.08 ml/L was recorded in the month of October, but the minimum dissolved oxygen concentration of 5.27 ± 0.00 ml/L was recorded in the month of May.

The seasonal variation in dissolved oxygen content was flucutated between 5.3 and 7.5 ml/L. However, the maximum dissolved oxygen content (7.5 ± 0.27 ml/L) was recorded during the monsoon season and the minimum dissolved oxygen content (5.3 ± 0.06 ml/L) was recorded during the postmonsoon season. A positively correlation in Dissolved oxygen was recorded between Rainfall and THB (r = 0.814 and 0.744. In agreement to the result of present study, Hari *et al.* documented the higher level of dissolved oxygen (7.8 ml/L) during the month of December and the lower level (5.4 ml/L) during the month of October during the study period of 2007 in Thondi costal water.

Similarly, Meeran *et al.* (2011) accounted the maximum dissolved oxygen of 4.26 ml/L during the month of November and the minimum amount of dissolved oxygen (3.30 ml/L) during the month of April during the stsuy period of 2008 in near Thondi coast of Nambuthalai seawater. Almost most recently, Santhosh Kumar and Perumal (2011) reported the maximum level of dissolved oxygen (5.2 ml/L) was recorded during the monsoon and a minimum level of dissolved oxygen (3.6ml/L) was noted in summer season from the cosatal waters of Palk bay region.

Nitrite (NO_2)

The monthly variation in nitrite content recorded in the water sample. The monthly average nitrite content in the water samples recorded was 2.72 ± 0.24 µM/L. The maximum nitrite content of 3.10 ± 0.03 µM/L was recorded in the month of November and the minimum nitrite content of 2.44 ± 0.04 µM/L was observed during the month of May. Seasonal fluctuation in nitrite content was varied from 2.50 ± 0.02 to 3.09 ± 0.01 µM/L. The minimum nitrite content of 2.50 ± 0.02 µM/L was recorded during the summer period and maximum nitrite content of 3.09 ± 0.01 µM/L was recorded during the monsoon period. These exibt a positive correlation between nitrite content and rain fall, THB and DO (r = 0.652; 0.852 and 0.917) (Table 1).

Nitrate

Nutrients are one of the important factors for regulating the growth, reproduction and biochemistry of all marine organisms (Kannan and Kannan, 1996). In general, amount of all nutrients were found to be higher in the monsoon season. This is mainly because of the input

of river run off and land run off. Moreover, presence of surface water than bottom water (Hari *et al.,* 2010). In the present study, the nutrients like nitrite, nitrate, reactive silicate, inorganic phosphate and total phosphate were analyzed during the study period.

The monthly variation in nitrate content documented in the water samples was 5.52 ± 0.856 µM/L. The lowest nitrate content of 4.23 ± 0.012 µM/L was noticed during the month of May, whereas the highest nitrate content of 6.92 ± 0.029 µM/L was recorded during the month of October. The seasonal variation in nitrate concentration ranged from 4.44 ± 0.19 to 6.79 ± 0.15 µM/L. The lowest nitrate content (4.44 ± 0.19 µM/L) was observed during the premonsoon season, and the highest nitrate content (6.79 ± 0.15 µM/L) was recorded during the monsoon season. A positive correlation was obtained between nitrate content with rainfall (r = 0.741), THB (r = 0.864), DO (r =0.963) and nitrite (r = 0.942). In support to the result of present study, Satpathy *et al.* (2010b) studied the seasonal variation of nitrite content at Kalpakam coastal waters and recorded the maximum nitrite content of 2.91 µ/mol/L during the monsoon season and minimum nitrite content of 0.06 µ/mol/L during the pre-monsoon season. In accordance to the above results, Santhosh kumar and Perumal, (2011) investigated the seasonal variation of nitrite content at Palk bay region and they recorded the maximum nitrite content of 0.896 µg/L during the month of November and the minimum nitrite content of 0.74 µg/L during the month of January.

Reactive Silicate

The spatio-temporal variation of silicate in coastal water is influenced by several factors, more importantly the proportional physical mixing of seawater with fresh water (Purushothaman and Venugopalan 1972), adsorption of reactive silicate into suspended sedimentary particles, chemical interaction with clay minerals, coprecipitation with humic compounds and iron (Stephns and Oppenheime,

1972), and biological removal by phytoplankton, especially by diatoms and silicoflagellates. The monthly variation on reactive silicate content (19.4 ± 0.078 µM/L) was recorded during the month of November and the minimum reactive silicate content (15.4 ± 0.047 µM/L) was recorded in the month of May. The maximum reactive silicate content was recorded during the monsoon season and the minimum reactive silicate content was observed during the premonsoon season. It showed a positive correlation with rain fall (r = 0.655), THB (r = 0.746), DO (r = 0.928), NO_2 (r = 0.897) and NO_3 (r = 0.957). In consonance with the present study, Santhosh Kumar and Perumal (2011) reported that the monthly variation of silicate content in surface water sample collected from Palk bay coast inferred that the silicate content was maximum (61.92µg/L) during the month of October, 2007 (monsoon season), whereas, it was minimum (24.85 µg/L) in the month of March, 2008 on premonsoon period. Satpathy *et al.* (2010b) emphasized that, the concentration of silicate of Kalpakkam Coastal water was ranged from 2.33 to 76.13 µmol/L during the study period of February, 2006 and January, 2007. In the present study the silicate content was positively correlated with DO (r = 0.928); nitrite (r = 0.897); nitrate (r = 0.957) whereas the negative correlated with the physical parameters.

Inorganic phosphate

Phosphate constitutes the most important inorganic nutrient that can limit the phytoplankton production in tropical coastal marine ecosystems (Cole and Sanford, 1989). Phosphate concentration in coastal waters depends upon its concentration in the fresh water that mixed with the seawater within the land–sea interaction zone, phytoplankton uptake, addition through localized upwelling, and replenishment as a result of microbial decomposition of organic matter. Usually, seawater serves as the main source of phosphate in estuarine

and coastal waters except those receives fresh water contaminated with domestic wastes containing detergent and wastes from agro field rich with phosphate-phosphorous fertilizers (Satpathy *et al.,* 2010a).

The dissolved inorganic phosphate content of the water samples recorded during the study period at 4.20 to 6.20 µ/mol/L with an average of 5.1 ± 0.65 µM/L. The maximum inorganic phosphate content (6.20 ± 0.09 µM/L) was recorded during the month of October, whereas the minimum inorganic phosphate content (4.20 ± 0.09 µM/L) was recorded during the month of May. The highest inorganic phosphate content (6.0 ± 0.12 µM/L) was recorded during the monsoon season and lowest inorganic phosphate content of 4.5 ± 0.08 µ/mol/L was noticed during the summer season. It showed a positive correlation with rain fall (r = 0.694), THB (r = 0.876), DO (r = 0.893), nitrite (r = 0.976), nitrate (r = 0.923) and silicate (r =0.884). Recently, Santhosh Kumar and Perumal (2011) reported that the maximum inorganic phosphate was recorded during the monsoon season, possible due to intrusion of upwelling seawater in to the creek, which in turn increased the level of phosphate. The minimum inorganic phosphate was noticed during summer season on Ayyampattinam coastal water, Palk bay region. It could be attributed to the limited flow of fresh water, high salinity and utilization of phosphate by phytoplankton.

Total Phosphorus

Recently, Santhosh Kumar and Perumal (2011) reported that the maximum inorganic phosphate was recorded during the monsoon season, possible due to intrusion of upwelling seawater in to the creek, which in turn increased the level of phosphate. The minimum inorganic phosphate was noticed during summer season on Ayyampattinam coastal water, Palk bay region. It could be attributed to the limited flow of fresh water, high salinity and utilization of phosphate by phytoplankton.

The monthly difference in total phosphorus content of the water sample showed significant variation. It was varied between 12.30 and 20.20 µM/L. The maximum of 20.20 ± 0.03 µM/L was noticed in the month of October and the minimum of 12.30 ± 0.05 µM/L was recorded in the month of June. The mean average total phosphorus content of the source water was 16.38 ± 2.13 µM/L. The seasonal variation in total phosphorus concentration was varied from 11.59 ± 1.79 to 19.50 ± 1.26 µM/L. The maximum total phosphorus content (19.50 ± 1.26 µM/L) was observed during the monsoon season and the minimum (11.59 ± 1.79 µM/L) was recorded during the summer season. The correlation coefficient result inferred that, the positively correlation was observed in total phosphorus content with rain fall, THB, dissolved oxygen and other seawater nutrients such as nitrite, nitrate, reactive silicate and inorganic phosphate (r = 0.727; 0.825; 0.862; 0.899; 0.915; 0.910 and 0.935). High concentration of inorganic phosphate observed during the monsoon and post monsoon seasons were due to the monsoonal flow of fresh water and land runoff. This was followed by a sudden decrease in nutrient concentration during the summer season, probably due to the utilization by micro and macro phytobenthic communities (Bowman *et al.*, 1982).

Phytoplankton Community Structure on chosen study areas

Phytoplankton Species Composition in around of RK beach

Throughout the entire study extending over a period of one years (Jan- Dec -2019), a total of 3400 individuals of 12 species of Phytoplankton were observed in and arounds of RK beach. In toto, 12 species, among **tham**, the *Climacosphenia elongate* was maximum recorded followed by *Skeletonema sp*. observed the second dominante species in this **atudy** area. On the other hand, the highest diatoms was observed in the month of October and the minimum birds was recorded in the month of July respectively. In totally, 12 different species

were frequently obsered in the RK beach.. Among **tham**, twelve species such as *Nitzschia sigma, Climacosphenia elongate, Pleurosigma directum, Chaetoceros compressus, Asterionella japonica, Arachnoidiscus sp, Tabellaria sp, Hemidiscus sp, Coscinodiscus centralis, Rhizosolenia curvata, Skeletonema sp and Ditylum brightwelli.* (plate 1). However, similarly result observed that Giuseppina G. Lai et al., 2019 was **rported** that the In total, 207 diatom taxa from 59 genera were identifed, of which 61 (23 genera) in the springs of Auvergne, and 178 (55 genera) in the springs of Sardinia

Percentage distribution of phytoplankton in around on RK beach

The percentage distribution of phytoplankton communities were documented at RK beach study area, where as the maximum distribution of 30% was recorded in *Climacosphenia elongate* follwed by *Ditylum brightwelli* was also noticed that the second most dominant species in the study area. However, the minimum distribution of 0.9% was recorded in Hemidiscus sp, and other phytoplankton communities followed by 13 to 2 % in the order of *Nitzschia sigma> Climacosphenia elongate > Pleurosigma directum > Chaetoceros compressus > Asterionella japonica > Arachnoidiscus sp > Tabellaria sp > Hemidiscus sp > Coscinodiscus centralis > Rhizosolenia curvata > Skeletonema sp and Ditylum brightwelli.*

Futher more, during the study periods (January to December) the distribution phytoplankton pattern was varied observation of diatoms communities and it ranged from 3.8% to 18.7%. From this, the maximum diatom community distribution of 18.7% was observed in the month of October and the less diatoms community (3.8%) was also recorded in the months of July **follwed** by the month of November > January > December > February > September > March > April > June > August respectively.

Diversity indices of phytoplankton communities at RK beach

Species Dominace (D)

The diatoms's species dominance (D) was calculated and it ranged from 0.131 to 0.271 duirng the study periods at RK beach. From this, the highest dominace (0.271) was recorded in the month of November and the least dominace (0.131) was noticed in the month of July (Fig 3). But, the phytoplankton dominace species were assorted in the persent study area and it follwed by the maximum **dominace** (0.2744) was noticed in *Hemidiscus sp;* whereas, the least **dominace** of 0.09387 was documented in *Skeletonema sp,* and the other phtoplankton species were recorded in varied **dominace** levels (Fig 4).

Simpson Species richness (1-D) : At the same time, diatoms species richness (D') did not express much variation at RK beach region and it ranged between 0.73 and 0.869. Here, the maximum diatoms's species richness of 0.969 was noticed during the month of July (Fig 5), whereas the minimum diatoms's richness of 0.73 was recorded during the month of November. However, the phytoplankton community species richness was ranged between 0.746 and 0.910. The maximum species richness was recorded in Spotted *Skeletonema sp,* and the minimum species richness was documented in the species of *Hemidiscus sp* (Fig 6).

Shannon- Weiner species diversity index (H')

Totally, 12 different **diatos** were identified. The monthly variation on the common diatoms diversity index (H') was in between 1.678 and 2.202. The maximum diatoms's diversity index of 2.202 was recorded in the month of July, whereas minimum bird's diversity index of 1.678 was recorded during the month of November (Fig 7). Further more, the phytoplankton species diversity index was calculated and it ranged from 1.511 to 2.447 during the study periods. From this, the highest diversity index (H') (2.447) was noticed in *Skeletonema sp.* and the least diversity index (H') of 1.659 was recorded in *Hemidiscus sp*. at RK beach (Fig 8)

Pielou's evenness (J')

The monthly variation on diatom's **communites** of Pielou's evenness (J') analyzed in study region during the study period evidenced remarkably higher (0.918) diatoms's evenness index during the month of July and the lower (0.675) diatomss evenness recorded during the month of November. In the present study the eveness of the phytoplankton diversity was docementd at study region and the results of the pielou's eveness varied from 0.832 to 0.985. The maximum eveness (0.9747) noticed in *Skeletonema sp,* and the minimum eveness of 0.8357 was recorded in *Rhizosolenia curvata*. (Fig 9 and Fig 10)

Badsi et al., 2012 High value of Shannon's index (H ') was recorded. Dash (1996) Reported that the high value of Shannon's index (H ') signifies the planktonic diversity. Low values of Shannon's index were recorded in February in all stations. This may be due to heavy rain in Massa. Bajpai (1997) reported that the low diversity of the species would be due to the disturbance such as flooding. Adesalu and Nwankwo (2008) and Rajagopal (2010) reported that the low value of Shannon's index of phytoplankton population in rainy season is due to dilution of area. This index of diversity (H ') shows a value below to 3 for all stations during the study period. This indicates a low specific structure of these groups. Indeed, a low diversity characterizes, in principle, young settlments of Species. While a great diversity indicates mature settlements, the low diversity index shows a weak internal structure of populations.

Conclusion

The results showed that the influence of the salinity gradient on the compositional of the phytoplankton community. According to the results *Hemidiscus sp;*is dominated by Diatoms, mainly of the genera *Nitzschia sigma, Climacosphenia lengthen, Pleurosigma directum,*

Chaetoceros compressus, Asterionella japonica, Arachnoidiscus sp, Tabellaria sp, Hemidiscus sp, Coscinodiscus centralis, Rhizosolenia curvata, Skeletonema sp and Ditylum brightwelli from the state of Andhra Pradesh. Water sample analysis of Physico- chemical parameters were studied and species diversity also studied.

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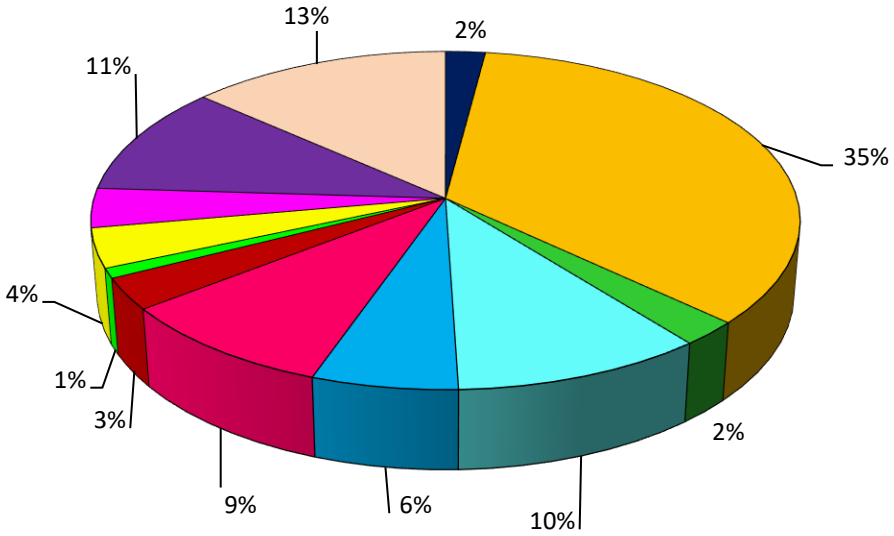
Fig 1: Percentage distribution of one year diatom's diversity in RK beach



Nitzschia sigma | *Climacosphenia elongate* | *Pleurosigma directum*

Chaetoceros compressus | *Asterionella japonica* | *Arachnoidiscus sp*

Tabellaria sp | *Hemidiscus sp* | *Coscinodiscus centralis*

Rhizosolenia curvata | *Skeletonema sp* | *Ditylum brightwelli*

Fig 2: Percentage distribution of every month diatom's diversity in **RK beach**

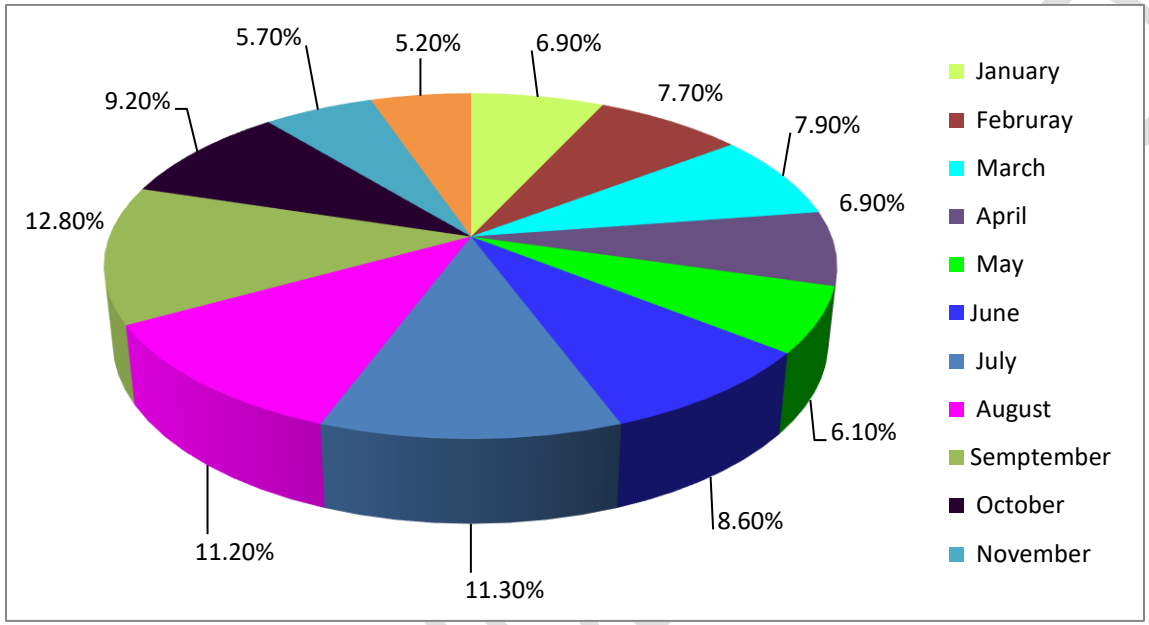


Fig 3: Monthly diversity of dominance species **(???)** Dominance_D in RK beach

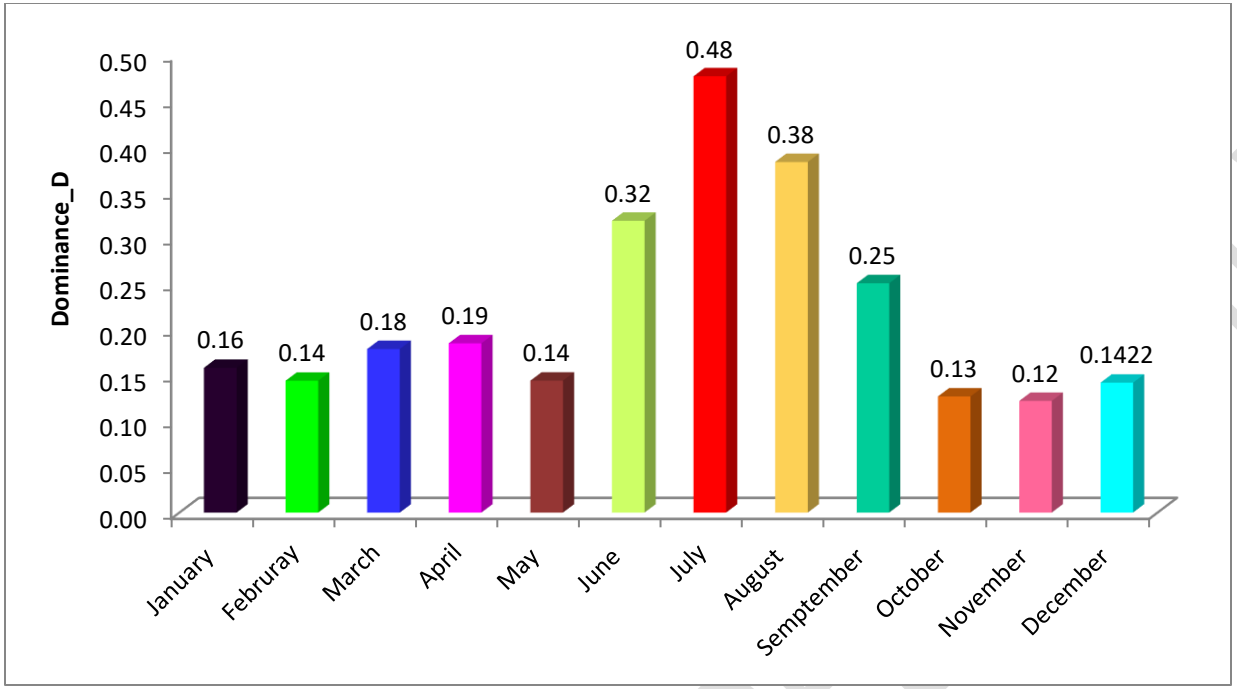


Fig 4: One year species diversity of dominance species Dominance_D in RK beach

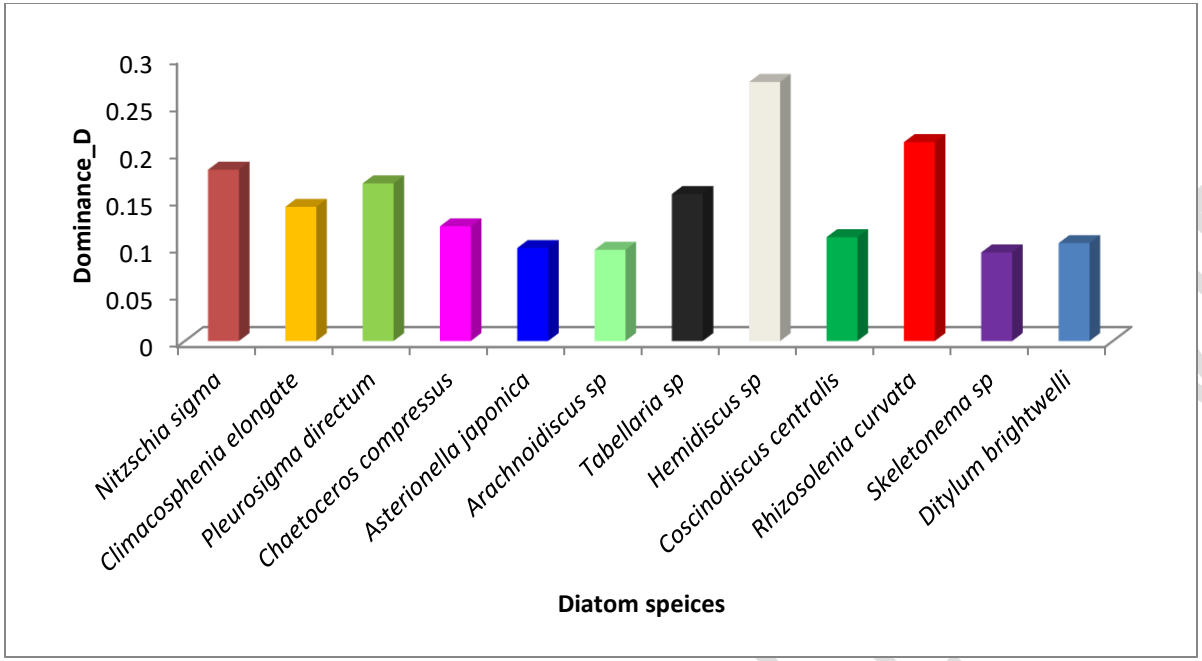


Fig 5: Monthly species diversity of Simpson species richness_D in RK beach

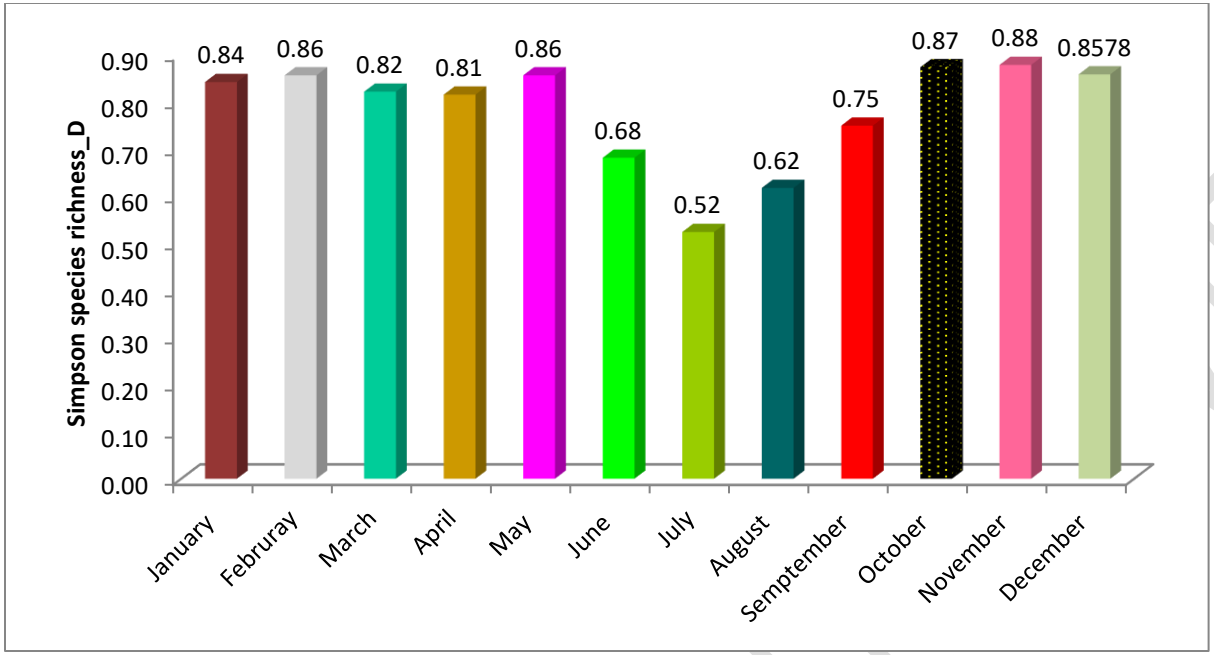


Fig 6: one year species diversity of Simpson species richness in RK beach

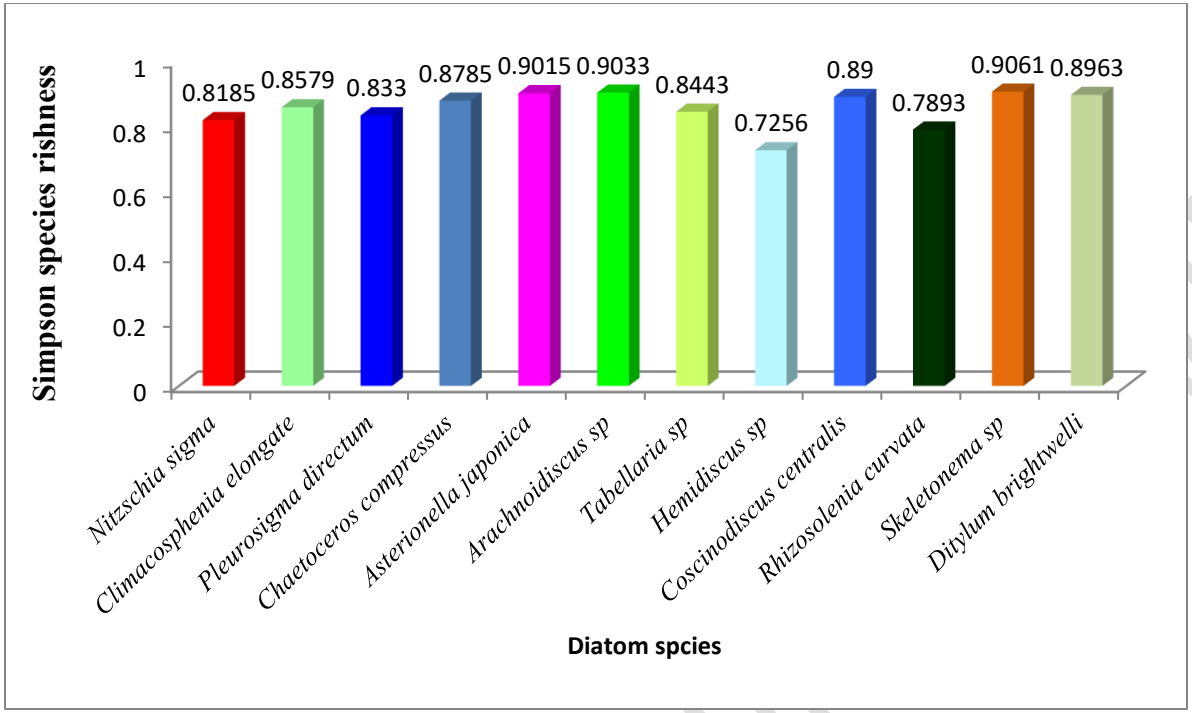


Fig 7: Monthly species diversity of shanon weiner index (H) in Rk beach

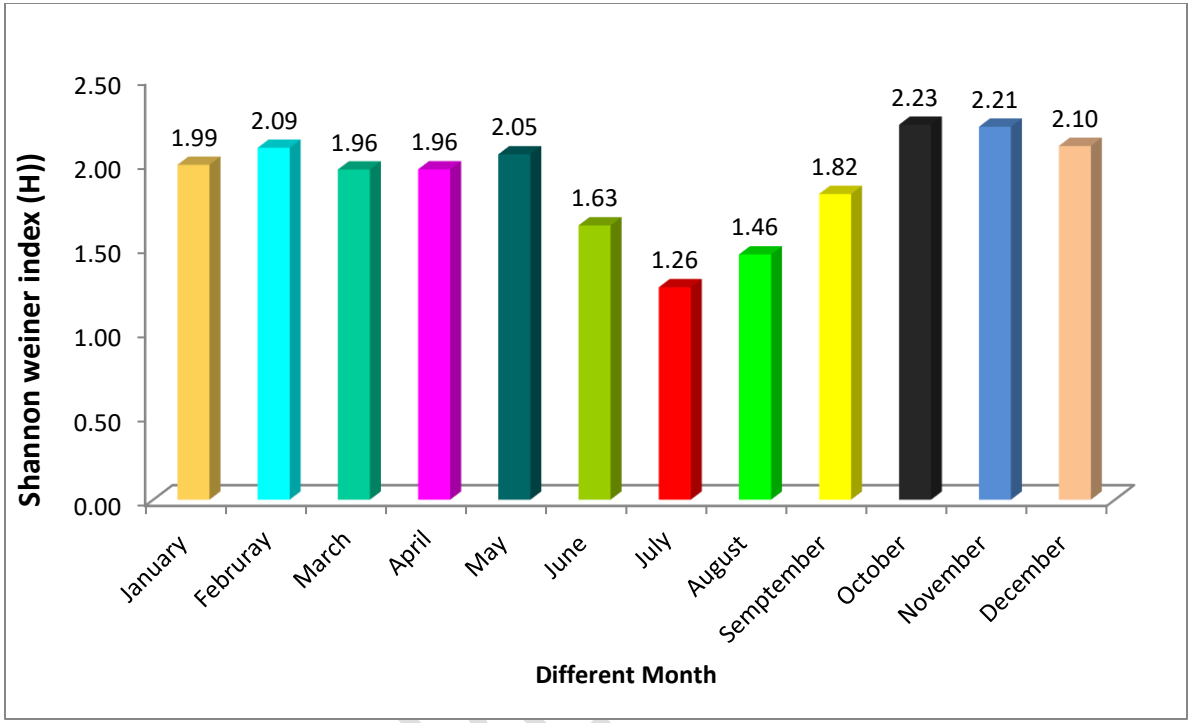


Fig 8: one year species diversity of shannon weiner index (H)

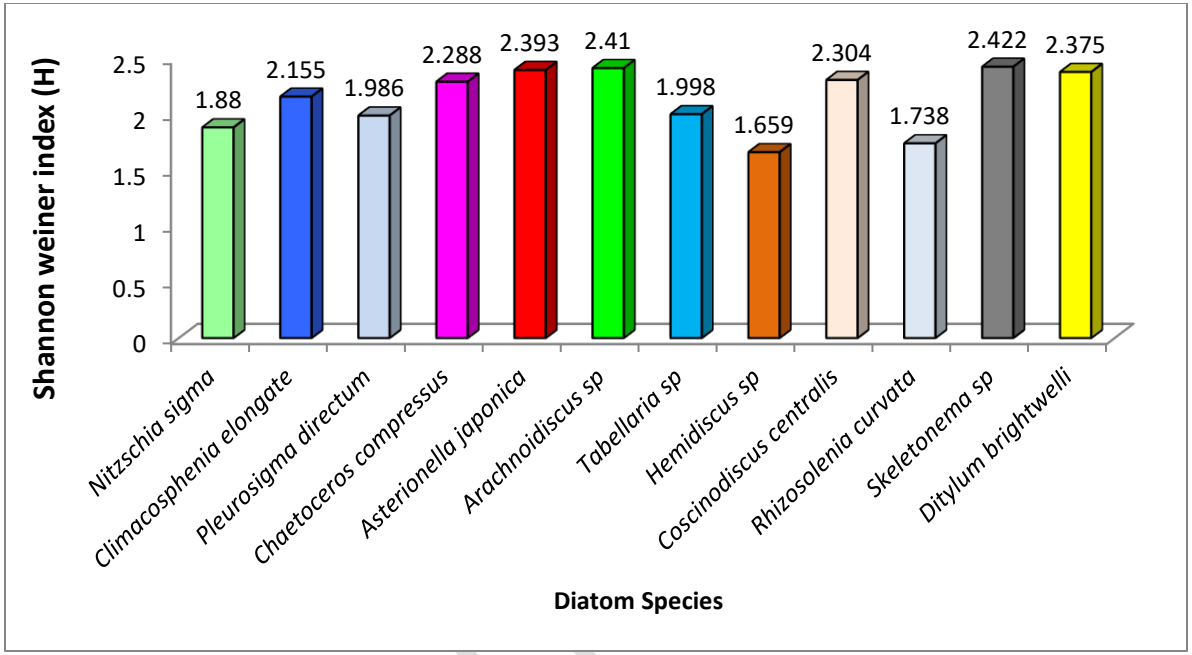


Fig 9: Monthly diatom's diversity (Equitability_J) in Rk beach area

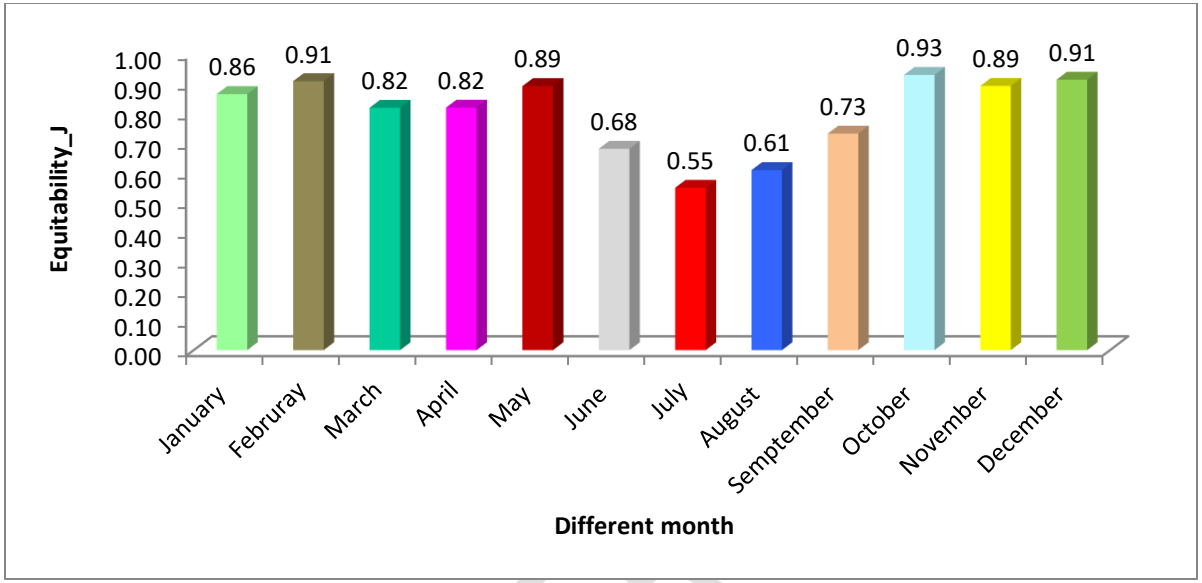


Fig 10: One year diatom's diversity (Equitability_J) in RK beach

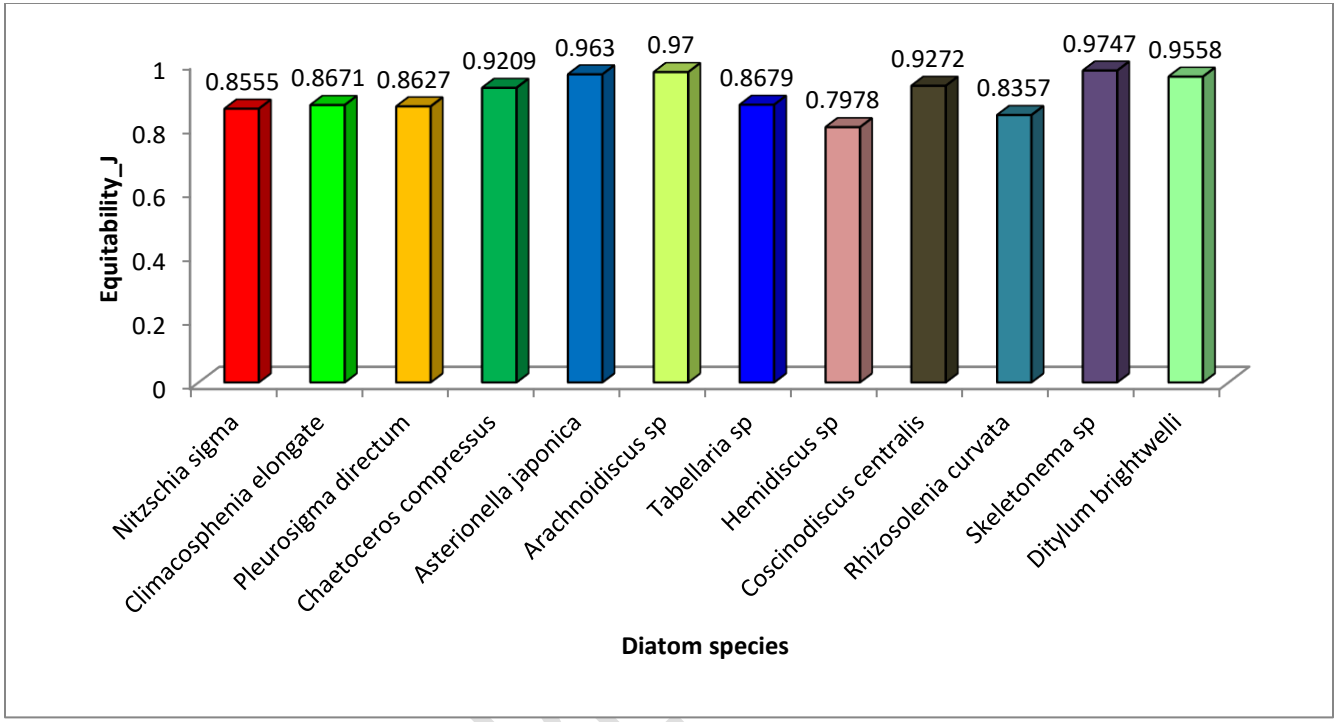


Table1: Monthly variation on rainfall, physicochemical parameters in RK beach coastal water samples during the study period (January to Dec, 2020)

Month	Rainfall (mm) *	AT (ºC)	SWT (ºC)	pH	Salinity (ppt)	DO (ml/L)	Nitrite (µ/mol/L)	Nitrate (µ/mol/L)	Reactive Silicate (µ/mol/L)	Inorganic Phosphate (µ/mol/L)	Total Phosphorus (µ/mol/L)
January	17.00	27±0.47	25±0.41	7.2±0.05	30±0.82	6.31±0.01	2.80±0.02	5.69±0.069	18.2±0.008	5.2±0.08	17.07±0.06
February	0.00	29±0.24	26±0.47	7.4±0.12	31±0.24	6.28±0.01	2.64±0.07	5.62±0.118	18.3±0.005	4.8±0.07	16.10±0.82
March	258.10	29±0.47	27±0.47	7.8±0.05	30±0.41	6.18±0.01	2.59±0.07	5.50±0.045	17.4±0.127	4.9±0.09	16.67±0.14

April	58.10	28±0.47	27±0.62	8.1±0.02	31±0.47	5.42±0.00	2.47±0.06	4.69±0.073	16.6±0.045	4.6±0.08	15.33±0.37
May	0.00	32±0.00	30±0.41	8.4±0.05	33±.0.00	5.27±0.00	2.44±0.04	4.23±0.012	15.4±0.047	4.2±0.09	14.13±0.03
June	22.80	31±0.24	29±0.24	7.8±0.12	31±0.47	5.59±0.01	2.50±0.07	4.39±0.086	15.6±0.245	4.4±0.04	12.30±0.05
July	28.40	30±0.09	27±0.82	7.6±0.12	32±0.24	5.71±0.00	2.53±0.04	5.19±0.041	16.1±0.082	4.5±0.11	14.13±0.09
August	12.20	26±0.82	25±0.24	7.8±0.08	31±0.47	5.61±0.02	2.69±0.08	5.26±0.033	16.7±0.041	4.9±0.06	16.13±0.02
September	17.60	25±0.41	25±0.82	7.4±0.12	30±0.47	5.82±0.01	2.81±0.08	5.33±0.053	17.1±0.033	5.6±0.11	17.27±0.05
October	451.40	25±0.41	22±0.47	7.1±0.04	27±0.47	7.82±0.08	3.09±0.00	6.92±0.029	19.3±0.086	6.2±0.09	20.20±0.03
November	333.00	23±0.47	22±0.82	7.2±0.05	28±0.24	7.40±0.07	3.10±0.03	6.87±0.094	19.4±0.078	6.0±0.10	19.10±0.08
December	119.00	24±0.71	23±.0.62	7.3±0.09	29±0.24	7.17±0.02	3.07±0.01	6.58±0.180	19.1±0.000	5.9±0.16	18.20±0.04
Mean ± SD	109.8	27 ± 2.75	26 ± 2.43	7.6 ± 0.38	30 ± 1.59	6.22±0.80	2.73±0.24	5.52±0.856	17.43±1.36	5.10±0.65	16.39 ± 2.13

*Data was collected from Metrological Department, Vishakapatnam. AT: Atmospheric temperature; SWT: Surface Water temperature; DO: Dissolved oxygen.

Table2: Percentage Distribution of one Year Diatom Diversity in RK beach

S.No	Name of the species	One year diatom's diversity (%)
1	Nitzschia sigma	2.063
2	Climacosphenia elongate	35.022
3	Pleurosigma directum	2.377
4	Chaetoceros compressus	10.224
5	Asterionella japonica	5.919
6	Arachnoidiscus sp	9.147
7	Tabellaria sp	3.049
8	Hemidiscus sp	0.941
9	Coscinodiscus centralis	3.767
10	Rhizosolenia curvata	3.767
11	Skeletonema sp	10.583
12	Ditylum brightwelli	13.543

Table3: Percentage Distribution Of Every Month Diatoms Diversity In RK beach

S. No	Month	Monthly distribution of diatoms diversity (%)
1	January	2.063
2	February	35.022
3	March	2.377
4	April	10.224
5	May	5.919
6	June	9.147
7	July	3.049
8	August	0.941
9	September	3.767
10	October	3.767
11	November	10.583
12	December	13.543

Table4: Diversity indicates of diatom's communities at RK beach region in one year diatom's diversity

S.No	Name of the species	Dominance_D	Simpson_1-D	Shannon_H	Equitability_J
1	Nitzschia sigma	0.1815	0.8185	1.88	0.8555
2	Climacosphenia elongate	0.1421	0.8579	2.155	0.8671
3	Pleurosigma directum	0.167	0.833	1.986	0.8627
4	Chaetoceros compressus	0.1215	0.8785	2.288	0.9209
5	Asterionella japonica	0.09848	0.9015	2.393	0.963
6	Arachnoidiscus sp	0.09669	0.9033	2.41	0.97
7	Tabellaria sp	0.1557	0.8443	1.998	0.8679
8	Hemidiscus sp	0.2744	0.7256	1.659	0.7978
9	Coscinodiscus centralis	0.11	0.89	2.304	0.9272
10	Rhizosolenia curvata	0.2107	0.7893	1.738	0.8357
11	Skeletonema sp	0.09387	0.9061	2.422	0.9747
12	Ditylum brightwelli	0.1037	0.8963	2.375	0.9558