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The Seasonal Fluctuation of Physico-Chemical parameters of River Mula-Mutha at Pune, India and their Impact on Fish Biodiversity

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Abstract

The paper highlights pollution status and impact on fish diversity in Mula-Mutha River and damps on it. Seventy two species was reported in 1942 in this river. However, it has been observed that fish diversity is gradually decreasing since last thirty years unprecedently, mainly due to manifold human activity. Fish diversity in midway of river is becoming rare and only four species have been reported form polluted stretch of river. The river Mula-Mutha is flowing through city area and is one of the important sources of water body because of seven dams on it and its importance in agricultural, industrial and development of Pune city. Its perennial nature supports abundance of aquatic life including fish fauna. About Sixty Three species of different fishes have been reported from upstream from January2003- December -2007 and only Four species of fishes in the downstream during winter and summer. The Mula-Mutha River and its tributaries are highly polluted due to domestic and industrial wastes. The physico-chemical aspects of water pollution of Mula-Mutha Rivers was analysed seasonally with respect to following parameters from July-2004 to May-2005. i. Water temperature, ii. pH, iii. Dissolved solids, iv. Dissolved oxygen, v. Free carbon dioxide, vi. Acidity, vii. Alkalinity, viii. Chloride content, ix. Nitrates, x. Phosphates, xi. Biological oxygen demand, xii) Chemical oxygen demand. It is observed that the level of these parameters was optimum during and winter and summer seasons. In the polluted stretch of this river, tolerant species as Aorichthysseengala, Oreochromismossambicusand Gambusiaaffinis as well as air breathing fish H. fossilisare found at many places.

Keywords: Physico-chemical characteristics, pollution, river Mula-Mutha.

Introduction

The Western Ghats is an important biogeographic zone of India and one of the global hotspots. The Northern part of Western Ghats gives rise to eastward flowing three major rivers like Godavari, Krishna and Cavery, as well westward flowing rivers and their tributaries which are major sources of fish fauna. The higher degree of precipitation, moderate climate and huge forest cover in Western Ghats supports abundance of aquatic life including fish fauna. Mula –Mutha is one of the major riverofBhima River and its tributary Pavana River is flowing through Pimpri Chinchwad Municipal Corporation of Pune District.

The pollution load into river Mula-Mutha has been increased due to rapid growth of Pune city both in urban and industrial areas. The Pavana Riveris carrying waste materials like sewage and industrial waste from Pimpri-Chinchwad Municipal Corporation. Industrial area is having industries like Hindustan antibiotics, Telco, Bajaj auto, Paper mills and others hundreds of small scale industries. The Mula River carries wastes from the west part of Pune city and both rivers confluence at Dapodi. Mutha River and its tributaries like Ambilvodaare more polluted than the MulaRiver, carrying waste material from remaining part of the city. Thereafter, these two rivers were confluence at Shivajinagar. This investigation shows the effects of pollution on the physico-chemical aspects of water of the Mula-Mutha River at Pune in monsoon, winter and summer seasons (2004-2005) at different sampling stations.

Sixty Three species of different fishes were collected from the river Mula-Mutha, Pune (Maharashtra State) during four year. It has been found that numbers of species are economically important which were reported earlier in the river, are not available now. There are many evidences of pollution of this river due to industrial and domestic wastes.

The freshwater fishes from different localities in Pune first time were collected and scientifically studied[1]. Thecomparatively exhaustive survey of fishes from various places of Mula and Mutha Rivers in and around Pune was done between 1936 and 1937[2]. Also gave considerable details regarding Mula and Mutha rivers and their vicinity, which are useful still quite applicable in many respects. A complete checklist of fishes of Pune, based on the collected by Fraser, was subsequently published[3], hasrecorded fifty-four species with their local names. He found Seventeen more species of fishes were not reported in Mula-Mutha in 1942making a tally of seventy-one species[3]. An additional survey of the same region was done reported in 1944[4]. Sixty species of various fishes was reported in 1963, of these sixty species; many were reported for the first

time[5]. Later on, thereportof 112 fish species in the freshwater of Pune District on the basis of collection carried out from 1966 to 1968[6]. They also reported a few fishes for first time. After a long interval i.e. in 2002 about 62 species of 17 families were reportedfrom Mula and Mutha River[7]. In 2003,102 specimens from water of Mula-Mutha River were listed out[8]. After four year i.e. in 200759 species were reported from Pavana River[8]. The study has been coupled with physico-chemical parameters of the Mutha River, Mula River and its tributary Pavana River. The existing studies indicate that the fish population is declined in downstream and upstream of rivers, as well as indams.

Material and Methods

Fishes were collected from polluted as well as non-polluted areas of the Mula-Mutha River with the help of local fishermen, also regularly visited fish markets, the common species only noted. Both the rivers was surveyed at many places from Mulsi dam on Mula river and Pavana dam until its confluence with the river with each other, as well as Khadakwasala damp upto Sangam bridge. All fishes were properly preserved in 10% formalin for further study and identified by using key[10-12].

For the physico-chemical studies we have selected three sampling stations A- Kumbharawada bridge on Muth River, B- Harris Bridge on Mula River and C- Bandgarden after confluence. These sites were selected on the basis of varied ecological condition of the exploration zone due to domestics and industrial wastes. Station A (Kumbharawada)- was selected on the right bank of river Mutha near Kumbharawada drain and Mangalwarpeth Nala converge with river Mutha; station B- (Harris Bridge) on Mula river about 1 km before the converge of river Mula with the river Mutha and after confluence of Pavana with Mula river. However station C- Bundgarden about 1 km after converge of both rivers and Municipal sewage treatment plant discharge the partially treated sewage water. The water samples were collected fortnightly by immersing a wide mouth bottle at the sub-surface level. Samples were collected during morning hours between 6.00 to 7.00 A.M., for DO, oxygen was fixed at the site of collection, the sample of water for physico-chemical characteristics were analyzed follow Standard Methods[13] in Deccan Ecolab.

Results and Discussion

Sixty three species of 17 families were collected from Mula-Mutha River and list of fishes is in the process of publication. Majority of fishes found in these rivers, which were previously mentioned in lists from Mula-Mutha River was published[3,4,7,8,9]. In the polluted stretch of this river, tolerant species as *Aorichthysseengala, Oreochromismossambicus* and *Gambusiaaffinis* as well as air breathing fish *H. fossilis*are found at many places, besides these *Labeo*, *Catla* and *Channa* species were reported occasionally in polluted area of Mula-Mutha River near convergence.

The growth, reproduction and the development of biota is influenced by physico-chemical factors, *i. e.* temperature, transparency, pH, dissolved oxygen, free carbon dioxide, acidity, alkalinity, chloride, nitrate, phosphate, biological and chemical oxygen demand. During the present investigation, the water temperature of the river stretch explored ranged between 22.3°C to 31.5°C. The minimum was recorded during winter and maximum during summer seasons at station-B. The pattern of fluctuation was more or less similar at all stations. The minimum and maximum temperature of the rivers shows a clear correlation with atmospheric temperature. The water temperature followed the atmospheric temperature being hottest during summer season and lowest during winter season. The minimum pH value was 6.73 which registered in summer season at station-C and the maximum pH 7.92 was recorded at station-B in winter[14]. However, seasonal variations of pH ranging from 6.73 to 7.28 are considered satisfactory for the production of biomass. The variations in pH are an important parameter in water body since most of the aquatic organisms are adapted to an average pH and do not withstand abrupt changes[15]. The average pH of the river water in the present study is well within the permissible limit of 6.5 (WHO1971) and confines within the tolerance limit of inland surface water (ISI: 2296-1982). The minimum dissolved solids were recorded 262mg/litre at station-B in summer season and maximum was 608mg/litre at same station during monsoon season.

The dissolved oxygen (DO) level was lowest recorded minimum at station all three stations during summer season. This might be due to overloading concentrations of organic and industrial wastes with retreating water level in this season. The fluctuations indicated an inverse relationship between temperature and dissolved oxygen. In summer when temperature was high, the water was unable to bind oxygen which therefore, was released. The free oxygen gets used up in the oxidation of organic matter, which consumes a part of oxygen and thus decreasing its concentration in water. The values of dissolved oxygen increased as much as 4.6mg/litre during monsoon. The heavy rains over flooded the river and thus the concentration of pollution gets diluted. This is in conformity with finding of[14,16]. The low dissolved oxygen values at all stations during summer season indicating the high levels of pollution at these points[17], criticized that the DO might fluctuate due to the alteration in water temperature.

Carbon dioxide is one of the essential constituents of aquatic ecosystem. The abundance of carbon dioxide exerts certain specific effects on aquatic biota. The river exhibited maximum Carbon dioxide as 24.3mg/litre at station-C during summer season, whereas the lowest concentration of Carbon dioxide 8.3mg/litre was recorded at station-B during monsoon season. In the present investigation Carbon dioxide was found to be inversely proportional to the dissolved oxygen. Free CO_2 contributes to the fitness of natural water as serves to buffer the environment against rapid shifts in the acidity or alkalinity and

also regulates biological process in aquatic communities and can form many compounds[18].

The minimum value of acidity was 156 mg/litre at station-B, whereas maximum value 385 mg/litre were recorded at station-C. Total alkalinity value ranged between 150 to 400mg/litre and minimum was recorded at station-B and maximum at station-C respectively, the values being higher in summer and lower during winters. During summer, increased decomposition of organic matter liberates CO_2, which in turn, prevents the dissociation of bicarbonates in carbonates, increasing its total alkalinity. The alkalinity values were high at the site due to addition of sewage and organic matter and bicarbonate show determined relationship with free carbon dioxide[18,19].

The low biological oxygen demand (BOD) values recorded during monsoon at all stations, with the lowest of 3.5mg/litre at station-A indicate a remarkable dilution and dispersion of the pollutants in the river. In the present investigation maximum BOD was observed during summer all the stations and observation is in agreement with[20]. The highest BOD values were recorded as 59mg/litre at station-C. Higher value of BOD observed during summer could be a result of reduced rate of water flow, degradation of organic waste and accumulation of wastes due anthropogenic activities, while low BOD values during monsoon may attribute to dilution of river water[21].

In the present study low COD values were recorded during monsoon at all the stations but minimum was 40.32mg/litre at station-B. Maximum COD observed during summer all the stations, with highest values of 190 mg/litre at same station. The higher COD values (970mg/litre to 2880mg/litre) were recorded in the polluted stretches of River Khari[22]. Increased level of COD observed during summer in the present study may be due to high temperature and raised evaporation of water, consumption of oxygen for degradation of organic matter and load of chemical waste discharged in to the river system. These observations are in agreement with[20,23]. High COD values indicate the presence of chemically oxidizablecarbonaceous matter as well as inorganic matter such sulphides, nitrates and reduced metal ions[24].

The chloride values were below the Class A-IV standards as per MPCB. They ranged between minimum of 38.5696mg/litre and maximum was 60.48mg/litre at station-B during in monsoon and summer respectively. A decrease in the chloride content during monsoon could be related to the dilution of water in the monsoon, while the summer peak could be linked to the catchment runoff and sewage disposal[16,17,18]. High chloride content indicates deterioration of water quality usually linked with increased sewage load[20].

A minimum value of nitrate was 0.085 mg/litre at station-C in summer, while maximum of 0.34mg/litre at station-B during monsoon season. Increased values of nitrate were recorded during monsoon season at all the three stations. In an earlier study an increasing pattern of concentration of Nitrate registered[20]. The observed increasing trend could be attributed to heavy rainfall and consequent drainage of sediments followed by the influx of allocthonous materials as well as excess decomposition activity in the river[17, 25].

The concentration of phosphate ranged between 85.0mg/litre during monsoon season at station-B to 154mg/litre in summer at station-C. Maximum phosphate values were recorded during summer at all the stations, while lower values the same were evident during monsoon season. Phosphate is the most critical and limiting factor in the maintenance of water fertility [26]. Domestic sewage and agricultural run-off containing nutrient fertilizers contributed to the increase in Phosphate in an aquatic ecosystem[17]. High phosphate values during summer could be due to lower quantity of water in river and discharge of waste water containing detergent and sewage.

Conclusion

The present study shows that the Mutha River from Vittal wadidown wards is highly polluted; its pollutants level is so high. This results into disappearance of fish fauna during winter and summer. In the polluted stretch of this river, tolerant species as *Oreochromismossambicus* and *Gambusiaaffinis*were found at many places. The Pavana River is carrying industrial and domestic wastes from Pimpri-Chinchwad Corporation. At many places hydrogen and methane gas bubbles have been observation, this is due anaerobic decomposition of organic and inorganic substances. In such a highly polluted water few air breathing and exotic fish *Oreochromismossambicus*have been found, but fishing is not done in downstream of Pavana River from Chinchwad. The Mula River is comparatively less polluted and having good fish diversity upto the confluence with Pavana River at Dapodi. Exotic fish *Oreochromismossambicus*has been reported from polluted as well as non-polluted part of Mula River even after confluence with Pavana River. The polluted areas with heavy influx of organic and innumerable industrial waste has been drastically reduced the biodiversity in city area and downstream of river. The waste water treatment plants need to be set up at the distance of 2 km for survival of river, preprocessing of the drainage wastes before its release in water, awareness about the river and its importance is necessary. A separate mechanism to keep municipal wastes free from the river need to be done for the survival of the river and ichthyofauna associated with it.

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Table-1
Physico-chemical characteristics of water of Mula-Mutha at various sampling stations in year- 2004

Parameters	Unit	Seasons	Sampling Stations		
			Station-A	Station-B	Station-C
Temperature	(^oC)	M	28.5	28.0	29
		W	23.4	22.3	24.6
		S	31	31.5	30
pH		M	7.1	7.28	7.06
		W	7.6	7.92	7.5
		S	6.8	6.98	6.73
Total Dissolved Solids	Mg/litre	M	586	608	585
		W	385	406	404
		S	271	262	288
Dissolved Oxygen	Mg/litre	M	4.1	5.6	4.3
		W	2.5	3.4	1.0
		S	0.8	1.2	0.5
Free CO_2	Mg/litre	M	9.0	8.3	8.76
		W	11.6	10.2	14.9
		S	19.2	16.5	24.3
Acidity	Mg/litre	M	213	156	264
		W	300	250	385
		S	163	210	250
Total Alkalinity	Mg/litre	M	190	320	175
		W	250	350	150
		S	358	400	360
Biological Oxygen Demand	Mg/litre	M	3.5	3.6	4.2
		W	20	21	38
		S	47	42	59
Chemical Oxygen demand	Mg/litre	M	76.608	40.32	88.704
		W	72	149.184	134
		S	168	190	172
Chlorides	Mg/litre	M	40.5326	38.5696	45.9385
		W	43.7099	55.6274	48.5665
		S	58.2798	60.48	58.212
Nitrates	Mg/litre	M	0.34	0.282	0.22
		W	0.20	0.114	0.17
		S	0.197	0.17	0.085
Phosphates	Mg/litre	M	98.0	85.0	123
		W	130	118	139
		S	148	125	154

M: Monsoon, W: Winter, S- Summer.

Table-2

Family /species	**Family/Species**
Notopteridae	**Bagridae**
Notopteruschitala (Hamilton-Buchanan)	*Aorichthysseengala*(Sykes)
***Notopterusnotopterus* (Pallas)**	*Mystusbleekeri* (Day)
Cyprinidae	*Mystuscavasius* (Hamilton- Buchanan)
Catlacatla(Hamilton-Buchanan)	***Mystusmalabaricus*(Jerdon)**
Cirrhinusfulungee(Sykes)	*Mystusmontanus*(Jerdon)
Cirrhinusmrigala(Hamilton-Buchanan)	*Rita pavimentatus*(Sykes)
Cirrhinusreba(Hamilton-Buchanan)	**Siluridae**
Gonoproktopteruskolus	*Ompokbimaculatus* (Bloch)
Labeoariza(Hamilton-Buchanan)	*Wallagoattu* (Schneider)
Labeoboggut (Sykes)	**Clariidae**
Labeocalbasu (Hamilton-Buchanan)	*Clariusbatrachus (*Linneaus)
Labeorohita (Hamilton-Buchanan)	**Sisoridae**
Neolissochilushexagonolepis(McClelland)	*Nangraitchkeea*(Sykes)
***Osteobramacotiopeninsularis*(Silas)**	**Heteropneustidae**
Osteobramaneilli (Day)	*Heteropneustesfossilis*(Bloch)
Osteobramavigorsii(Skyes)	**Belonidae**
Puntiusamphibius (Valenciennes)	*Xenentodoncancila*(Hamilton- Buchanan)
Puntiuschola (Hamilton-Buchanan)	**Aplocheilidae**
Puntiusjerdoni(Day)	*Aplocheiluslineatus*(Valenciennes)
Puntiussaranasubnasutus(Velenciennes)	*Aplocheiluspanchax*(Hamilton- Buchanan)
Puntiussophore(Hamilton-Buchanan)	**Poecillidae**
Puntiusticto (Hamilton-Buchanan)	*Gambusiaaffinis*(Baird & Girard)
***Puntiusvittatus*(Day)**	**Ambassidae**
***Rohteeogilbil*(Sykes)**	*Chandanama*(Hamilton- Buchanan)
***Chela laubuca*(Hamilton-Buchanan)**	*Pseudambassisranga*(Hamilton- Buchanan)
Salmostomaacinaces(Valenciennes)	**Cichlidae**
Salmostomaboopis(Day)	*Oreochromismossambica* (Peters)
Barliusbendelisis(Hamilton-Buchanan)	**Mugilidae**
Danioaequipinnatus(McClelland)	*Rhinomugilcorsula*(Hamilton- Buchanan)
Rasboradaniconius(Hamilton-Buchanan)	**Gobiidae**
Crossocheiluslatiuslatius(Hamilton-Buchanan)	*Glossogobiusgiuris*(Valenciennes)
Garragotyla(Gray)	**Channidae**
Garramullya (Sykes)	***Channamarulius*(Hamilton- Buchanan)**
Balitoridae, Nemacheilinae	*Channaorientalis*(Bloch & Schneider)
Nemacheilusanguilla(Annandale)	*Channastriatus*(Bloch)
Schisturadenisonidenisoni(McClelland)	**Mastacembelidae**
Oreonectes (Indoreonectes) evezardi(Day)	*Mastacembelusarmatus* (Lacepede)
Acanthocbitisbotia (Hamilton- Buchanan)	
Acanthocbitissinatus (Day)	
Cobitidae, Cobitinae	
Lepidocephalusguntea (Hamilton- Buchanan)	

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