PREFACE

The present work deals with the water quality of Nira river in Pune district, Maharashtra during 2012-13 in order to assess its suitability for pisciculture. Various parameters determined that seasonal fluctuations in water temperature, pH and nitrite were within the favorable limits for fish and fisheries practices. However, very low level of alkalinity during monsoon at station III, chloride during monsoon at all seasons, hardness during monsoon at station III, calcium during post-monsoon at all the stations, phosphate during winter at station III and during summer at all the stations were recorded. These parameters need to be modifying in order to favor the fish culture.

We wish to record my gratitude to UGC WRO Pune for award of research project for 2012-13. We are thankful to the Principal for providing necessary facilities. We are thankful to our colleagues for their cooperation and encouragements in the preparation of this work.

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EVALUATION OF POTENTIAL OF NIRA RIVER FOR AQUACULTURE ACTIVITIES

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ABSTRACT

The present work deals with the water quality together with the ichthyofauna of Nira river. Monthly changes in water quality parameters of Nira river were investigated to assess the suitability of this river for fish and fisheries practices.

Several parameters such as temperature, dissolved oxygen (DO), pH, alkalinity, chloride, hardness, calcium, magnesium, nitrite and phosphate have been studied for a period of thirteen months beginning from December 2012 to December 2013. Various physico-chemical parameters determined revealed that the fluctuations in water temperature, pH, dissolved oxygen, alkalinity, chloride, hardness, calcium, magnesium, nitrite and phosphate they were within the desirable limits for water used for fish and fisheries practices.

Key words

Bhima river, water quality

INTRODUCTION

India is having very rich sources of inland waters in the form of lakes, reservoirs and rivers. If we utilize these resources properly to culture the aquatic organism, the animal protein availability will be increased to meet our demand. For proper utilization of these resources, an understanding of different ecological features of these water bodies and species therein are essential. Unfortunately, as far as Pune district in Maharashtra is concerned, there are many water bodies which are contributing significantly to the total inland production scarcely an attention seems to have been paid towards systematic investigation on either of the diversity of ichthyofauna or total catch of the fishes from these water bodies. So it is felt that there is an urgent need to generate information on diversity of fishes from this river. Such a work at a latter stage would provide the required database for further development of riverine fishery in this region.

Water is a vital resource used for various activities such as drinking, irrigation, fish production, industrial cooling, power generation and many others (Sanjay S. Sathe et al., 2001). Fresh waters are perhaps the most vulnerable habits and are most likely to be changed by the activities of man. This essential resource is becoming increasingly scarce in many parts of the world due to severe impairment of water quality (Sudhakar et al.,1994).

Temperature and DO is one of the important parameter in water quality assessment. Temperature is directly related with chemical reaction and solubility of oxygen in water. DO presence is essential to maintain biological life in water.

The change in water temperature affects the chemical reaction going on in natural water also solubility of gases and nutrient cycle along with other biogenic processes. DO levels in natural waters depend on the physical, chemical and biological activities in water. The main sources of DO are from the atmosphere and the photosynthetic activities of the aquatic green plants which produce a distinct rise in the

amount of oxygen. DO presence in water is essential for aquatic life. Low oxygen in water is responsible for killing fish and other living organisms in water. The solubility of oxygen decreases with increase in temperature. The depletion of oxygen from water body also depends on the pollution quantity.

pH is a measure hydrogen ion concentration in water and indicates how much water is acidic or basic. The range of pH of water bodies is between 6 to 9. Many workers have observed the value of pH ranged from 8 to 9 in Indian waters. pH is considered as an important ecological factor and is result of the interactions of various substances in solutions in water and also of numerous biological phenomena. According to George (1997) the variation in pH is an important parameter in water body since most of the aquatic organisms are adapted to a average pH and do not withstand abrupt changes.

The alkalinity of most natural water is caused by dissolved bicarbonate salts. Water containing CO_2 from the atmosphere and from respiration of soil organisms dissolves Mg and Ca from a common mineral (dolomite, $CaCO_3.MgCO_3$) to produce hardness and alkalinity in ground water.

Chloride is invariably present in small amounts in almost all natural waters and its content goes up appreciably with increasing salinity.

Calcium plus magnesium (total hardness) reduce solubility of gases (like oxygen) and utility of water for drinking, irrigational and industrial purposes.

Nitrite is found in very low concentration in natural waters. Nitrite in water is formed either by oxidation of ammonia by aerobic nitrifying bacteria or by reduction of nitrates. Presence of even minute quantity of nitrite in water is indicative of organic pollution and prevailing low oxygen concentration.

Domestic and industrial effluents and agricultural runoff are the main sources of phosphorus in water, hence its high concentration is indicative of pollution.

The distribution of aquatic organisms is influenced by physical environment, chemical quality and biological interactions (Hynes, 1960). Changes in water quality affects aquatic life. Pollution of water caused by various human activities affects fish species (Hidaka and Tatsukawa, 1985). The environmental variability also strongly influences the fish population (Rekhow et al.,1987 and Freeman et al., 1988)

In the last few decades much attention is being paid to aquaculture as a source of food to feed growing population of the country. Fishes constitute the most conspicuous component of inland aquatic fauna and rank very high as source of protein. Fish form one of the most important group of animals for man and have received his attention from ancient times. Fish form rich source of food and also provides several by-products to us. Fish is an excellent food for man and provides protein, fat and vitamins A and D. Phosphorus and several other elements present in them that are essential for the health of man. Fishes have good taste and are easily digestible. Besides being a rich source of food, fishery provides new job opportunities also, reducing the pressure of unemployment. For sustained exploitation and simultaneous conservation of fisheries resources basic scientific information on biodiversity is essential. The study of fish diversity in river used for fish cultivation becomes an essential tool for better fish production. In the field of fish diversity earlier contributions were made by Rao et al. (1998), Sharma and Nayak (2001), Sakhare and Joshi (2002), Khedkar (2005), Meshram (2005), Jayabhaye et al. (2006), Kadam and Gayakwad (2006), Muley and Patil (2006) and Savalla (2006).

No well-organized fishing has so far been established in Nira river despite the fact that natural edible fishes do occur. It is in this view that it is thought of concentrating the fishery development program on this river. Knowledge of water characteristics is indispensable for fish culture and its production. The lack of information on fish diversity and popularizing less known fish variety in Nira river,

there is a need to survey fish fauna which will help in planning method for their effective exploitation for fish production. There is not much information available on the fish fauna occurring in the Nira river in Pune District and the fishery they support in India. Therefore, an attempt has been made to determine physico-chemical conditions and survey of fish fauna in the Nira river and examine how far this river could be used for fish and fisheries practices.

Nira river is one of the tributaries of Bhima river. This river originates in the eastern hilly regions of Varanda ghat. This river flows through the western side of Bhor taluka and further flows in the west-east dirction. Nira flows along the boundries of Pune, Satara and Solapur districts. Further down it joins Bhima river in Solapur district. Nira river serves as lifeline for the eastern parts of Sahyadri providing water for drinking, irrigation and industrial and fishing purposes. The river is filled not only in monsoon but almost round the year due to back waters of Vir dam. Banks of Nira river are richly populated with the vegetation and there is no visible pollution of water.

MATERIALS AND METHODS

Nira river is an important tributary of Bhima, Pune district, Maharashtra. Some smaller dams are constructed across the river for the purpose of water resource for drinking, agriculture, domestic uses and fisheries. Present study was conducted in about 50 km stretch of Nira river. Along the stretch of the river three sampling stations were selected. Station –I was Sangavi, station – II was Nira wagaj and station – III was Mekhali.

For determining physico-chemical conditions, monthly water samples were collected between 8.00 to 8.30 am at station – I, 9.00 to 9.30am at station – II and 10.00 to 10.30am at station – III from December 2012 to December 2013 in polythene bottles. For the estimation of dissolved oxygen content, the water sample was fixed immediately on the field and estimated in the laboratory using modified Winkler's method (Golterman *et al*, 1978). Temperature and pH was recorded on the field by centigrade thermometer and pen pH meter respectively. The alkalinity, hardness, calcium and magnesium were investigated by titration and nitrite and phosphate by spectrophotometer on the same day in the laboratory. (Golterman *et al,* 1978; APHA *et al*, 1985).

RESULTS AND DISCUSSION

The present investigation involves the assessment of Nira river in Baramati taluka by selecting three stations (as mentioned in materials and methods) in order to find out its suitability for pisciculture. Monthly variations of physico-chemical parameters of Nira river at different stations are shown in table-2. The data was divided in to four seasons, representing winter (December – February), summer (March – May), monsoon (June – September) and post-monsoon (October-November) and is presented in table-1.

Physico-chemical parameters like pH, temperature, dissolved oxygen, ammonia-nitrogen, phosphorus and chlorides have a greater influence on the survivability of the fishes (Devi Prasad *et al,* 2009). In the present study water temperature ranged from 19^0C (March, at station – III) to 28^0C (June and September at station II and station – III respectively). It was minimum (22^0C) during winter at station-I and maximum (26.50^0C) during monsoon and post-monsoon at station I and III respectively (Table – 1). Similar results were also reported by Muley and Patil (2006), Gupta *at al* (2009) and Pawar *et al* (2011). Sharma and Gupta (1994) had reported that fish growth was better at a temperature range of 14.5 to 38.5^0C. The water temperature in Nira river was found ideal for fish growth and productivity.

Tarzwell (1957) has suggested that a minimum of 3 mg/l dissolved oxygen is necessary for healthy fish and other aquatic life. In the present study dissolved oxygen

ranged between 3.32 (February, at station – II) to 7.7 mg/l (March, station – III). It was minimum (3.33 mg/l) in summer at station – II and maximum (7.16 mg/l) during summer at station – III. This level of oxygen in the river should be able to support good flora and fauna. Similar observations were recorded by Singh and Rai (1999) in river Ganga, Hiware and Jadhav (2001) in river Manjara, Rafeeq and Khan (2002) in river Godavari and Pawar *et al* (2011) in river Pravara.

pH ranged between 6.2 (September, at station- I) to 9.5 (January, at station - III). It was minimum (6.6) during monsoon at station- I and maximum (8.96) during winter at station – III (Table – 1).The pH was found to be almost on alkaline side throughout the study period which favors the growth of fishes (Swingle, 1967). Alkaline pH was also observed by Shaikh and Yeragi (2004) in river Tansa and Pawar *et al* (2011) in river Pravara during whole study period.

Alkalinity ranged between 69.66 (August, at station – III to 472.33 mg/l (March, at station – II). It was minimum (92.87 mg/l) during monsoon at station – III and maximum (535.54 mg/l) at station – I during summer. High alkalinity (535.54 mg/l) during summer at site – I is probably because of addition of waste (Table-1) Similar results were recorded by Pawar *et al* (2011) in Pravara river.

Chloride ranged between 15.17 mg/l (August, at station – III) to 1236.68 mg/l (June, at station – III). It was minimum (26.50 mg/l) during monsoon at station – III

and maximum (564.79 mg/l) during winter at station – III. The chloride concentration was quite low in this river at station – III during monsoon (August) which reflects that there is very less amount of organic waste of animal origin. However, chloride content at station – III was markedly higher during winter in comparison to other two sites which are indicative of a high degree of pollution by organic matter (Table – 1). Similar observations were recorded by Pawar *et al* (2011) in Pravara river.

Total hardness ranged between 80.00 (August, at station – II) to 1000.00 mg/l (June, at station – III). It was minimum (102.22 mg/l) during monsoon and maximum (987.66 mg/l) during summer at station – II. Relatively higher values of hardness content was recorded at station – III. The higher total hardness content was recorded maximum during summer season at all the three sites. It may be due to low water level and addition of calcium and magnesium salts from detergents and soaps used for cloth washing by the villagers (Table – 1).

The calcium level in the river ranged between 9.61 mg/l (November, at station – I) to 46.49 mg/l (July, at station – II). It was minimum 10.41 (mg/l) during post-monsoon at station – I and maximum (31.86 mg/l) during monsoon at station – II. Calcium content was recorded maximum during monsoon at all the three sites (Table – 1). It was supposed that the input of domestic and other sewage waste from the adjacent villages might be responsible to increase calcium content (Sati and Paliwal, 2008).

Magnesium ranged between 5.86 mg/l (November, at station – I) and 28.81 mg/l (June, at station – II). It was minimum (6.34 mg/l) during post-monsoon at station – I and maximum (19.40 mg/l) during monsoon at station – II (Table – 1). The data reveals high concentrations of bicarbonates of calcium and magnesium at all the three stations during monsoon possibly due to the regular deposition of large quantities of organic and inorganic wastes in to the river from the urban areas.

Nitrite ranged between 0.00 (December 2013, at station II) to 0.649 mg/l (March, at station – III). It was minimum (0.07 mg/l) during monsoon at station – III and maximum (0.60 mg/l) during summer at station – III (Table -1). Similar results were recorded by Pawar *et al* (2011) in Pravara river.

Phosphate ranged between 0.002 mg/l (December 2012, at station – III) to 0.582 mg/l (September, at station – II). It was minimum (0.008 mg/l) during winter at station – III and maximum 0.30 mg/l) during monsoon at station – II (Table – 1).Phosphate concentration increases towards downstream during rainy season due to heavy influx of domestic sewage, detergents and agricultural effluents (Muley and Patil, 2006). Phosphate concentration in the present investigation was found to be higher (except winter) than the standard permissible limits. The high concentrations of nutrients in the river water may be attributed to the fact that river receives huge amount of domestic and municipal sewage and solid wastes from the nearby towns.

The comparison of the water quality of Nira river with limits laid down by fresh water quality criteria for fish and fisheries practices (Chandra Prakash, 2001) suggested that, the river water may be considered suitable for fish culture as the seasonal fluctuations in water temperature, dissolved oxygen, pH and nitrite in all the season and alkalinity during monsoon to post-monsoon at station – I, in winter to monsoon at station – II and in all the season at station – III, chloride during monsoon only at station – II, hardness during monsoon and post-monsoon at all the stations, magnesium during post-monsoon at all the stations and phosphate during winter at all the stations are within the desirable limits for fish and fisheries practices. However low level of alkalinity and chloride during monsoon at stations II and III, hardness during summer at station III, calcium during monsoon at all the three stations, magnesium during summer at stations II and III and high level of alkalinity during summer at station – III, chloride during winter and summer at station II, hardness during winter and summer at station – III and phosphate during monsoon at all the three stations were recorded. These parameters need to be modifying in order to favor the fish culture.

It was found that Nira river was suffering from the domestic type of pollution and most of the parameters showed their peak values at station III. Hence, it is suggested that station – III and also station – II in some extent should be protected from the anthropogenic activities for preventing further deterioration in the water quality of the river. Some of the measures, which demand immediate attention, are the: 1) Treatment of sewage and solid waste from surrounding human settlements, 2)

An improved sanitation and waste disposal programme needs to be initiated and 3) Change the agricultural practices in order to reduce the non-point pollutants from the source. Organic farming in these areas may be encouraged.

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Table 1 : Seasonal variation of physico-chemical parameters of Nira river during December 2012 to December 2013.

SR	Parameter	Station	Season			
			Winter	Summer	Monsoon	Post-monsoon
1	Temperature (^{0}C)	I	22.00 ± 1.00	25.0 ± 1.41	26.5 ± 1.73	26.00 ± 2.82
		II	22.33 ± 2.08	23.5 ± 0.70	25.5 ± 1.00	25.5 ± 2.12
		III	22.33 ± 1.15	22.00 ± 4.24	26.00 ± 1.41	26.50 ± 0.70
2	Dissolved oxygen	I	6.53 ± 0.77	4.29 ± 0.65	4.00 ± 0.25	6.34 ± 0.65
		II	4.11 ± 1.12	3.33 ±1.42	4.38 ± 0.61	5.68 ± 0.28
		III	6.58 ± 0.90	7.16 ± 0.76	4.01 ± 1.08	6.02 ± 0.19
3	pH	I	8.7 ± 0.00	8.8 ±0.00	6.6 ± 0.69	6.9 ± 0.14
		II	8.6 ± 0.00	8.35 ± 0.35	7.17 ± 0.72	6.85 ±0.21
		III	8.96 ± 0.47	8.00 ± 0.56	7.07 ± 0.87	6.8 ± 0.14
4	Alkalinity (mg/l)	I	429.33±34.04	535.54±69.74	128.22±63.47	268.25±28.63
		II	378.97±61.09	457.77±15.78	97.10±26.38	242.16±35.58
		III	316.50±28.61	470.44±51.88	92.87±23.00	269.30±73.96
5	Chloride (mg/l)	I	229.90±51.83	339.63±42.65	48.40±31.10	148.91±24.95
		II	206.06±40.79	301.88±28.37	28.06±17.61	119.73±26.81
		III	564.79±95.80	564.79±95.80	26.50±11.59	189.59±18.91
6	Hardness (mg/l)	I	368.80±52.26	353.33±4.66	128.33±58.22	246.80±21.89
		II	404.00±85.51	791.00±28.79	109.33±39.31	188.66±1.88
		III	622.86 ±35.69	987.66±11.23	102.22±16.77	253.66±70.23
7	Calcium (mg/l)	I	22.49 ± 5.85	16.96 ± 3.59	31.72 ± 10.83	10.41 ± 1013
		II	14.32 ± 2.30	15.22 ± 2.26	31.86 ±12.61	15.09 ± 3.59
		III	28.93 ± 4.44	17.35 ± 2.66	29.63 ± 6.36	13.49 ± 2.07

8	Magnesium (mg/l)	I	13.70 ± 3.66	10.33 ± 2.18	19.32 ± 6.60	6.34 ± 0.68
		II	8.72 ± 1.39	9.27 ± 1.37	19.40 ± 7.68	9.19 ± 2.18
		III	17.62 ± 2.70	10.57 ± 1.61	18.05 ± 3.87	8.22 ± 1.25
9	Nitrite (mg/l)	I	0.19 ± 0.07	0.22 ± 0.19	0.20 ± 0.23	0.18 ± 0.00
		II	0.19 ± 0.02	0.43 ± 0.53	0.12 ± 0.09	0.19 ±0.06
		III	0.59 ± 0.27	0.60 ± 0.05	0.07 ± 0.04	0.15 ± 0.00
10	Phosphate (mg/l)	I	0.07 ± 0.06	0.06 ± 0.04	0.14 ±0.04	0.11 ± 0.04
		II	0.021 ± 0.00	0.029 ± 0.00	0.30 ± 0.20	0.11 ± 0.00
		III	0.008 ± 0.00	0.04 ±0.03	0.13 ± 0.07	0.11 ±0.05

Table 2: Monthly variation of physico-chemical parameters of Nira river during December 2012 to December 2013

SR	Parameter	Station	Months											
			D	J	F	M	A	J	J	A	S	O	N	D
1	Temperature ^{0}C	I	22.0	21	23	24	26	28	25	25	28	28	24	21
		II	23	20	24	23	24	25	25	25	27	27	24	21
		III	23	21	23	19	25	26	25	25	28	27	26	22
2	Dissolved Oxygen (ml/l)	I	7.28	6.58	5.73	3.83	4.76	4.20	4.20	3.68	3.92	6.81	5.88	5.78
		II	5.40	3.62	3.32	3.33	4.34	4.48	3.83	4.01	5.20	5.88	5.48	5.96
		III	7.00	5.54	4.21	7.7	6.62	5.6	3.64	3.64	3.16	5.88	6.16	6.53
3	pH	I	8.7	8.7	8.7	8.8	8.8	7.7	7.4	6.6	6.2	7.0	6.8	6.9
		II	8.6	8.6	8.6	8.6	8.1	7.9	7.7	6.5	6.6	7.0	6.7	6.6
		III	8.8	9.5	8.6	8.4	7.6	8.1	7.5	6.4	6.3	6.9	6.7	6.6
4	Alkalinity (mg/l)	I	435.30	460.0	392.70	469.30	608.33	529.0	199.0	76.33	109.33	248.00	288.50	294.00
		II	323.30	369.30	444.33	472.33	441.00	460.00	91.00	74.30	126.00	217.00	267.33	357.30
		III	330.30	283.60	335.60	442.00	530.33	439.00	115.66	69.66	93.30	217.00	321.60	357.60
5	Chloride (mg/l)	I	287.92	213.62	188.17	291.18	356.19	371.52	83.91	26.00	35.29	131.27	166.56	162.23
		II	163.09	210.83	244.27	279.84	291.92	333.90	16.09	19.81	48.29	100.77	138.69	166.25
		III	454.18	618.57	621.63	733.46	1036.99	1236.68	38.35	15.17	26.00	105.51	273.68	232.19

6	Hardness (mg/l)	I	425.20	359.20	322.00	350.00	358.67	351.33	194.00	83.00	108.00	227.00	266.66	263.00
		II	308.00	432.00	472.00	771.00	778.00	824.00	94.00	80.00	154.00	187.33	190.00	194.00
		III	604.60	600.00	664.00	978.00	985.00	1000.00	120.00	86.67	100.00	204.00	303.33	232.00
7	Calcium (mg/l)	I	28.53	22.12	16.83	19.50	14.42	24.35	46.49	22.92	33.13	11.22	9.61	34.73
		II	11.70	15.23	16.03	16.83	13.62	47.29	23.24	20.04	36.87	12.55	17.63	17.10
		III	28.29	33.66	24.85	15.47	19.24	29.09	31.50	21.32	36.61	14.96	12.02	16.03
8	Magnesium (mg/l)	I	17.38	13.48	10.26	11.88	8.79	14.81	28.33	13.96	20.18	6.83	5.86	21.16
		II	7.13	9.27	9.76	10.25	8.30	28.81	14.16	12.20	22.46	7.65	10.74	10.42
		III	17.24	20.50	15.14	9.43	11.72	17.73	19.19	12.99	22.30	9.11	7.33	9.76
9	Nitrite (mg/l)	I	0.235	0.103	0.243	0.087	0.360	0.548	0.121	0.029	0.122	0.184	0.189	0.125
		II	0.217	0.212	0.166	0.058	0.818	0.244	0.090	0.027	0.137	0.148	0.243	0.0
		III	0.176	0.548	0.719	0.649	0.549	0.630	0.059	0.040	0.129	0.162	0.152	0.143
10	Phosphate (mg/l)	I	0.152	0.043	0.042	0.026	0.095	0.172	0.105	0.183	0.101	0.144	0.083	0.115
		II	0.027	0.019	0.018	0.022	0.036	0.192	0.115	0.313	0.582	0.115	0.122	0.142
		III	0.002	0.009	0.013	0.017	0.071	0.127	0.050	0.236	0.146	0.156	0.082	0.132