



Effect of Physico-chemical properties of water on population of Macrozoobenthos of Kunghada Bandh Lake, Dist.- Gadchiroli, Maharashtra (India)

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Abstract— Correlation study of physicochemical properties with biota of any fresh water body depicts the status of any ecosystem. Correlation of physicochemical parameters with benthic organisms especially macrozoobenthos of Kunghada Bandh Lake was organized to know the status of this fresh water ecosystem. This type of study is very useful to calculate the quality of water and restoration of such type of fragile ecosystem time to time. Samples were collected from five different sampling stations for two years i.e. from February 2012 to January 2013 and February 2013 to January 2014. Macrozoobenthos were collected from all five stations by using 'Ekman's dredge' and 'Van-Vin grab'. Annelids observed more in monsoon and winter than summer. Total 09 species of arthropods were recorded. Minimum average of Arthropods was recorded in summer and maximum average of Arthropods in monsoon. The same trend was followed by molluscan species. The increased concentrations of most of the chemical parameters in summer affects on the population of most of the faunal component in decreased manner.

Keywords— Physico-chemical, Population, Macrozoobenthos, Kunghada bandh.

I. INTRODUCTION

The study of hydrobiology means relation between water and living thing i.e. micro and macro organisms present in aquatic ecosystems (Chatwal G.R.,1996). Kunghada Bandh Lake (latitude 20.22°N and longitude 80.01°E.) is constructed by British Government in 1890 present in Chamorshi Tahsil of Gadchiroli district which is easternmost part of Maharashtra state of India. Lake having area near about 5.95 sq. km. occupying water capacity 3.017 cubic density while the useful water storage is about 2.844 cubic density. It is the huge lake and having water spread area about 34.70 hectare. Perimeter of the lake is 1372 meter having main canal of 8.96 kilometer in length. This study is organised for the determination of correlation and effect of physicochemical parameters on population of benthic organisms especially macrozoobenthos of the lake. This type of study is always

useful to maintain fair quality of water and restoration of such type of fragile ecosystem time to time.

The physico-chemical and biological factors affect the quality of water according to their characteristics and nature.

Benthic organisms or zoobenthos is the group of community of an organisms which live on, in or near the shore of water body, this zone is also known as profundal zone or benthic or bottom zone. Zoobenthos generally cannot survive in the upper parts of the water column due to the pressure difference between the lower and upper parts of the water column. The food chains of most of the benthic organisms are comprises dead and decaying matter and most of them are detritivores in nature. The main food sources of these organisms are planktons, algae and other organic runoff that comes from catchment area of lake. Various physic-chemical and biological factors play an

important role in the presence or absence of benthic organisms in any aquatic ecosystem. For this correlation

study; macrobenthos having size more than 1 millimeter or 1,000 micrometer (μm) were taken in to consideration.



Fig.1:Satellite image of 'Kunghada Bandh' (Curtsy: Google map)

II. MATERIAL AND METHODS

The water samples and macrozoobenthos were collected from five different stations covering East, West, North, South and Centre part of lake. The water samples collected in a plastic can from each station and immediately analysed in the laboratory. Some parameters were analysed on the spot such as temperature, pH, dissolved oxygen, etc. by using titrimetric mobile test water kit and digital devices. The macrozoobenthos were collected from all five stations in white enamel tray by using 'Ekman's dredge' and 'Van-Vin grab'.

The samples were collected every month during morning period two years i.e. February 2012 to January 2014 and categorized them according different species. During the investigation various parameters like physical, chemical and biological were taken into consideration for correlation study.

The analyses of all collected samples were determined by as per available and prescribed standard methods(AWWA , APHA ,2005, Santhanam *et.al.*, 1989, Trivedi R.K. and Goel P.K., 1984,Welch P.S.,1952). The collected macrozoobenthos were segregated and identified according to different phylum up to species level with the help of various standard keys (Needham J.G.,1962 and Tonapi G.T., 1980). The densities of macrozoobenthos were calculated by using the following formula.

$$N/M^2 = \frac{n \times 10^4}{A}$$

Where,

N= Total No. of organisms (actual count of particular species in its residing habitat)

n = No. of organisms per sample (actual count of particular species per dredge)

A= Area of the sampler (6" X 6" X 6").

III. RESULT AND DISCUSSION

1. Physico- chemical parameters:

Most of the physico-chemical factors affect the quality of water which results in fluctuation in frequency of benthic organisms (BIS.,2012).

The minimum average of temperature (22.38, ± 0.92) was recorded in winter and maximum average of temperature (25.98, ± 1.56) in summer as compared to the annual average of temperature (24.73, ± 2.03). Temperature mostly increases during summer and declines during winter because of atmospheric temperature are highest in summer and winter has lowest (Dubey M.A. *et.al.*, 2013, Rajanna A.H. and Belagalli S.L., 2011),. During the study, temperature recorded lowers in winter and more in summer.

pH is the most important factor in water both for flora and fauna. The acceptable limit of pH in drinking

water should be in the range of 6.5 to 8.5 (BIS, 2012). The minimum average pH (7.67, ± 0.17) was recorded in monsoon while maximum average pH (8.11, ± 0.11) in summer as compared to the annual average of pH (7.94, ± 0.65). It occurs might be due to the when photosynthesis uses up dissolved CO₂, which acts like carbonic acid. Carbon dioxide removal, in effect reduces the pH of water.

Total solids (mg/lit.) are equal to the suspended solids plus total dissolved solids. Minimum average of total solids (78.25, ± 4.49) was recorded in winter and maximum average of total solids (102.25, ± 6.27) in summer as compared to the annual average of total solids (93.42, ± 12.92). Total dissolved solids (mg/lit) comprise inorganic salts and some small amounts organic matter which are dissolved in water. The acceptable limit of Total dissolve solids in drinking water should not be more than 500 mg/l (BIS, 2012). The minimum average of total dissolved solids (60.88, ± 4.88) was recorded in winter and maximum average of total dissolved solids (81.5, ± 5.18) in summer while average of total dissolved solids is 74.21, ± 11.21 . Total dissolved solids mostly increase during summer due to increases in sedimentation and decrease in quantity of water which results in decrease in depth of water also. Suspended solids used as an indicator to check water quality. The minimum average of suspended solids (17.37, ± 1.56) was recorded in winter and maximum average of suspended solids (20.75, ± 1.44) in summer (Wilson, P.C., 2010)

Turbidity (NTU) in water is caused by suspended matter, such as silt, clay, finely divided organic and organic matter, soluble coloured organic compounds, microscopic organisms, and planktons (AWWA-APHA., 2005). The acceptable limit of Turbidity in drinking water should not be more than 1 NTU (BIS, 2012). The minimum average of turbidity (6.3, ± 0.25) was recorded in winter and maximum average of turbidity (7.32, ± 0.22) in monsoon as compared to the annual average of turbidity (6.78, ± 0.49) (Wilson, P.C., 2010).

Electrical conductivity (μ mhos) is the measure of a material's ability to conduct or accommodate of an electric current or an electric charge. Minimum average of electrical conductivity (95.0, ± 5.43) was recorded in winter and maximum average of electrical conductivity (114.37, ± 9.81) and annual average of electrical conductivity is (107.46, ± 11.29). Conductivity mostly increases during summer because of surface evaporation of water which results in rising of concentration of salts while decline in conductivity during in winter is due to the sedimentation and utilization of minerals by growing phytoplankton and macrophytes (Puri, P.J *et.al.* 2010).

A high level of hardness is not health concern but still up to 80 mg/lit is standard limit for drinkable water ((AWWA-APHA., 2005). Both calcium and magnesium are very useful for plants and animals. The acceptable maximum limit of total hardness in drinking water should be 200 mg/l (BIS, 2012). Minimum average of total hardness (63.16, ± 2.96) was recorded in winter and maximum average of total hardness (86.95, ± 3.57) in summer as compared to the annual average of total hardness (76.02, ± 10.91). It might be due to high temperature in summer which results in the breakdown of rocks, less amount of water and domestic uses specially detergents (Sukund, B.N. and Patil, H.S., 2004)). Calcium is very important for the formation of bones in vertebrates and shell in molluscans. A low level of calcium in water reduces the number of fauna. Minimum calcium hardness (31.32, ± 0.99) was recorded in winter and maximum calcium hardness (41.72, ± 5.53) in summer and annual average of calcium hardness is (37.08, ± 5.69). Calcium hardness was mostly decline during winter and increases in summer in lake water (Karim L.R. *et.al.*, 2012 and Kumar B.M. *et.al.*, 2004). Magnesium is very important for plants to form chlorophyll; less amount of magnesium reduces the population of phytoplankton and aquatic plants. The minimum average of magnesium hardness (31.35, ± 2.17) was recorded in winter and maximum average of magnesium hardness (45.22, ± 5.23) in summer as compared to the annual average of magnesium hardness (38.78, ± 7.29). The magnesium hardness recorded less in winter because most of the magnesium is utilized by large vegetation (Shinde, S.K. *et.al.*, 2010).

Calcium plays an important role in the maintenance of structural and functional integrity of cell membranes in ion retention and absorption of both flora and fauna (Wetzel, R.G., 1975). The acceptable limit of Ca⁺⁺ in drinking water should not be more than 75 mg/l (BIS, 2012). Minimum average of Ca⁺⁺ (12.72, ± 0.48) was recorded in winter and maximum average of Ca⁺⁺ (16.69, ± 2.21) in summer as compared to the annual average of Ca⁺⁺ (14.90, ± 2.22). Magnesium is very important for plants to form chlorophyll; less amount of magnesium reduces the number of phytoplankton and plants. It also acts as micronutrient in enzymatic transformation, especially in algae, bacteria and fungi. Minimum average of Mg⁺⁺ (7.52, ± 0.52) was recorded in winter and maximum average of Mg⁺⁺ (10.85, ± 1.26) in summer as compared to the annual average of Mg⁺⁺ (9.31, ± 1.75). It might be due to the degradation of plants, more leaching of rocks in summer and most of the magnesium is utilized by large vegetation in monsoon and winter (Pawar S. and Sonawane S., 2011).

Table1: Average monthly values of physico-chemical parameters during two years (Feb. 2012 to Jan. 2014)

S.N.	Parameters	Unit	Summer				Monsoon				Winter			
			FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
01	Water Temperature	⁰ C	24	25.2	26.5	28.2	27.1	26.1	25.5	24.6	23.85	22.5	21.5	21.7
02	Ph	8.0	8.0	8.25	8.2	7.9	7.75	7.45	7.6	7.95	8.3	7.9	7.95
03	Total Solids	mg/lit	97	96.5	103.5	112	116	98	93.5	91.5	83	82	76	72
04	TDS	mg/lit	76	78	82.5	89.5	94	79	74	74	66	65.5	56	56
05	Suspended Solids	mg/lit	21	18.5	21	22.5	22	19	19.5	17.5	17	16.5	20	16
06	Turbidity	NTU	6.45	6.6	6.7	7.15	7.2	7.65	7.4	7.05	6.7	6.3	6.15	6.05
07	Elect. Cond.	μmhos	102	110.5	116	129	120.5	113.5	110.5	107.5	103	96	88	93
08	Total Hardness	mg/lit	81.85	85.65	88.95	91.35	86.5	81.4	76	67.95	63.9	60.6	60.45	67.7
09	Ca - Hardness	mg/lit	38.55	44.35	34.75	49.25	38	41.2	40.4	33.15	32.5	31.9	29.85	31.05
10	Mg - Hardness	mg/lit	43.3	41.3	54.2	42.1	48.5	40.2	35.6	34.8	31.4	28.7	30.6	34.7
11	Calcium-(Ca ⁺⁺)	mg/lit	15.42	17.74	13.9	19.7	15.2	16.48	16.16	13.26	13	12.76	11.94	13.2
12	Magnesium-(Mg ⁺⁺)	mg/lit	10.39	9.91	13.01	10.1	11.64	9.65	8.54	8.35	7.54	6.89	7.34	8.33
13	Dissolved Oxygen	mg/lit	5.7	5.8	5.8	5.55	6.0	6.3	6.55	6.8	6.4	6.55	5.95	5.85
14	Free CO ₂	mg/lit	5.8	5.9	6.2	6.6	6.05	5.6	5.5	5.2	5.3	5.2	4.75	4.9
15	Alkalinity	mg/lit	68.1	72.35	74.25	75.95	76.3	71.6	68.35	64.65	58.95	58.65	57.25	59.4
16	Acidity	mg/lit	5.65	5.3	5.0	4.7	4.5	4.25	4.3	4.05	3.8	3.6	3.4	4.0
17	Phosphate	mg/lit	0.68	0.79	0.92	1.09	1.92	1.41	1.13	0.09	0.07	0.12	0.085	0.17
18	Nitrate	mg/lit	0.21	0.285	0.39	0.56	0.68	0.98	0.98	1.11	1.04	0.64	0.22	0.25
19	Sulphate	mg/lit	18.75	20.1	21.75	22.4	22.8	23.1	20.85	19.4	17.8	17.15	16.65	17.35
20	Chloride	mg/lit	4.7	4.5	4.6	5.3	5.9	6.7	6.8	6.9	7.1	6.35	6.0	6.25

Table 2: Average annual and seasonal values of physico-chemical parameters during two years (Feb. 2012 to Jan. 2014)

S.N.	Parameters	Unit	Annual				Summer	Summer	Monsoon	Monsoon	Winter	Winter
			Min	Max	Avg.	SD	Avg.	SD	Avg.	SD	Avg.	SD
1	Water Temperature	$^{\circ}\text{C}$	21.5	28.2	24.72	2.02	25.97	1.55	25.82	0.90	22.38	0.92
2	pH	7.45	8.3	7.93	0.24	8.11	0.11	7.67	0.16	8.02	0.16
3	Total Solids	mg/lit	72	116	93.41	12.92	102.25	6.26	99.75	9.67	78.25	4.49
4	TDS	mg/lit	56	94	74.20	11.33	81.5	5.18	80.25	8.19	60.87	4.87
5	Suspended Solids	mg/lit	16	22.5	19.20	2.07	20.75	1.43	19.5	1.62	17.37	1.55
6	Turbidity	NTU	6.05	7.65	6.78	0.48	6.72	0.26	7.32	0.22	6.3	0.24
7	Elect. Cond.	μmhos	88	129	107.45	11.29	114.37	9.80	113	4.82	95	5.43
8	Total Hardness	mg/lit	60.45	91.35	76.02	10.91	86.95	3.57	77.96	6.87	63.16	2.96
9	Ca - Hardness	mg/lit	29.85	49.25	37.07	5.69	41.72	5.52	38.18	3.13	31.32	0.99
10	Mg - Hardness	mg/lit	28.7	54.2	38.78	7.28	45.22	5.23	39.77	5.44	31.35	2.16
11	Calcium–(Ca^{++})	mg/lit	11.94	19.7	14.89	2.21	16.69	2.21	15.27	1.25	12.72	0.47
12	Magnesium–(Mg^{++})	mg/lit	6.89	13.01	9.30	1.74	10.85	1.25	9.54	1.30	7.52	0.52
13	Dissolved Oxygen	mg/lit	5.55	6.8	6.10	0.38	5.71	0.10	6.41	0.29	6.18	0.29
14	Free CO_2	mg/lit	4.75	6.6	5.58	0.52	6.12	0.31	5.58	0.30	5.03	0.22
15	Alkalinity	mg/lit	57.25	76.3	67.15	6.85	72.66	2.92	70.22	4.28	58.56	0.80
16	Acidity	mg/lit	3.4	5.65	4.37	0.65	5.16	0.35	4.27	0.16	3.7	0.22
17	Phosphate	mg/lit	0.07	1.92	0.70	0.58	0.87	0.15	1.13	0.66	0.11	0.03
18	Nitrate	mg/lit	0.21	1.11	0.61	0.33	0.36	0.13	0.94	0.15	0.53	0.33
19	Sulphate	mg/lit	16.65	23.1	19.84	2.23	20.75	1.42	21.53	1.50	17.23	0.41
20	Chloride	mg/lit	4.5	7.1	5.92	0.89	4.77	0.31	6.57	0.39	6.42	0.41

Dissolved oxygen fluctuates seasonally. Most of the aquatic animals and plants are very sensitive to the dissolved oxygen. Temperature, light, turbidity also fluctuate the concentration of dissolved oxygen. If it declines then the survival rate of animals and plants also declines. Benthic organisms are adapted to the low concentration of water due to which they can survive in low concentration of dissolved oxygen. More oxygen concentration in water indicates the good quality of water (Welch, P.S., 1952). The minimum average of dissolved oxygen ($5.71, \pm 0.1$) was recorded in summer and maximum average of dissolved oxygen ($6.41, \pm 0.29$) in monsoon as compared to the annual average of dissolved oxygen ($5.47, \pm 0.48$). Low temperature in monsoon and winter than summer, leads to presence of high dissolved oxygen (Prasad B. N. and Manjula S., 1980, Zutshi D.P. and Vass K.K., 1978). Like dissolved oxygen, carbon dioxide also plays an important role in respiration and photosynthesis process. Generally more dissolved free carbon dioxide occurs in water body with large vegetation and dead and debris material. It is indirectly proportional to the dissolved oxygen as if there is high dissolved oxygen then there is low free carbon dioxide and vice versa. The minimum average of free carbon dioxide ($5.04, \pm 0.22$) was recorded in winter and maximum average of free carbon dioxide ($6.12, \pm 0.31$) in summer as compared to the annual average of free carbon dioxide ($5.58, \pm 0.52$) (Kaushik S. and Saxena D.N., 1991).

Alkalinity of surface water is mainly a function of carbonate, bicarbonate and hydroxide content and it is taken as an indication of the concentration of these constituents. The acceptable limit of Total Alkalinity in drinking water should not be more than 200 mg/l (BIS, 2012). Minimum alkalinity ($58.56, \pm 0.80$) and maximum alkalinity ($72.66, \pm 2.92$) respectively noted in winter and summer as compared to the annual average of alkalinity ($67.15, \pm 6.86$).

Strong mineral acids, weak acids such as carbonic and acetic and hydrolyzing salts such as aluminium sulphates or iron may contribute to the measured acidity. Acids also contribute to corrosiveness and influence chemical speciation, biological processes, and chemical rates. It also reflects change in the quality of the source of water (AWWA-APHA., 2005). The low acidity ($3.7, \pm 0.22$) was recorded in winter and maximum acidity ($5.16, \pm 0.35$) in summer. The acidity was mostly decline in winter and increase in summer as photosynthesis uses up dissolved carbon dioxide.

Phosphorous is very essential nutrient as all living organisms require phosphate to make DNA and ATP. Animals easily meet their phosphate needs by eating other living things. Plants absorb phosphate from

ground and rocks. The minimum average of phosphate ($0.11, \pm 0.04$) was recorded in winter and maximum average of phosphate ($1.14, \pm 0.69$) in monsoon as compared to the annual average of phosphate ($0.71, \pm 0.59$). Phosphate mostly increases during monsoon due to increase in algal bloom and surface run-off while decreases in summer due to decrease in algal bloom and less vegetation in water (Welch, P.S., 1952).

Nitrate is an important source of nitrogen for plant and animal life. Animal matter, human and animal waste, household septic systems and fertilizers are the common sources of nitrogen. Excess nitrogen in drinking water has been found to cause methemoglobinemia or Blue Baby Syndrome (Fewtrell, L. 2004). The minimum average of nitrate ($0.36, \pm 0.13$) was recorded in summer and maximum average of nitrate ($0.94, \pm 0.16$) in monsoon as compared to the annual average of nitrate ($0.61, \pm 0.33$). Nitrate mostly increases during monsoon due to increase in vegetation and surface run-off which include fertilizers while decreases in summer due to decrease in vegetation and surface run-off in water (Chatwal G.R., 1996, Das A.K., 1989 and Pande P.C. *et.al.*, 1969).

Sulphates occur naturally in numerous minerals, including Epsomite ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$), Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), Barite (BaSO_4). The reversible inter conversion of Sulphate and Sulphide in the natural environment is known as the 'sulphur cycle'. The EPA secondary Drinking Water Regulations recommend a maximum concentration of 250 mg/l. Minimum average of sulphate ($17.24, \pm 0.41$) and maximum average of sulphate ($21.54, \pm 1.51$) in monsoon observed in lake water as compared to the annual average of sulphate ($19.84, \pm 2.23$). Sulphate mostly increases during monsoon due to surface run-off which include fertilizers while decreases in summer due to decrease in surface run-off in water (Kaur H. *et.al.*, 1996).

Chloride concentrations vary considerably according to the mineral content of the earth in any given area. Chlorides are dissolved from rock and soils. The minimum average of chloride ($4.77, \pm 0.31$) maximum average of chloride ($6.57, \pm 0.4$) in Summer and monsoon respectively as compared to the annual average of chloride ($5.92, \pm 0.9$). Chloride mostly increases during monsoon due to surface runoff (AWWA-APHA., 2005).

2. Macrozoobenthos:

Benthic organisms play a very important role in the ecosystems. Depending upon the size they are mainly categorized into three types- Macrozoobenthos, Meiozoobenthos and Microzoobenthos (Mare M.F., 1942). The influence of benthic organisms varies according to the quality and quantity of water body

Table 3: Total number of macrozoobenthos (N/M²) observed during two year (Feb. 2012 to Jan. 2014)

Class, Order & Family	SUMMER (N/M ²)				MONSOON (N/M ²)				WINTER (N/M ²)			
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
C- Oligochaeta	377.78	311.11	155.56	44.44	111.11	266.67	244.44	377.78	355.56	400.00	311.11	244.44
F- Tubificidae	222.22	155.56	88.89	0.00	44.44	155.56	133.33	200.00	177.78	222.22	177.78	133.33
F- Lumbricidae	155.56	155.56	66.67	44.44	66.67	111.11	111.11	177.78	177.78	177.78	133.33	111.11
C- Hirudinea	88.89	66.67	22.22	0.00	22.22	66.67	111.11	133.33	88.89	133.33	88.89	111.11
C- Arachnida	88.89	66.67	22.22	0.00	44.44	88.89	111.11	111.11	133.33	155.56	111.11	111.11
C- Crustacea	44.44	22.22	0.00	0.00	44.44	88.89	111.11	66.67	88.89	44.44	66.67	44.44
C- Insecta	444.44	266.67	177.78	22.22	244.44	333.33	711.11	666.67	533.33	555.56	400.00	511.11
O- Odonata	155.56	88.89	22.22	0.00	111.11	133.33	222.22	244.44	200.00	222.22	133.33	155.56
O- Diptera	177.78	44.44	88.89	0.00	66.67	200.00	288.89	266.67	288.89	288.89	244.44	244.44
F- Culicidae	66.67	22.22	44.44	0.00	22.22	44.44	111.11	88.89	111.11	111.11	88.89	44.44
F- Culicidae	44.44	0.00	0.00	0.00	44.44	88.89	66.67	111.11	88.89	44.44	66.67	88.89
F- Tabanidae	66.67	22.22	44.44	0.00	0.00	66.67	111.11	66.67	88.89	133.33	88.89	111.11
O- Hemiptera	111.11	133.33	66.67	22.22	66.67	155.56	200.00	155.56	44.44	44.44	22.22	111.11
F- Nepidae	66.67	66.67	44.44	0.00	44.44	88.89	111.11	66.67	44.44	0.00	22.22	66.67
F - Nepidae	44.44	66.67	22.22	22.22	22.22	66.67	88.89	88.89	0.00	44.44	0.00	44.44
C-Gastropoda	488.89	288.89	155.56	44.44	133.33	355.56	444.44	533.33	577.78	466.67	488.89	444.44
F-Viviparidae	200.00	133.33	66.67	44.44	0.00	111.11	155.56	177.78	155.56	111.11	133.33	155.56
F-Thiaridae	88.89	44.44	0.00	0.00	44.44	88.89	88.89	133.33	111.11	88.89	133.33	88.89
F-Lymnaeidae	111.11	66.67	44.44	0.00	44.44	66.67	111.11	88.89	133.33	88.89	88.89	111.11
F-Pachilidae	88.89	44.44	44.44	0.00	44.44	88.89	88.89	133.33	177.78	177.78	133.33	88.89
C-Bivalvia	200.00	133.33	66.67	0.00	200.00	266.67	311.11	377.78	311.11	377.78	288.89	266.67
F-Unionidae	66.67	44.44	22.22	0.00	44.44	88.89	88.89	133.33	88.89	133.33	88.89	88.89
F-Unionidae	88.89	44.44	44.44	0.00	88.89	88.89	88.89	133.33	155.56	111.11	111.11	88.89
F- Unionidae	44.44	44.44	0.00	0.00	66.67	88.89	133.33	111.11	66.67	133.33	88.89	88.89
Total Number of species(N/M²)=	1733.33	1155.56	622.22	111.11	800.00	1622.22	2044.44	2266.67	2088.89	2133.33	1755.56	1733.33

Table 4: Statistical analysis of Macrozoobenthos (N/M²) observed during two years (Feb. 2012 to Jan. 2014)

Class, Order & Family	Genus & Species	A-Avg.	S-Avg.	M-Avg.	W-Avg.	A-SD	S-SD	M-SD	W-SD	A-Total	S-Total	M-Total	W-Total
C-Oligochaeta	————→	266.67	222.22	250.00	327.78	108.49	130.53	94.77	57.47	3200.00	888.89	1000.00	1311.11
F-Tubificidae	<i>Limnodrillushoffemeistry</i>	142.59	116.67	133.33	177.78	65.71	82.21	56.66	31.43	1711.11	466.67	533.33	711.11
F-Lumbricidae	<i>Lumbricus variegatus</i>	124.07	105.56	116.67	150.00	44.87	50.61	39.67	28.87	1488.89	422.22	466.67	600.00
C-Hirudinea	<i>Hirudinaria granulosa</i>	77.78	44.44	83.33	105.56	42.07	35.14	42.67	18.43	933.33	177.78	333.33	422.22
C-Arachnida	<i>Hydracarina</i> sp.	87.04	44.44	88.89	127.78	43.94	35.14	27.22	18.43	1044.44	177.78	355.56	511.11
C-Crustacea	<i>Gelasimuss</i> sp.	51.85	16.67	77.78	61.11	33.13	18.43	24.85	18.43	622.22	66.67	311.11	244.44
C-Insecta	.————→	405.56	227.78	488.89	500.00	196.29	152.65	203.06	59.84	4866.67	911.11	1955.56	2000.00
O-Odonata	Dragonfly nymph & Damselfly nymph	140.74	66.67	177.78	177.78	73.89	60.86	56.66	35.14	1688.89	266.67	711.11	711.11
O-Diptera	.	183.33	77.78	205.56	266.67	101.48	65.73	86.60	22.22	2200.00	311.11	822.22	1066.67
F-Culicidae	<i>Culex</i> larvae	62.96	33.33	66.67	88.89	37.22	24.85	35.14	27.22	755.56	133.33	266.67	355.56
F-Culicidae	<i>Anopheles</i> larvae	53.70	11.11	77.78	72.22	36.80	19.25	24.85	18.43	644.44	44.44	311.11	288.89
F-Tabanidae	<i>Tabanus</i> sp.	66.67	33.33	61.11	105.56	41.57	24.85	39.67	18.43	800.00	133.33	244.44	422.22
O-Hemiptera	.	94.44	83.33	144.44	55.56	56.02	42.67	48.43	33.33	1133.33	333.33	577.78	222.22
F-Nepidae	<i>Nepas</i> sp.	51.85	44.44	77.78	33.33	31.86	27.22	24.85	24.85	622.22	177.78	311.11	133.33
F-Nepidae	<i>Ranatraelongata</i>	42.59	38.89	66.67	22.22	29.34	18.43	27.22	22.22	511.11	155.56	266.67	88.89
C-Gastropoda	.————→	368.52	244.44	366.67	494.44	166.66	165.55	148.66	50.61	4422.22	977.78	1466.67	1977.78
F-Viviparidae	<i>Vivipara bengalensis</i>	120.37	111.11	111.11	138.89	55.52	60.86	68.49	18.43	1444.44	444.44	444.44	555.56
F-Thiaridae	<i>Melanoidesstriatella</i>	75.93	33.33	88.89	105.56	42.99	36.85	31.43	18.43	911.11	133.33	355.56	422.22
F-Lymnaeidae	<i>Lymnaealutiola</i>	79.63	55.56	77.78	105.56	35.67	40.06	24.85	18.43	955.56	222.22	311.11	422.22
F-Pachilidae	<i>Fanusater</i>	92.59	44.44	88.89	144.44	52.77	31.43	31.43	36.85	1111.11	177.78	355.56	577.78
C-Bivalvia	.————→	233.33	100.00	288.89	311.11	113.13	74.54	64.79	41.57	2800.00	400.00	1155.56	1244.44
F-Unionidae	<i>Lamellidensmarginalis</i>	74.07	33.33	88.89	100.00	38.84	24.85	31.43	19.25	888.89	133.33	355.56	400.00
F-Unionidae	<i>Lamellidenscorreanus</i>	87.04	44.44	100.00	116.67	40.02	31.43	19.25	24.22	1044.44	177.78	400.00	466.67
F-Unionidae	<i>Parreysiacorrugata</i>	72.22	22.22	100.00	94.44	42.67	22.22	24.85	24.22	866.67	88.89	400.00	377.78

Avg = Annual Average, S. Avg = Summer Average, M. Avg = Mansoon Average, W. Avg = Winter Average, SD= Standard Deviation

Other than food for different prey, different types of benthic organisms have different role in ecosystems like bio indicators of water. During qualitative analysis 19 species of macrozoobenthos from Phylum-Annelida, Arthropoda and Mollusca were noted during the collection from all sites of Kunghada Bandh.

After quantitative analysis, minimum average of total macrozoobenthos (905.56N/M^2) was recorded in summer and maximum average of total macrozoobenthos (1927.18N/M^2) in winter as compared to the annual average of total macrozoobenthos (1505.56N/M^2). Seasonal fluctuation of macrozoobenthos was observed due to quantity of water and depth of water in lake (Dutta S.P. et.al., 2000, Rosenberg D.M. and Resh W.H., 1992).

During the study period three species of annelids were found i.e. *Limnodrilus hoffmeisteri*, *Lumbricus variegatus* and *Hirudinaria granulose*. Minimum annelids (266.67 N/M^2) were recorded in summer while maximum (433.33 N/M^2) in winter as compared to the annual average of Annelids (344.44 N/M^2) which covering 29.91 % out of the total number of macrozoobenthos (Chapman P.M. et.al., 1982 and Glowacka I., et.al., 1976). Oligochaeta mostly prefer organically rich environment and remain dominated in severally polluted conditions. Oligochaeta are adapted to every kind of water and are found in vegetation, algal bloom, in floating rotting material and bottom mud. During investigation, annelids observed more in monsoon and winter than summer (Wetzel, R.G., 1975).

Arthropods are the largest phylum with a great diversity. Total 9 species of arthropods were observed from lake i.e. *Hydracarina* sp., *Gelasimus* sp., *Dragonfly* sp., *Damselfly* sp., *Culex* sp., *Anopheles* sp., *Tabanus* sp., *Nepa cinerea* and *Ranatra elongata*. During the study minimum population (288.89 N/M^2) of arthropods were recorded in summer while maximum (694.44 N/M^2) in monsoon season. Arthropods were covering 37.07 % out of the total macrozoobenthos population. The seasonal fluctuation in arthropod population was observed due to quantity of water and depth of water. The aquatic insects are known to have strong relationship with water fluctuations (Ebert T.A. and Balko., 1987). As hardness, carbonates and bicarbonates increase in water the stages of developmental stages to observed minimum (Fraser F.C., 1934 and Lonkar S.S. et.al., 2014). Dipterans noted more when dissolved oxygen increases with decreasing temperature. Such type of favourable conditions affects on population of dipterans (Kodarkar M.S., 1995 and Mathew P.M., 1978). Hemiptera are mainly found at the S₃ and S₄ sites of lake as these sites were received maximum runoff contains organic substances (Kaushik S. and Saxena D.N., 1991).

Phylum Mollusca is the second largest phylum with great diversities and species richness, basically gastropoda and bivalvia are the only two classes represented the molluscan in fresh water bodies (Shanmugam A. and Vairamani S., 2005). In all 7 species (4 gastropodes and 3 bivalves) were recorded from this fresh water aquatic ecosystem i.e. *Vivipara bengalensis*, *Melania striatella*, *Fanus ater*, *Lymnea luteola*, *Parreysia corrugata*, *Lamellidens marginalis*, and *Lamellidens correaui*. Minimum population of Molluscan (344.44N/M^2) was recorded in summer and maximum (805.56N/M^2) in monsoon as compared to the annual average of Molluscan (601.85N/M^2) covering 40.02 % out of the total population of macrozoobenthos of lake. As the pH of lake water not acidic the population of mollusca is in fair quantity (Apte D., 1988). With the increased volume of water the population shows more during rainy season (Bath K.S. et.al, 1999 and Tijare R.V., 2012).

IV. CONCLUSION

Various physic-chemical parameters play an important role in water quality as well as diversity and richness of organisms. Mostly temperature is a very important factor. Others factors like pH, Dissolved oxygen, free CO₂, Suspended solids, etc. also affect the frequency of macrozoobenthos. It was mostly observed macrozoobenthos found very less in summer season than monsoon and winter season. Phylum Arthropoda were dominated among the all group which is followed by mollusca and then annelids.

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