Seasonal variation of Phyico chemical parameters of Teesta river of sub Himaliyan region, India.

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Abstract : The present investigation was carried out on the Teesta river at three stations to study the seasonal change of phyStation-1co-chemical factors . The parameters studied were air and water temperature, turbidity, pH, total dissolved solid, total suspended solid, total solid, conductivity, dissolved oxygen, biological oxygen demand, free carbon dioxide, chloride, salinity, total alkalinity, hardness, nitrate, phosphate and Station-1licate. The seasonal variation of the different parameters i.e Pre monsoon, Monsoon, and Post Monsoon has been discussed.

Keywords - Teesta River, physico-chemical parameters

Introduction

Northern part of West Bengal, popularly mentioned as North Bengal is endowed with numerous fresh water rivers. River "Teesta" is one of them. The main stream of this river is connected by different tributaries. One of them is Karala which originates from the Baikunthapur forest and flows down to the river Teesta near Daspara (Mandal Ghat) in Jalpaiguri Town. This River bisects the Jalpaiguri district town in two halves. The total catchments area of the river is 141 km^2 most of which is covered by arable land. The baStation-1n of this river sustains life and livelihoods of tea gardeners, fishermen and slum-dwellers. Tea gardeners consume the water resource for tea plantation and drain off the utilized excess water which carries variety of pesticides and fertilizers to that river (Karala) .The fisherman utilize the downstream of this river for fish capture. Slum-dwellers exploit the water resource for bathing, washing of cloths etc. Sewage from municipality, garbage from market and ash of cremation directly mix up with this river. As a result the phyStation-1cal, chemical and biological characteristics of the river water are gradually changing and producing the harmful effect on aquatic biota and thereby human beings. A quantity of phyStation-1co-chemical variables were undertaken to get an adequate knowledge of their oscillating rhythmic phenomena, and to throw a greater inStation-1ght into the nature of the system.

The objectives of this investigation were to explore phyStation-1cal and chemical properties of this river water in different seasons of the year, to study the diverStation-1ty of fin-fish resources in this riverine wetland and correlate the fish population with hydrological parameters.

Materials and Methods

Three different stations were selected in that river for sampling of water. The station-I (Aquiduct) is near the origin of the river. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°47'13" N, 88°32'17" E, and 402 ft. correspondingly. The station-II (Hakim Para) is located in the district town and behind the hospital & market. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°31'51" N, 88°43'23" E, and 283 ft. respectively. The Station-3is located at the junction of Teesta and Karala near Daspara. Its latitude, longitude, and elevation (from Mean Sea Level) are 26°28'42" N, 88°44'27"E, and 268 ft. respectively. Nineteen phyStation-1co-chemical parameters were under taken for the detailed investigation. Fortnightly the water samples were collected at the depth of 1 ft. The time of collection was 6.30 am to 8.30 am. All fifteen days samples were brought together as monthly average. Al1 water sample were collected in duplicate form by two glass DO (Dissolved Oxygen) bottles with the capacity of 150 ml each and one large PVC (1 litter capacity) bottle. Immediately the water samples were transferred to the departmental laboratory for all phyStation-1co-chemical studies except the air, water temperature, pH, conductivity and total dissolved solid (TDS). The air temperature was measured with the help of ordinary mercury thermometer at 1 ft. above surface water and the water temperature was measured with the same thermometer by placing it inStation-1de the water at the depth of 1 ft. on the three sampling stations. The depth of water body was measured by a marked (in ft.) wooden stick at the time of sampling. Other phyStation-1co- chemical parameters were analyzed in the departmental laboratory in the same day as early as posStation-1ble (within 2-3 hours) except BOD. The turbidity was measured by Turbidity meter and results are reported in units called Nephelometric Turbidity Units (NTUs). The pH, total dissolved solid (TDS), and conductivity were measured during sampling by Deluxe water and soil analyStation-1s kit (Model-171 of Electronics India). The total suspended solid (TSS) was measured by evaporation method and the total solid (TS) was calculated by the sum of TDS and TSS values. The dissolved oxygen, free carbon dioxide, BOD, chloride, salinity, hardness and total alkalinity, nitrate, phosphate and Station-1licate were measured at the departmental laboratory in accordance with APHA (1995). The fishes were captured at three stations by different nets. At station-I the fishes were captured by cast net (mesh Station-1ze 6mm. X 6 mm.) and naphi jal (local contrivance, mesh Station-1ze 5mm.X 5mm). In station II and III the fishes were captured by vessel net or khara jal (local contrivance, mesh Station-1ze 6 mm. X 6 mm.), gill net (variable mesh Station-1zes), and cast net (5mm X 5 mm. mesh Station-1ze). After capture the color, color patterns, spots etc. were noted immediately and their picture was taken by a powerful camera. The fishes were killed by formalin solution containing one part commercial formalin (37-40% HCHO) + nine part glass distilled water and 7 gm Borax/liter (Jayaram, 1981). All the fishes were kept in this buffer formalin solution for 4-5 hours for proper fixation. The fishes were identified by the literature of Talwar & Jhingran, 1991 and Jayaram, 1999 & 2006 and were confirmed from Freshwater Fish Section of Zoological Survey of India. The threat status and endemism of fishes were asStation-1gned following Barman (2007).The diverStation-1ty and evenness indices were calculated by the references of Shannon & Wiener (1949) and Pielou (1975).

Results and Discussion

The results are presented in Table-1, 2 and 3

Maintenance of a healthy aquatic ecosystem depends on the phyStation-1co-chemical properties as well as biological characteristics. Physico-chemical factors of water not only affect the distribution patterns and abundances of species; they also play an important part in species richness (the number of species in any given location). Temperature is one of the most important phyStation-1cal parameters, which controls the physico chemical and biological activities and distribution of biota. Water bodies naturally show changes in temperature seasonally and daily; however, man- made changes to stream water temperature will affect fish's ability to reproduce. Many lakes and rivers exhibit vertical temperature gradients. The main source of temperature in water body is solar system. In the entire study the air temperature ranged between 9-29°C at station- 1, 12-28°C at station- 2 and STATION-3. On any sampling day, the temperature of station- 2 and station- 1 did not differ greatly but between station- 1 & station- 2 and station- 1 & station- 2 varied greatly.

This may be due to the distance between the stations and interval between the samplings. During pre-monsoon the water temperature at station- 1 and station- 2 lied in the range 29-30°C which was greater than the air temperature but at station- 2 it was 24-28°C and was lower than the air temperature. This is due to the thermal properties, depth and mixing of cold water from the hills. Throughout the monsoon at station- 1 the water temperature was 24 - 30°C, at station- 2 28 - 30°C and at station- 1 27 - 30.3°C. For the period of post-monsoon it was 12-19 °C at station- 1, 15 - 21°C at station- 2 and 15 - 20.5°C at station- 1. station- 3. It also showed positive correlation with air temperature at both the stations . Turbidity is the optical property of a water sample that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Light's ability to pass through water depends on the amount of suspended material present. Turbidity may be caused when light is blocked by large amounts of Station-1lt, microorganisms, plant fibers, sawdust, wood ashes, chemicals

and coal dust. Any substance that makes water cloudy will cause turbidity. The most frequent causes of turbidity in lakes and rivers are plankton and soil eroStation-1on from logging, mining, and dredging operations. Turbidity affects fish and aquatic life by interference with sunlight penetration and reduces photosyntheStation-1s in plant resulting in lower oxygen concentrations and large carbon dioxide concentrations. For the period of study, monsoon showed the maximum turbidity range but the pre and post monsoon showed the least range. At the confluence of Teesta and Karala the water was more turbid than other two sampling Station-1tes. As the turbidity depends upon the TSS, so it shows Station-1gnificant poStation-1tive correlation with it. It may be due to the soil eroStation-1on. One of the important factors that serve as an indicator of pollution of water body is pH. The pH of natural water can provide important information about many chemical and biological processes and provides indirect correlations to a number of different impairments. At the period of study, the average pH on station- 1 and station- 3 during pre and post monsoon was acidic. During early monsoon it was neutral to alkaline. The station- 2 which is located at the heart of the town (Jalpaiguri) showed acidic pH during both the seasons. The acidic pH may be due to the high organic load and decompoStation-1tion. The rain water is responStation-1ble for neutralization and finally to alkaline. The fluctuation of pH in this lotic system may be due to the buffering capacity. Total solid (TS) of water is represented by the sum total of TDS and TSS. The solid substances present in the water stay either in dissolved or suspended forms. The dissolved forms are smaller and lighter than suspended ones. The TDS values of water ranged from 0.02 to 0.05 ppt at station- 1, 0.04 to 0.1 ppt at station- 2 and 0.04 to 0.07 ppt at station- 3. Comparatively station- 2 showed maximum TDS concentration. The TSS values of water ranged from 0.02-0.1 ppt at station- 1, 0.02-0.3 ppt at station- 2 and 0.07-1.00ppt at station- 3. Comparatively station- 3 showed maximum TDS. The TDS and TSS were irreverStation-1bly related. This may be due to the addition of solids from runoff water. Depth of water body is another important phyStation-1cal factor of lotic systems that controls the productivity and diverStation-1ty of living things. At the period of study, the depth was maximum in station- 3 and minimum in station- 1. At both the stations the depth showed least at post and pre monsoon. This river has been Station-1lted day by day due to soil eroStation-1on and that finally caused irregular depth. Electrical conductivity (EC) in natural waters is the normalized measure of the water's ability to conduct electric current. This is mostly influenced by dissolved salts present in water body. The EC values of water samples ranged from 30 to 40(μs/cm) at station- 1, 64 to 89 (μs/cm) at station- 2 and 43 to 53(μs/cm) at station- 3. Comparatively station- 2 showed maximum EC. The EC depends upon the concentrate of ions and nutrients and variation of dissolved solids. Dilution water during rain depletes the EC value of water. It showed poStation-1tive correlation with TDS. The variation of conductivity indicates the uneven occurrence of un-ionized chemical substances and due to poor irrigation management, minerals from rain water run off, or other discharges.

Oxygen is an important eco-chemical parameter which is essential for the metabolism of all aquatic aerobically respired biota. Dissolved oxygen in water indicates water quality and diverStation-1ty of living things. The concentrations ranged from 4.05 to 8.1ppm at station- 1, 2.43-6.5 ppm at station- 2 and 3.24-6.61 ppm at station- 3. The highest values of DO were recorded from the end of pre monsoon to mid monsoon at all the stations. In the present study it showed a positive correlation with pH and temperature. This may be due to turbulence and oxygenation resulting from rain falls and mixing up of gleaming aerated water. Addition of varieties of biodegradable pollutants from domestic sewage, municipality's wastes, garbage from market and hospital etc. stimulate the growth of micro organisms which consume the dissolved oxygen for decompoStation-1tion. So the concentration gradually depletes. The present observation is in agreement with similar reported by Chakraborty, 1998 and Barat & Jha, 2002.

Table1. Physico -chemical Parameters of water at station- 1 Teesta river

Parameters	Seasons					
	Pre-monsoon		Monsoon		Post-monsoon	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Air temperature (°C)	26-27	26.5±0.5	26-29	27.25±1.1	9-16	13.5±2.7
Water temperature (°C)	29-30	29.55±0.46	24-30	27.68±2.27	12-19	17±2.9
Turbidity (NTU)	8-32	19.75±9.3	20-42	33±8.8	5-15	8.75±4.1
pH	6.7-7.3	6.9±0.23	6.9-7.3	7.15±0.17	6.8-6.9	6.83±0.04
Total dissolved solid (ppt)	0.03-0.05	0.04±0.01	0.02-0.03	0.025±0.001	0.02-0.04	0.0325±0.001
Total suspended solid (ppt)	0.04-0.08	0.0625±0.015	0.07-0.1	0.0875±0.013	0.02-0.06	0.0375±0.018
Total solid (ppt)	0.07-0.12	0.1025±0.02	0.10-0.12	0.1125±0.001	0.04-0.1	0.07±0.03
Conductivity (µs/cm)	38-40	39.25±0.83	30-32	31.25±0.83	32-38	35±2.12
Dissolved oxygen (ppm)	5.28-6.5	5.7±0.48	5.68-8.1	6.69±1.05	4.05-4.86	4.4±0.3
Free CO_2 (ppm)	5.84-7.04	6.66±0.5	5.84-6.14	5.98±0.14	6.26-6.82	6.68±0.24
Salinity (ppt)	0.037-0.045	0.041±0.0002	0.035-0.044	0.038±0.0003	0.034-0.039	0.036±0.0002
BOD (ppm)	0.80-1.82	1.38±0.37	0.00-0.67	0.47±0.27	0.82-1.15	0.95±0.14
Nitrate (ppm)	0.25-0.65	0.46±0.18	0.1-0.22	0.15±0.05	0.15-0.20	0.19±0.02
Phosphate (ppm)	0.11-0.23	0.1925±0.05	0.05-0.12	0.073±0.03	0.06-0.09	0.075±0.011
Station-1licate (ppm)	0.52-0.61	0.543±0.04	0.12-0.22	0.16±0.04	0.17-0.38	0.238±0.08
Chloride (ppm)	2.2-5	3.2±1.15	3-7.5	4.45±1.81	4-8.1	6.025±1.45
Total alkalinity (ppm)	28-33	30.25±1.79	28-29.6	28.68±0.66	29.5-30.1	29.93±0.23

Table2. Physico-chemical Parameters of water station- 2 **of** Teesta river

Water quality (PhyStation-1co-chemical)	Seasons					
	Pre-monsoon		Monsoon		Post-monsoon	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Air temperature (°C)	26-27	26.5±0.5	25-28	26.18±1.14	12-18	15.25±2.38
Water temperature (°C)	29-30	29.5±0.5	28-30	28.75±0.83	15-21	18.5±2.29
Turbidity (NTU)	10-35	19.25±9.4	35-62	48±10.9	5-15	8.75±4.1
pH	6.1-7.1	6.43±0.41	6.8-7.1	6.9±0.12	6.3-6.7	6.53±0.18
Total dissolved solid (ppt)	0.06-0.1	0.0875±0.016	0.04-0.05	0.045±0.001	0.06-0.08	0.0725±0.001
Total suspended solid (ppt)	0.05-0.1	0.08±0.02	0.1-0.3	0.2125±0.089	0.02-0.08	0.0425±0.025
Total solid (ppt)	0.14-0.19	0.1675±0.02	0.15-0.34	0.2575±0.08	0.1-0.14	0.115±0.02
Conductivity (µs/cm)	70-89	79.75±7.95	64-67	65.5±1.5	67-71	68.5±1.66
Dissolved oxygen (ppm)	4.4-6.5	4.98±0.88	4.46-6.49	5.02±0.85	2.43-4.05	3.38±0.7
Free CO_2 (ppm)	4.9-9.2	7.59±1.78	4.9-5.3	5.15±0.17	5.4-6.84	6.15±0.61
Salinity (ppt)	0.048-0.063	0.054±0.00056	0.042-0.045	0.043±0.00009	0.043-0.049	0.047±0.00025
BOD (ppm)	0.96-3.62	2.77±1.1	0.81-1.17	0.95±0.14	1.21-2.59	1.76±0.52
Nitrate (ppm)	0.31-0.84	0.583±0.239	0.10-0.25	0.20±0.0612	0.25-0.30	0.275±0.025
Phosphate (ppm)	0.27-0.31	0.285±0.015	0.06-0.11	0.078±0.019	0.07-0.17	0.1075±0.039
Station-1licate (ppm)	0.49-0.61	0.535±0.045	0.12-0.22	0.16±0.039	0.17-0.38	0.2375±0.083
Chloride (ppm)	10-18.08	13.095±3.08	6.9-8.2	7.275±0.54	7-10.5	9.375±1.386
Total alkalinity (ppm)	30-35	33.25±2.05	30-32	31.38±0.82	32.3-33.5	32.8±0.52

The biological oxygen demand (BOD) gives an idea of the quantity of biodegradable organic matter present in an aquatic system which is subjected to aerobic decompoStation-1tion by microbes. Accordingly it provides a direct measurement of the state of pollution. The concentration of BOD ranged from 0.00 to 1.82 ppm at station- 1, 0.81 to at station- 2 and 0.81-2.52 at station- 2. At both the stations, the BOD values were highest for the period of premonsoon and minimum for the period of monsoon. This hydro chemical parameter was irreverStation-1bly correlated with DO at all three stations and supports the observations of Ray & David, 1966 and Barat & Jha, 2002.The BOD level indicates that station- 2 is more polluted than other two stations.

Table3. Physico-chemical Parameters of water at station- 3 **of** Teesta river

Parameters	Seasons					
	Pre-monsoon		Monsoon		Post-monsoon	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Air temperature (°C)	27-28	27.25±0.43	25-28	26.175±1.14	12-18	15±2.12
Water temperature (°C)	24-28	25.075±1.69	27-30.3	28.325±1.21	15-20.5	17.875±1.95
Turbidity (NTU)	15-45	24.25±12.1	30-75	55±18.4	5-17	10.5±4.5
pH	6.4-7.1	6.63±0.29	6.8-7.2	7.03±0.18	6.4-6.6	6.53±0.08
Total dissolved solid (ppt)	0.04-0.07	0.059±0.011	0.04-0.042	0.041±0.0001	0.04-0.06	0.05±0.001
Total suspended solid (ppt)	0.15-1.00	0.38±0.36	0.25-1.00	0.65±0.31	0.07-0.17	0.1225±0.04
Total solid (ppt)	0.21-1.04	0.439±0.35	0.292-1.04	0.691±0.31	0.13-0.21	0.1725±0.03
Depth (ft)	12-15	12.75±1.3	20-23	20.75±1.3	12-15	14.25±1.3
Conductivity (μs/cm)	50-53	51.75±1.3	43-45	44±1	45-49	46.5±1.66
Dissolved oxygen (ppm)	4.05-5.83	4.9±0.63	4.86-6.61	5.6±0.65	3.24-3.79	3.6±0.21
Free CO_2 (ppm)	8.64-9.5	9.21±0.35	5.1-5.84	5.44±0.34	6.64-7.04	6.83±0.19
Salinity (ppt)	0.048-0.054	0.051±0.0002	0.039-0.042	0.041±0.0001	0.041-0.048	0.046±0.0003
BOD (ppm)	0.92-2.52	1.8±0.58	0.81-0.92	0.85±0.05	0.97-1.72	1.36±0.32
Nitrate (ppm)	0.26-0.52	0.335±0.108	0.20-0.40	0.2875±0.089	0.25-0.30	0.275±0.025
Phosphate (ppm)	0.11-0.21	0.158±0.043	0.05-0.11	0.068±0.025	0.07-0.09	0.078±0.0008
Station-1licate (ppm)	0.52-0.61	0.5575±0.04	0.12-0.22	0.16±0.04	0.17-0.38	0.2375±0.08
Chloride (ppm)	10-13.1	11.4±1.12	5.1-6.7	5.975±0.57	6.1-10	9.025±1.69
Total alkalinity (ppm)	27.5-30.5	29.5±1.22	26-29	27.53±1.48	28.7-29.6	29±0.37

Free carbon dioxide is an odorless as well as colorless gas produced during the respiration cycle of animals, plants and bacteria. All animals and many bacteria use oxygen and release carbon dioxide. Green plants, in turn, absorb the carbon dioxide and, by the process of photosyntheStation-1s, produce oxygen and carbon-rich foods. Carbon dioxide quickly combines in water to form carbonic acid, a weak acid. The presence of carbonic acid in waterways may be good or bad depending on the water's pH and alkalinity. If the water is alkaline (high pH), then carbonic acid will act to neutralize it. But if the water is already quite acidic (low pH), the carbonic acid will remain un-dissociated. In the present study, the free carbon dioxide concentration ranged from 5.84-7.04 ppm at station- 1, 4.9-9.2 ppm at station- 2 and 5.1-9.5 ppm at station-3 respectively. It is inversely related with pH at both the stations. The result of carbon dioxide indicates high organic load in two down stream stations i.e., station- 2 and station- 3. Alkalinity is not a pollutant. It is a total measure of the substances in water that have "acid-neutralizing" ability. pH measures the strength of an acid or base. Alkalinity indicates a solution's power to react with acid and "buffer" its pH. Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes. In the present study, total alkalinity (TA) represents to bicarbonate alkalinity only. Average TA values were observed maximum during the pre monsoon and minimum during monsoon at both the stations. The pH, CO_2 and TA were interrelated to each other. TA with pH showed negative correlation but with CO_2 showed poStation-1tive correlation. This may be due to the rate of decompoStation-1tion of discharged organic matters from different sources.

Chloride concentration is one of the indicators of water pollution (Munawar, 1970). It is also related with the concentration of salinity. In the present study, the average chloride concentration showed an increase from station- 1 (8.1 ppm) to station- 2 (18.08 ppm) and thereafter decreased at station- 3 (13.1 ppm). Minimum concentrations were recorded during monsoon and maximum were recorded during pre-monsoon at both the stations. This may be due to he the organic waste load particularly sewage contamination.

Salts are naturally occurring compounds of a metal and non-metal cause salinity of water on dissolution. The importance of salinity of aquatic life is reflected in the difference between fresh water and marine water species. If salinity concentration is more than 1 ppt, it is called saline water. In the present study, the salinity of water was very poor and always less than 1 ppt. It ranged from 0.034-0.045 ppt at station- 1, 0.042-0.063 ppt at station- 2 and 0.039-0.054 ppt at station- 3. Chloride is one of the major inorganic anions in water, which is related with salinity. It suggests that, organic wastes directly mixed with water body increasing the chloride concentration which finally increases the salinity during pre-monsoon. During monsoon rain fall dilutes the concentration of chloride causing the decrease of salinity.

To study water quality of Teesta River, three nutrient factors were selected. Nitrate (NO^-) is one of the important nutrients in water body and is the common form of nitrogen in natural water. Nitrite (NO^-) is oxidized to nitrate after entering an aerobic regime. Station-1milarly, plants and microorganisms reduce nitrate into nitrite but nitrite ion is quickly oxidized back to nitrate once it re-enters the water. Natural sources of nitrate are igneous rock, plant decay and animal debris

(including fish, wild animals and birds), and discharges from car exhausts. Nitrate stimulates the growth of plankton and water weeds that provide food for fish.

This may increase the fish population. However, if algae grow too wildly, oxygen levels will be reduced and fish will die. In the present study, the nitrate concentration ranged from 0.1 to 0.65 ppm at station- 1, 0.1 to 0.84 ppm at station- 2 and 0.2 to 0.52 ppm at station- 3. Maximum concentration was estimated during pre-monsoon at all the stations. The average values were low at station- 1 in comparison to other two study Station-1tes. This may be due to the contamination of nitrogenous fertilizer from tea gardens, sewage, rottenning of jute by farmers etc.

Phosphate (orthophosphate or total reactive phosphorus [TRP]) is the ionized form of orthophosphoric acid. In solution and in natural water, phosphate ion will have many forms and will be at a pH dependent equilibrium. The higher the pH, the more PO^{3-} will form from the deprotonation of HPO^{2}. Unlike total ammonia, phosphates are less soluble and less volatile, therefore, phosphates form salts with calcium and magneStation-1um and fall out of solution to accumulate in the sediment. Phosphates ions in natural water exist in solution in its ionized form, as salts, in organic form or as a particulate species. Higher concentration rarely occurs, because after it enters a water system, it will be rapidly up taken by plants and bacteria. In general, phosphorous is an essential nutrient to living organisms. Inorganic phosphate, another ingredient of cultural eutrophication in water body, ranged from 0.05-0.23 ppm at station- 1, 0.06-0.31 ppm at station- 2 and 0.05-0.21 ppm at station- 3. At both the stations its concentration was maximum during pre-monsoon and the least when rainy season appears. This nutrient showed poStation-1tive correlation with nitrate. This may be due to the domestic discharge and agricultural runoff where phosphate containing fertilizers are used, and changes in land use in areas where phosphorous is naturally abundant in the soil.

Silicate (soluble) is another nutrient of fresh water body. Slicon is usually present as a form of hydrated amorphous Station-1licon or polymerized Station-1licic acid, but once it is solidified and depoStation-1ted, the amorphous Station-1licon does not act as a source of supply during deficiency (Lewin, 1961). In the present study the Station-1licate concentration ranged from 0.12 to 0.61 ppm in the river and more or less uniformly distributed. Like other two nutrients its concentration was greater at pre-monsoon in comparison to other two seasons. This may due to release soluble Station-1licate from bottom mud, rocks, mineralization and disruption of Station-1licic acid containing living things frustules by zooplanktons. Beklemishev, 1961 and Teasenow, 1966 reported that, the dissolved Station-1licate was greatly accelerated by the disruption of diatom frustules by zooplanktons.

The present observation is in agreement with Station-1milar ones reported by Growns et al., 2003. The submerged weeds might have importance in fish assemblage and aggregation.

CONCLUSTATION-1ON

Aquatic ecosystems contain three sub-systems. The first involves the phsico chemical sub-system, the second sub-system includes all the biota and the third depending upon the productivity is a social sub-system and determines what the problems are, what has caused them and what their solutions ultimately will be. In the present investigation, the station- 2 (Hakim Para) appears to be more disturbed by external influences compared to the Aquiduct and Daspara. The station- 1 seems to be the least polluted. The domestic sewage, garbage from market, drainage materials from hospital, leaching of fertilizers & pesticides from tea gardens, use of ichthyotoxic substances for fish capture and ashes of cremation directly mix up with that river and are clearly manifested in these results. The deterioration of water quality is related with above causes. The results obtained from the present investigation shall be helpful in future management of the river Teesta.

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