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# LIMNOLOGICALLY IMPORTANT PHYSICOCHEMICAL PARAMETERS OBSERVED IN MARINE WATER SAMPLES AROUND DIGHA COAST IN BAY OF BENGAL

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## INTRODUCTION

Sea water, in addition to containing substantial amount of salt (sodium chloride) contains a variety of important chemical constituents like nitrate, phosphate, sulphate, silicate, chloride of Sodium, Potassium, Magnesium, Iron, Zinc, Nickel, Cobalt, Copper, Lead *etc.* It is well-established fact that the survival and normal well being/viability of the entire Faunal Diversity in an ecosystem depends on composition of such parameters. Any significant alteration in such Chemical and Physical parameters (collectively called as Limnological parameters) as the component of Marine Environment may significantly affect the entire chain and even be catastrophic to a few susceptible living organisms up to the extent of extinction. It is with this view point that we had monitored/ analyzed the associated water samples in respect of important Physical and Chemical parameters as components of limnogical constituent. Such important Physical parameters arc namely : Temperature, Density, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), pH, Conductance, Turbidity *etc.* The Chemical parameters include : Chlorinity, Salinity, Alkalinity, Free Carbon Dioxide, Total Hardness, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Sulphate, Nitrate, Oxylate, Phosphate *etc.*

Although similar studies on such aspects at different places of Indian Ocean as well as Bay of Bengal has been widely carried out by variety of researchers, but very little work at the coastal area surrounding this important tourist place has been carried out. Hence, we are regularly monitoring such water quality parameters as a baseline data for the past fifteen years (ever since the establishment of this centre). As experimental strategy, the water samples collected fortnightly and periodically throughout the year for the consecutive five years (March 1998 to February 2004) have been studied and reported through data vide Table nos. 1-6 respectively.

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**Table 1. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 1998 to February 1999.

| | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | I | II | I | II | I | II |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 28 | 30 | 30 | 29 | 27 | 25 |
| pH | 8.00 | 8.10 | 7.90 | 7.80 | 8.00 | 8.10 |
| Density | 1.018 | 1.020 | 1.015 | 1.012 | 1.016 | 1.018 |
| TDS (g/l) | 100 | 110 | 130 | 120 | 110 | 115 |
| TSS (g/l) | 100 | 105 | 125 | 115 | 105 | 110 |
| Cond. (mho) | 42.80 | 41.60 | 40.50 | 38.00 | 42.00 | 40.00 |
| Chlorinity (g/l) | 16.00 | 16.50 | 13.50 | 11.50 | 13.20 | 14.00 |
| Salinity (g/l) | 28.80 | 29.70 | 24.30 | 20.70 | 23.70 | 25.20 |
| Alkalinity | 28 | 25 | 27 | 26 | 30 | 25 |
| Total hardness | 600 | 640 | 670 | 525 | 610 | 590 |
| Free $CO_2$ | Nil | Nil | Traces | Nil | Nil | Nil |
| D.O. | 9.00 | 8.70 | 9.30 | 9.00 | 8.90 | 8.40 |
| B.O.D. | 6.00 | 5.80 | 6.20 | 6.00 | 5.90 | 5.60 |
| Sulphate | 270 | 300 | 275 | 300 | 310 | 305 |
| Nitrate (µg/l) | 100 | 110 | 105 | 95 | 100 | 105 |
| Phosphate (µg/l) | 120 | 145 | 130 | 125 | 120 | 125 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

**Table 2. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 1999 to February 2000.

| | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | I | II | I | II | I | II |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 28 | 30 | 31 | 30 | 27 | 25 |
| pH | 8.05 | 8.10 | 8.15 | 7.90 | 7.95 | 8.10 |
| Density | 1.015 | 1.018 | 1.017 | 1.016 | 1.015 | 1.017 |
| TDS (g/l) | 36.10 | 37.00 | 30.45 | 26.00 | 29.00 | 31.90 |
| TSS (g/l) | 100 | 110 | 125 | 120 | 110 | 115 |
| Cond. (mho) | 42.00 | 41.50 | 40.50 | 38.50 | 41.50 | 40.00 |
| Chlorinity (g/l) | 16.00 | 17.00 | 15.00 | 12.00 | 14.00 | 15.50 |

**Table 2. :** *(Cont'd.).*

| | | | | | | |
|---|---|---|---|---|---|---|
| Salinity (g/l) | 28.50 | 30.60 | 27.00 | 21.60 | 25.20 | 27.90 |
| Alkalinity | 35 | 25 | 20 | 30 | 25 | 25 |
| Total hardness | 610 | 650 | 670 | 500 | 610 | 590 |
| Free $CO_2$ | Nil | Nil | Nil | Traces | Nil | Nil |
| D.O. | 8.70 | 9.10 | 9.00 | 8.90 | 9.00 | 8.50 |
| B.O.D. | 5.80 | 6.00 | 6.00 | 5.90 | 6.00 | 5.80 |
| Sulphate | 290 | 300 | 280 | 310 | 300 | 295 |
| Nitrate (µg/l) | 100 | 110 | 100 | 90 | 95 | 100 |
| Phosphate (µg/l) | 125 | 140 | 120 | 130 | 115 | 125 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

**Table 3. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 2000 to February 2001.

| | **Premonsoon** | | **Monsoon** | | **Postmonsoon** | |
|---|---|---|---|---|---|---|
| | **I** | **II** | **I** | **II** | **I** | **II** |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 29 | 30 | 30 | 28 | 25 | 26 |
| pH | 8.00 | 8.05 | 7.95 | 7.90 | 8.00 | 8.05 |
| Density | 1.016 | 1.015 | 1.018 | 1.014 | 1.016 | 1.017 |
| TDS (g/l) | 36.00 | 35.50 | 31.50 | 28.10 | 30.10 | 32.00 |
| TSS (g/l) | 100 | 110 | 120 | 125 | 115 | 110 |
| Cond. (mho) | 41.00 | 41.50 | 40.00 | 39.50 | 40.10 | 41.50 |
| Chlorinity (g/l) | 16.00 | 16.50 | 15.50 | 12.00 | 13.50 | 14.50 |
| Salinity (g/l) | 28.80 | 29.70 | 27.90 | 21.60 | 24.30 | 26.10 |
| Alkalinity | 30 | 25 | 20 | 27 | 35 | 30 |
| Total hardness | 590 | 600 | 650 | 700 | 620 | 590 |
| Free $CO_2$ | Nil | Nil | Nil | Nil | Nil | Nil |
| D.O. | 9.00 | 8.40 | 9.30 | 9.00 | 9.00 | 8.80 |
| B.O.D. | 6.00 | 5.60 | 6.20 | 5.90 | 6.00 | 5.80 |
| Sulphate | 275 | 285 | 275 | 300 | 320 | 290 |
| Nitrate (µg/l) | 95 | 100 | 90 | 105 | 115 | 95 |
| Phosphate (µg/l) | 125 | 135 | 110 | 120 | 110 | 130 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

**Table 4. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 2001 to February 2002.

| | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | I | II | I | II | I | II |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 28 | 29 | 30 | 29 | 27 | 26 |
| pH | 8.10 | 7.90 | 8.00 | 7.95 | 8.05 | 8.00 |
| Density | 1.016 | 1.017 | 1.018 | 1.017 | 1.018 | 1.016 |
| TDS (g/l) | 37.20 | 38.50 | 31.50 | 27.00 | 30.00 | 32.50 |
| TSS (g/l) | 105 | 110 | 125 | 120 | 110 | 105 |
| Cond. (mho) | 43.50 | 42.00 | 41.50 | 39.00 | 42.20 | 41.00 |
| Chlorinity (g/l) | 17.00 | 18.20 | 14.50 | 12.00 | 14.00 | 15.00 |
| Salinity (g/l) | 30.60 | 32.70 | 26.10 | 21.60 | 25.20 | 27.00 |
| Alkalinity | 30 | 35 | 25 | 30 | 20 | 30 |
| Total hardness | 600 | 630 | 700 | 650 | 645 | 610 |
| Free $CO_2$ | Nil | Nil | Traces | Nil | Nil | Nil |
| D.O. | 9.00 | 8.50 | 9.10 | 8.80 | 9.00 | 9.30 |
| B.O.D. | 6.00 | 5.60 | 5.90 | 5.90 | 6.00 | 6.10 |
| Sulphate | 300 | 310 | 295 | 270 | 340 | 350 |
| Nitrate (µg/l) | 120 | 110 | 105 | 110 | 115 | 95 |
| Phosphate (µg/l) | 130 | 135 | 120 | 125 | 110 | 130 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

**Table 5. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 2002 to February 2003.

| | Premonsoon | | Monsoon | | Postmonsoon | |
|---|---|---|---|---|---|---|
| | I | II | I | II | I | II |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 29 | 30 | 31 | 30 | 28 | 25 |
| pH | 8.10 | 8.00 | 7.90 | 7.80 | 8.00 | 8.05 |
| Density | 1.016 | 1.017 | 1.018 | 1.016 | 1.017 | 1.018 |
| TDS (g/l) | 37.20 | 38.00 | 31.00 | 32.00 | 31.00 | 36.00 |
| TSS (g/l) | 105 | 110 | 105 | 120 | 125 | 130 |
| Cond. (mho) | 42.00 | 41.00 | 40.60 | 39.60 | 39.00 | 40.60 |
| Chlorinity (g/l) | 16.00 | 17.50 | 14.00 | 15.00 | 16.50 | 17.00 |

**Table 5. :** *(Cont'd.).*

| | | | | | | |
|---|---|---|---|---|---|---|
| Salinity (g/l) | 30.20 | 32.50 | 26.00 | 21.30 | 25.10 | 27.20 |
| Alkalinity | 28.80 | 31.50 | 25.20 | 27.00 | 29.70 | 30.60 |
| Total hardness | 650 | 640 | 675 | 550 | 620 | 595 |
| Free $CO_2$ | Nil | Nil | Traces | Nil | Nil | Nil |
| D.O. | 9.00 | 8.70 | 9.30 | 9.10 | 8.90 | 9.20 |
| B.O.D. | 6.00 | 5.80 | 6.20 | 6.00 | 6.00 | 6.10 |
| Sulphate | 300 | 290 | 295 | 310 | 305 | 310 |
| Nitrate (µg/l) | 105 | 112 | 110 | 95 | 98 | 100 |
| Phosphate (µg/l) | 130 | 125 | 110 | 120 | 115 | 125 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

**Table 6. :** Observed Physicochemical values for the sea water samples collected periodically from Digha coast for the period March 2003 to February 2004.

| | **Premonsoon** | | **Monsoon** | | **Postmonsoon** | |
|---|---|---|---|---|---|---|
| | **I** | **II** | **I** | **II** | **I** | **II** |
| **Parameter** | **Mar–Apr** | **May–Jun** | **Jul–Aug** | **Sep–Oct** | **Nov–Dec** | **Jan–Feb** |
| Temperature °C | 30 | 31 | 29 | 30 | 27 | 26 |
| pH | 8.00 | 8.00 | 7.50 | 8.00 | 8.50 | 8.00 |
| Density | 1.017 | 1,018 | 1.019 | 1.015 | 1.017 | 1.019 |
| TDS (g/l) | 37.00 | 40.00 | 35.00 | 34.00 | 30.00 | 38.00 |
| TSS (g/l) | 110 | 115 | 105 | 125 | 120 | 127 |
| Cond. (mho) | 41.50 | 41.50 | 40.00 | 39.00 | 39.50 | 40.50 |
| Chlorinity (g/l) | 16.50 | 18.00 | 15.00 | 15.50 | 16.50 | 17.50 |
| Salinity (g/l) | 29.70 | 42.40 | 27.00 | 27.90 | 29.70 | 31.50 |
| Alkalinity | 28.00 | 32.50 | 25.50 | 25.00 | 29.00 | 30.00 |
| Total hardness | 655 | 645 | 675 | 540 | 610 | 605 |
| Free $CO_2$ | Nil | Nil | Traces | Nil | Nil | Nil |
| D.O. | 9.00 | 8.50 | 9.20 | 9.00 | 8.80 | 9.00 |
| B.O.D. | 6.00 | 5.80 | 6.10 | 6.00 | 5.90 | 6.00 |
| Sulphate | 310 | 295 | 290 | 300 | 325 | 300 |
| Nitrate (µg/l) | 102 | 110 | 100 | 90 | 105 | 100 |
| Phosphate (µg/l) | 125 | 135 | 115 | 120 | 125 | 115 |

All the values are in mg/l, unless otherwise mentioned—T.D.S. = Total Dissolved Solids; T.S.S. = Total Suspended Solids; D.O. = Dissolved Oxygen; B.O.D. = Biochemical Oxygen Demand.

The seasonal occurrence of commercial sea fish species in this coastal zone is given through Table no. 7. Such data were collected from the Drag net catches by random sampling.

**Table 7. :** Seasonal abundance of Commercial sea fish species at Digha coastal zone (during the study period : March 1998 to February 2004).

| Fish groups | No. of spp. (available in the region) | Season | | |
|---|---|---|---|---|
| | | Pre Monsoon | Monsoon | Post Monsoon |
| Sharks | 7 | 4 | 7 | 6 |
| Rays | 6 | 3 | 6 | 4 |
| Clupeids | 5 | 5 | 5 | 5 |
| Engrualids | 3 | 3 | 3 | 3 |
| Sardines | 2 | 1 | – | 2 |
| Ariids | 2 | 2 | 2 | 2 |
| Chirocentrid | 1 | 1 | 1 | 2 |
| Harpodon | 1 | – | 1 | 1 |
| Sillaginids | 2 | 1 | 2 | 3 |
| Lates | 1 | – | 1 | 1 |
| Carangids | 3 | 3 | 3 | 3 |
| Serranids | 5 | 3 | 5 | 4 |
| Pomfrets | 3 | 3 | 3 | 3 |
| Lutjanids | 4 | 4 | 4 | 3 |
| Lethrinids | 3 | 3 | 3 | 2 |
| Sciaenids | 7 | 4 | 4 | 3 |
| Serombrid | 1 | 1 | 1 | 1 |
| Trichiurids | 3 | 1 | 3 | 3 |
| Leiognathids | 2 | 1 | 2 | 4 |
| Mugilids | 5 | 4 | 5 | 4 |

## DESCRIPTION OF THE STUDY AREA

Studies observed during the period (March 1998 to February 2004} had been done from the water samples collected around Digha sea beach which is situated close to the Gangetic mouth of the east coast of India at latitude 21°36" N and longitude 87°30" E. The coastline is straight and the beach is flat and compact. Marine water samples were collected in sterile glass bottles at the distance of 10–20 meters inside from the sea surface both at the low and high tides in a stretch of 500 meters on either side of the beach near our Research Centre.

## MATERIALS AND METHODS

The physical and chemical parameters like temperature, pH and Dissolved Oxygen were measured immediately after the sampling in the field only. The samples were generally collected regularly once or twice a week throughout the study period for carrying out measurements in the laboratory for both the Physical and Chemical parameters. Surface water temperature, density, total dissolved solids and total suspended solids were measured through conventional means. However, pH and conductance were measured by the Elico pH meter (model No. LI–120) and Elico conductivity meter (model No C.M. 180) respectively. The Chemical parameters like chlorinity/salinity were measured by Argentometric titration. Modified Winkler's method was used for the estimation of Dissolved Oxygen and the Biochemical oxygen Demand (incubating the water sample at 20 +1° C in a BOD incubator model No. C.L. 65, Remi cooling incubator (for five days). Phosphate and Nitrate were determined by Grashoft (1976) method. The remaining chemical parameters like total hardness, free carbon dioxide, alkalinity and sulphate were computed by the estimations developed and defined by Martin (1970), Wilson (1975), Atson (1978), NEERI (1988), Lewis publishers (1990), Nemerow & Dasgupta (1991), APHA (1998).

Because of significant role of monsoon in deciding the general physicochemical composition of Marine water and also in commercial activity of marine living resources, the data are demarcated in three distinct parts; **pre monsoon, monsoon** and the **post monsoon** period. Each season was further subdivided into early and late parts, each representing the block of two months duration.

## RESULTS

The mean values for such Limnologically important physicochemical parameters for every two months of interval distinct to pre and post periods of a particular season for all the three climatic conditions are expressed here through the Tables namely no. 1-6, respectively for the period (March 1998–February 2004). The occurrence of free carbon dioxide was distinctly reported only during the monsoon period that too in the traces, The significance of mean values of different parameters reported was analyzed using one way analysis of variance technique : Snecedar and Cochran (1967) for each parameter separately.

From the results observed here, it appears that except the temperature, chlorinity/salinity, conductance as well as dissolved solids, all other parameters remain almost constant to the seasonal/diagonal variations, which depict the normalcy in the general water quality parameters of our study samples taken from around Digha sea beach. The significance of the variation of chlorinity/salinity data with regard to monsoonal change is such that such values increase moderately to significant to higher range from monsoon to post monsoon and further to pre monsoon respectively.

## DISCUSSION

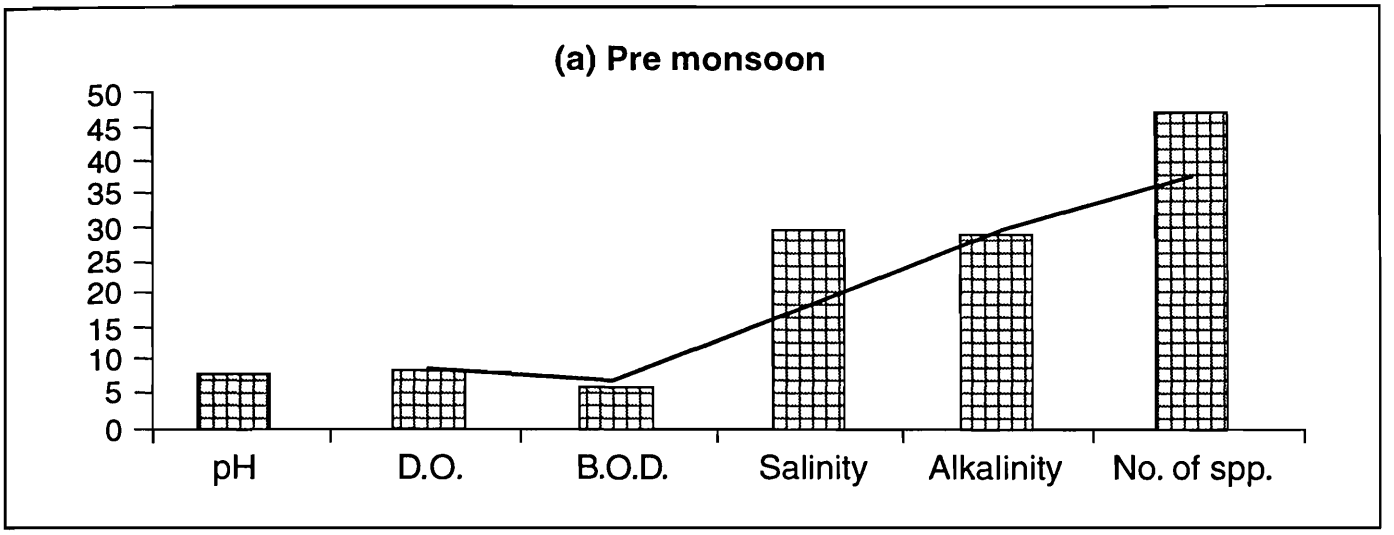
The significance of the present work is highlighted here with the fact that similar studies at various riverine and marine points had been undertaken by sufficient number of workers such as in India by Zingde *et al.* (1980), Mathur *et al.* (1986), Malik *et al.* (1995), Srivastava *et al.* (1996), Elango *et al.* (1992) as well as by ourselves (1999). The significance of such work can be understood with the apprehension that any significant alteration in such physicochemical values may cause catastrophic situation for a large variety of associated marine fauna. Although Digha being a relatively pollution free zone where the general profile of such limnologically important physicochemical parameters remain static, which is due to very insignificant level of contaminants/ pollutants like-heavy metals, pesticides, insecticides/herbicides as well as hydrocarbons in the sea water composition. But our ongoing activity in this regard is of great significance from the pollution measuring as well as limnological observations point of view to prepare a baseline data for further studies.

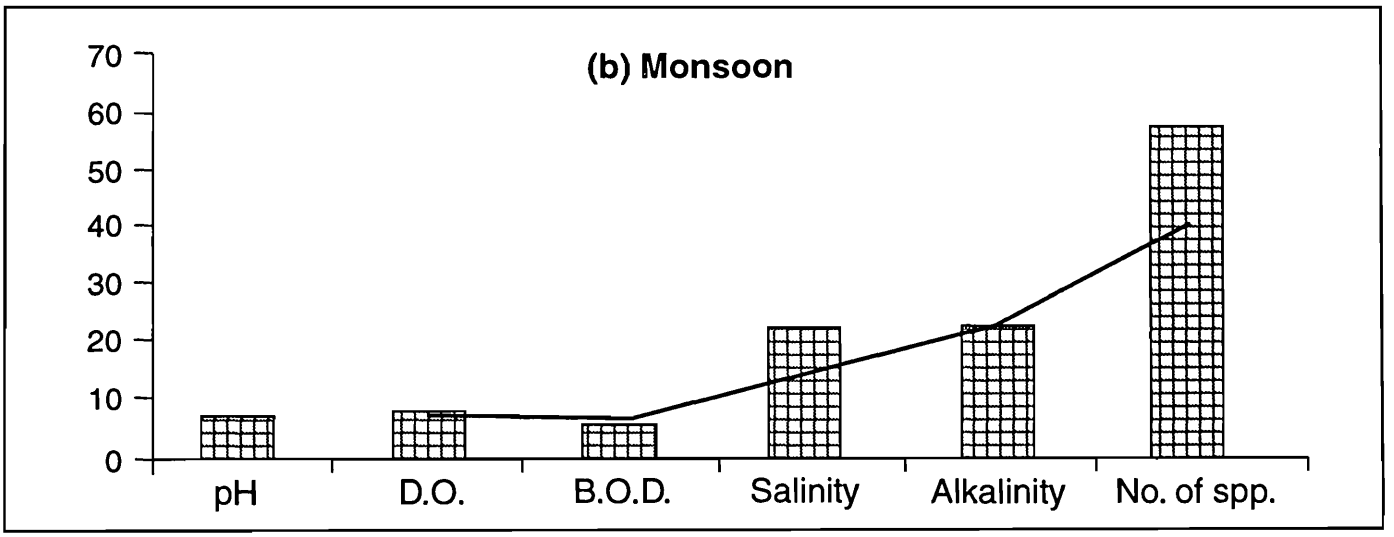
In this regard, it is worth to mention that continuous and indiscriminate use and exposure of such highly toxic substances in and around sea coast will damage the fabric of marine flora and faunal diversity at a very large scale up to the extent of the extinction of certain vulnerable species of fishes, shrimps, phytoplanktons and zooplanktons etc. It is well established fact that the sudden and excessive changes in Dissolved Oxygen, Biochemical Oxygen Demand (BOD), alkalinity, salinity and pH etc. may adversely affect a large number of marine species up to the extent of total disappearance in the chain process. A comparison of the number of fish species available during the pre monsoon, monsoon and post monsoon periods in relation to these Physico-chemical factors is expressed through Figures no. 1 (a-c). From the trend lines, the relationship between dissolved oxygen, alkalinity and the availability of species is evidenced.

It is with this logic that the regular monitoring of such biologically important physicochemical parameters from the coastal marine water samples is being carried out as a broad objective of our laboratory at this center for establishing a database as well as estimating the actual potential and the associated threat of environmental impact from the ongoing hotel as well as agricultural and other miscellaneous activities around this beautiful sea beach which has to be protected at any cost both from the heritage as well as from the commercial fishing point of view as marine commercial fishing is a major source of common people livelihood and also earning potential foreign money. Therefore, ever since the establishment of this laboratory (in 1992), we are regularly monitoring such parameters as ongoing project of immense utility.

## SUMMARY

Digha, the small but aesthetically very important place in Eastern Coast is of immense potential value both from tourism as well as commercial fishing point of view. The same is evident from



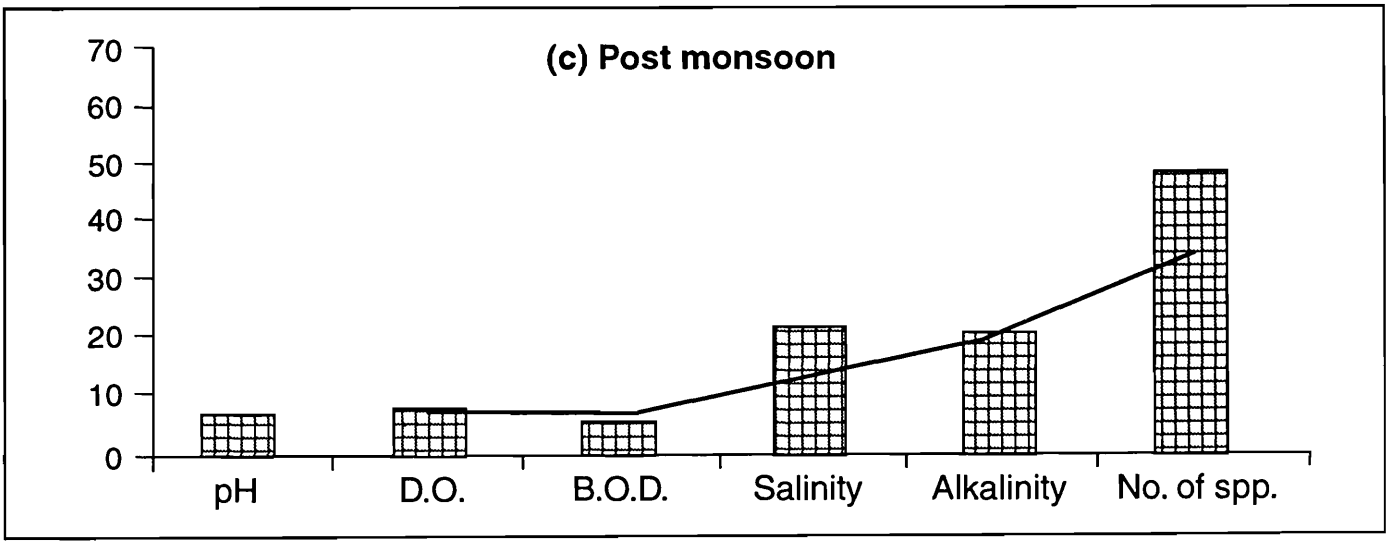




**Fig. 1.** (a-c) : Comparison of number of fish species available during pre monsoon, monsoon and post monsoon periods in relation to physico-chemical factors.

documented reports of the hotel/tourism as well as marine fish products' commercial venture. For preparing annual profile of limnologically important physicochemical parameters, sea water samples were analyzed as an ongoing project/activity of our Laboratory for furnishing baseline data for industry as well as researchers, which had been the theme of our study for consecutive six years period (March 1998 to Feb. 2004). Such data are very useful for correlating the occurrence and abundance of a particular marine sp. important from the Biological researchers or for the commercial viability point of view. It is scientifically well established fact that sea water quality affects survival and development of diversified faunal asses,

It is with this reason that we had undergone such study to record important physical data like : Temperature, Density, pH, Total Dissolved Solids, Total Suspended Solids, Conductance and Chemical parameters like : Chlorinity, Salinity, Alkalinity, Total hardness, Free Carbon Dioxide, Dissolved Oxygen, Biochemical Oxygen Demand Sulphate, Nitrate, Phosphate. Although general trend of such parameters' constancy is maintained throughout the year except in case of chlorinity/ salinity, which varies significantly raising from monsoon to post monsoon and from post monsoon to pre monsoon period. Our observations reported here for these physicochemical parameters (for past six years-March 1998 to February 2004) merit from the point of view of assessing expected pollution threat from ongoing Agriculture and Hotel activities which release significant amount of harmful pollutants like pesticides/insecticides, hydrocarbons, detergents etc. A small amount of pollution in sea water may alter these vital physicochemical parameters, which in turn may hamper the viability of entire marine faunal diversity affecting the commercial fish product, and livelihood of large number of associated fishermen.

## ACKNOWLEDGEMENT

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