Biospectra : ISSN: 0973-7057, Vol. 14(2), September, 2019, pp. 43-50
An International Biannual Refereed Journal of Life Sciences

Animal Science

ISSN : 0973-7057

Int. Database Index: 663 www.mjl.clarivate.com

Fish diversity and abundance in relation to water quality of Medninagar, Palamu, Jharkhand (India)

Pradeep Kumar* & Anjana Verma
Department of Zoology, Vinoba Bhave University, Hazaribagh, Jharkhand, India

Received :28th April, 2019 ; Revised : 09th June, 2019

Abstract : This paper represents the Freshwater fish diversity, abundance and richness status of Medninagar, Palamu, Jharkhand was studied in three sampling sites. The present study has shown that Nawatoli pond, Kachrwa dam and Bara talab supported 3 fish species belonging the same class, order and family. Fish diversity was assessed Shannon-Weiner Index (H), Simpson's Dominance Index (D), Simpson's Index of diversity (I-D), Pielons Evenness and Margalef Index of species richness and seasonal water quality parameters such as water, temperature, pH, electrical conductivity, free CO_2, DO, BOD hardness, chloride, nitrate and phosphate has been recorded and were found suitable for fish population. It can be concluded that reservoir supported rich fish population; it needs proper management and utilization of these fish's wealth and sustainable steps to monitor and conserve these fish health. However, the present paper deals with fish diversity in the freshwater fishes of Medninagar, Palamu, as these water bodies harbour a large number of fish fauna. The survey is based on observations and description of fishes as recorded in Systems Nature by Carls Linnaeus.

Key words: Freshwater fishes, water quality, biodiversity indices, Cyprinidae, Growth, Palamu, Jharkhand

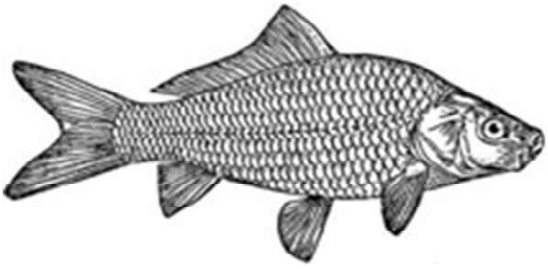
INTRODUCTION

Fish perform all their body functions in water because it is totally dependent upon water to breathe, feed and grow, excrete wastes and reproduce understanding the physical and chemical qualities of water. Water has very unique density qualities. Most liquids become denser as they become cooler. However, water gets dense as it cools until it reaches a temperature of approximately 39°F. As it cools below this point, it becomes higher until it freezes (32°F). As ice develops, water increases its volume by 11 per cent. The increase in volume allows ice to float rather than sink, a characteristic that prevents ponds from freezing solid. It is the fact that water can dissolve more substances than any other liquid. This is why, it is called universal solvent. Beside oxygen, water temperature is one of the important factors that affect the growth of fish. Fishes are cold-blooded organisms and acquire approximately the same temperature as their surroundings. The temperature of the water affects the activity, behaviour, feeding, growth and reproduction of all fishes. Metabolic rates in fish double for each 18°F rise in temperature. Temperature also determines the amount of dissolved gases (oxygen, carbon dioxide, nitrogen etc.) in the water. The cooler the water the more solubility of the gases. Water has its maximum density at 39.2°F. In spring season, water temperature is nearly equal at all ponds depths. As a result, nutrients, dissolved gases, and fish wastes are evenly mixed throughout the pond. As the day become warmer, the surface water becomes warmer and lighter while the

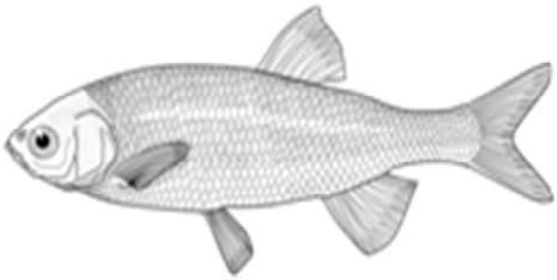
*Corresponding author :
Phone : 9835726048
E-mail : arshad.nitp@gmail.com

cooler-denser water forms a layer underneath. Circulation of the cooler bottom water is prevented because of the different densities between the two layers of water. Dissolved oxygen levels decrease in the bottom layer since photosynthesis and contact with the air reduced. The already low oxygen levels are further reduced through decomposition of waste products, which settle to the pond bottom. Localized dissolved oxygen depletion poses a very real problem to the fish culturists.

MATERIALS AND METHODS



Labio rohita



Catla catla

Cirrhinus mrigala

1. Study Area

The study area was situated at Medininagar, Palamu, Jharkhand. Palamu district is located in the South-West of Jharkhand State. It is a part of Chotanagpur highlands, covered with green bush vegetation. Due to maximum height at Pat region, it gives pleasant situation. Here high rainfall occurs in comparison to other parts of Jharkhand. It has rugged topography. Region is covered with lava, where the ocean lava was erupted; the region is formed by lava deposit of igneous and metamorphic rocks. Due to the mechanical action of the agents of demidatran volcaner rocks have been eroded and transformed into lalurope soil.

Due to leeward action of the water on the surface, rugged topography of granite and other metamorphic rocks are seen. North Koel River is the most popular river of this region. Budhaghagh and Gautam dhara are two famous waterfall situated in this region. There are a number of ponds in this region like Nawatoli, Kachrwa dam, Bara talab. All these tanks are utilized for various purposes by the local people. Water is fresh and aquatic creatures are utilized by human beings. The climate of this region is monsoon type, but due to the highland area, this region is cooler than the other parts of Jharkhand. It has low temperature in summer season and receives high rainfall in rainy season as comparison to the other parts of Chhotanagpur highlands. This region seems very beautiful in rainy season; Green vegetation and cloudy weather attract tourism in this region.

The fishes such these biomass and efficiently convert them into animal protein in order to help farmers for fish culture in this area because of its high protein content. So a detail study is urgently required to correlate the growth of fish with respect to local environment that surround the water body and influence water quality. These works have immense significance for Jharkhand where large population depends on fishing not only as food source but also for their livelihood.

2. Fish Samples Collection

Fish samples were collected from different selected localities during the study period from September 2017 to October 2018 with the help of local fishermen using different types of nets namely gill nets, cast nets and

dragnets. Immediately photographs were taken prior to preservation since formalization decolorizes the fish colour. 10% formalin solution was prepared for preservation of fish samples. Fish brought to the laboratory were fixed in this solution in separate jars according to the size of species. Smaller fishes were directly placed in the formalin solution while large fishes were given an incision on the abdomen before they were fixed.

3. Fish Identification

The fishes were identified by using Dutta Munsi & Srivastava (1988), Talwar and Jhingran (1991) and Jayaram (1999) methodology

4. Diversity Indices

Species diversity can be managed separately either as species richness or evenness or diversity as a whole. Species richness was measured by Index of Richness (denoted by R) given by Margalef (1958). Species evenness was measured with evenness index (denote by E) given by Hill (1973).

Diversity of the species calculated directly with a variety of indices, of which two commonly used are Shannon-Weiner Index or simply the Index of diversity as given by Shannon and Weiner, 1963) and Index of dominance given by Simpson (1949). Shannon's index has a direct relationship with the species diversity, whereas Index of dominance has an inverse relationship.

5. Water Sample collection for physico-chemical analysis

Surface water samples were collected in polythene cans from different sampling sites of the Medininagar reservoir. Air and water temperature, pH, DO and free CO_2 were determined on the spot itself and for BOD determination water samples were collected in BOD bottles. For further analysis, samples were transported to laboratory and analyzed other parameters using standard procedures (APHA, 1985, 2005).

Periodical estimates of fish growth and yield in relation to water samples were collected and analysed for computation of fish population dynamics and impact of physico-chemical complexes on fish yield of the water bodies. The whole exercise also involved network analysis and rendering of food chains/food web of the existing ecosystems.

Analytical studies in the selected water bodies were carried out for two years 2016 to 2018 in different seasons, prebreeding, breeding and post breeding. Mean values are presented here. However, methodology of APHA – 1985, 2005 used for experimental work. Three different seasons have been considered to determine that water condition affect the body of fishes, physiology taking growth index as measurement.

RESULTS AND DISCUSSIONS

The present investigation of fish fauna in Medininagar reservoir showed that most of the fishes recorded were widely distributed in the lentic and lotic waterbodies of Medininagar reservoir. The members of Cypriinidae family dominate the fish populaation.

The economically important and cultivated fishes were also recorded and includes *Labio rohita, Cirrihinus mrigala, Catla catla*. The economically important and cultivable above fishes and reservoir can be exploited for commercial production of fishes for better improvement of socio-economic condition of local people.

Table - 1 : Fish abundance and biodiversity status in Medininagar, Palamu, Jharkhand

Sl.No.	Name of Bony fish	Zoological Name	Abundance	Biodiversity	Habitat
1	Rohu	*Labeo rohita (Ham)*	A-2	LR-nt	Lentic and Lotic
2	Mrigala Naini	*Cirrhinus mrigala*	A-2	LR-nt	Do
3	Katla	*Catla catla*	A-2	VU	Do

A – 2 : Common
VU : Vulnerable
LR-nt : Lower risk near threatened

As far as biodiversity status (IUCN-1994) is concerned Different diversity indices were calculated as per standard methods. The Shannon-Weiner fish diversity index of Medninagar reservoir ranged from 2.4 to 3.0. The Simpson's dominance index values ranges between 0.08 and 0.2. Simpson's index of Diversity (1-D) also ranges between 0 and 1 but now, the greater the value, the greater the sample of diversity. This makes more sense. In the present study, the Simpson's index of Diversity (1-D) values fluctuated between 0.89 and 0.95. However, Pielou's evenness values were ranges from 0.6 to 0.9. The Margalef index of species richness values revealed 1.48 to 2.4. (Table No.2).

Table-2 : Fish diversity indices of Medninagar, Palamu, Jharkhand

Diversity indices	Range
Shannon - Weiner Index (H)	2.4- 3.0
Simpson's Dominance Index (D)	0.08-0.2
Simpson's Index of Diversity (I-D)	0.89- 0.95
Pielou's evenness	0.6- 0.9
Margalef index	1.48 -2.4

Table 3 : Seasonal variation of physico-chemical parameters in the water samples of Medninagar, Palamu, Jharkhand during 2017-2018

Parameters	Site 1			Site 2			Site 3		
	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy
Air Temp.	28±2.16	33±0.81	28.5±2.51	28±2.16	33.5±0.57	28.25±3.30	29±2.44	32.75±1.25	28.75±3.77
Water Temp.	25.25±0.5	29±2.16	26.75±1.70	25.25±0.5	29.75±1.89	26.5±1.91	26±0.81	30.25± 1.71	27.25±2.87
Turbidity	30.82±22.35	21.75±10.37	52.62±29.23	15.35±3.92	28.7±10.83	49.82±30.57	15.5±4.20	26.25±6.34	56.5±28.38
pH	7.43±0.15	7.62±0.09	7.47±0.15	7.52±0.06	7.63±0.08	7.52±0.14	7.43±0.23	7.65±0.07	7.40±0.22
Alkalinity	51.11±6.61	59.25±2.27	42. 78± 4.45	S6.13±8.33	61.45±1.47	42.58±13.41	55.03±5.92	61.50±2.08	40.08±13.21
EC	133.75±8.38	165.5±13.72	121.35±37.42	136.75±6.89	167±7.39	120.67±35.93	155.75±34.27	I 9.5±9.74	140.5±21.11
CO_2	2.47±0.74	1.4±0.52	2.55±0.92	2.54±0 91	1.45±0.58	2.63±0.83	2.31±0.47	1.49±0.53	2.68±0.72
DO	7.31±1.53	6.18±1.l5	5.79±1.10	7.52±1.02	5.75±0.62	5.72±0.71	8.28±1.50	6.38±0.83	5.72±1.26
COD	8.8±6.34	16.1±9.46	4.50± 1.73	12.5±2.88	12.25±6.94	11.5±5.51	10.22±9.25	15.5±9.98	14.75±9.28
BOD	1.01±0.68	2.47±1.40	0.83±0.04	1.17±0.47	1.31±0.67	1.21±0.44	1.18±0.84	2.20±1.39	1.77±1.23
Hardness	50.5±5.0	62.0±11.54	44.00± I 0.70	47±5.29	62.5±9	48±11.77	56.25±9.53	67.5± 12.33	52.5±9.84
Chloride	21.98±0.81	26.59±4.68	20.27±3.00	21.45±2.19	26.57±5.12	21.62±4.81	24.89±1.71	27.65±5.37	23.04±1.36
NO_3	0.108±0.059	0.165±0.03	0.328±0.221	0.13±0.09	0.162±0.04	0.34±0.25	0.120±0.06	0.142±0.026	0.340±0.285
PO_4	0.011±0.008	0.012±0.007	0.009±0.005	0.004±0.002	0.012±0.006	0.007±0.004	0.006±0.003	0.013±0.006	0.009±0.004

All The parameters are expressed in mg/L except temperature (^oC) turbidity (NTU), pH, electrical conductivity (μmhos/cm)

Water Quality Parameters

The physico-chemical characteristics of water have an important role in supporting fish diversity freshwater ecosystems. The seasonal average values of physico-chemical parameters of the reservoir are depicted in the Table 3. In the present study, air temperature was recorded in the range of 28.00±2.16 during winter season to 33.50±0.58^oC at Site 1. Water temperature was varied between 25.25±0.50^oC at Site 1 and 2 during winter season and 30.25±1.71^oC at the site 3 during summer season. pH was in the range of 7.40±0.22 at site 3 during rainy season and 7.66±0.07 at site 3 during summer season. A minimum

value of electrical conductivity was recorded at site 120.68±35.93 mhos/cm during rainy season and a maximum of 169.50±9.75 mmhos/cm at site 3 during summer season. Free CO_2 was observed in the range of 1.41±0.52 at site 1 during summer season to 2.68±0.72 mg/L at site 3 during rainy season. DO level was varied between 6.19±1.16 mg/L at site 1 during summer season to 8.28±1.50 mg/L at site 3 during winter season. Biological oxygen demand for 3 days at 27°C was fluctuated between 0.83±0.04 mg/L at site 1 during rainy season and 2.48±1.41 mg/L at site 1 during summer season. Total hardness was registered in the range of 44.00±10.71 mg/L at site 1 during rainy season to 67.50±121.37 mg/L at site 3 during summer season. Nitrate concentration was observed in the range of 0.108±0.06 mg/L at site 2 during rainy season. Phosphate content was fluctuated between 0.012±0.01 mg/L at site 2 & 3 during summer season.

The diversity index indicates good correlation with overall species richness across the sites and could be utilized by the biodiversity conservation managers for prioritization of sites of conservation and habitat restoration. *Bergerot et al*. (2008) developed indices for fish biodiversity conservation concern, rarity index and fish magnitude values for prioritization of sites' for large scale European freshwater basin in France. *Lasne et al*., (2007) used fish zonation and identified indicator species for the evaluation of the ecological status of the Loire basin (France). They also carried out a discriminant analysis on environmental variables revealed that they could be mainly determined by the slope, temperature, and depth.

During study, it was found that abundance and diversity of fishes were found to be very high in respect to extent of water body. The maximum numbers of species were recorded from low land areas. According to *Shaikh et al*., (2011) in low and middle land areas fresh water fish diversity was found to be very high. It is due to deep water bodies that allow niche segregation in order to enable the fishes to live without facing more intra and inter specific competitions. During summer, when maximum level of water decreased due to hot air and high temperature most of the fishes migrated toward low land for survival. But during winter season, diversity of fish fauna is abundant due to clear water, preference of maximum amount of phyto and zooplankton as compared to rainy season. The presence of exotic species in the reservoir may be due to migration from nearby water bodies with flood water.

The mean air and water temperature values were similar and slightly high during summer season. pH is considered as an indicator of overall productivity that causes habitat diversity (*Raj and Jayasekhar*, 2007). The pH of most the natural water is varied between 6.0 and 8.5. In the present study, the seasonal mean pH was close to neutral. According to *Goldman and Horne (1983),* low pH < 5.0 can severely reduce aquatic species diversity. However, the range of water pH was reasonably good for fish population. The conductivity values were higher in the summer season due to decreases in the total volume of water, whereas; low in rainy season because of dilution factor (*Alam et al*., 2007). CO_2 has a great effect on photosynthesis which affect the fish growth. There is no much variation in the concentration of free CO_2 throughout the study period. *Fafioye et al.,* (2005) have observed similar trend in Omi waterbody Ago Iwoye (Nigeria). Further, free CO_2 more than 20 mg/L is toxic to fish (Battul et al., 2007). The observed values were below 20 mg/L of free CO_2 hence, water is more suitable for fish diversity. Dissolved Oxygen is a primary and comprehensive indicator of water quality in surface water. The decline of dissolved oxygen level has a serious implication for the health of aquatic system. The optimum value for good water quality is 4 to 6 mg/l of DO, which ensures healthy aquatic life in a water body (*Santosh and Shrihari*, 2008). In the present study, DO level was more than 4 mg/L at all sites. Further, DO level was high in winter followed by summer and rainy season. The reason could be low temperature, turbulence of surface water by high wind action etc. And its level drops in summer due to high metabolic rate of organisms (*Salve and Hiware*, 2006) and limited turbulence in the reservoir (*Mwaura*, 2006). BOD value can be used as a measure the degree of water pollution and is useful in evaluating self -purification capacity of a water body.

The seasonal BOD values were slightly high in summer, low during winter and rainy season. Higher values of BOD in summer season due to higher microbial activity and elevated temperature (*Patel,* 1999). As per the hardness values, water belonging to soft (0-60 mg/L) and moderate (60-120 mg/L) category. Seasonal variation of total hardness shows that its concentration was high in summer

and more or less similar in other seasons. The high hardness during summer season could be due to reduced water level and increased salts content in water (Kemdirim, 2005). Nitrate (NO_3) is an essential nutrient for aquatic plants in natural waters. An excess concentration of nitrate tends to stimulate algal growth and leads to eutrophic conditions. Seasonal nitrate concentration was high during rainy season at all stations and remained similar in winter and summer season. The higher concentration of nitrate during rainy season could be due to leaching of nitrate from agricultural fields. Phosphorus concentrations above 0.02 mg/L in reservoirs tend to produce algal blooms. However, in the present study, phosphate was below 0.02 mg/L. Its concentration was high in rainy season than summer and winter season. The overall water quality parameters indicated that water is suitable for fish life in the reservoir.

This ichthyofaunal study indicates that this waterbody is rich in diversified fish fauna consists of native species, economical, cultivable. Changes in fish community, directly or indirectly affect other components of the reservoir ecosystem including physical, chemical and biological characteristics. Habitat loss and environmental degradation has seriously affected the fish fauna. Conservation of fish diversity assumes topmost priority under changing circumstances of gradual habitat degradation. Therefore, a sustainable strategies needs to explore more fish species, utilization and save fish community of this reservoir. The study will provide future strategies for development and fish conservation.

ACKNOWLEDGEMENT

Authors are grateful to authorities of P.G. Department of Zoology, Vinoba Bhave University, Hazaribagh for providing facilities to carry out this research, library and laboratory facility, and the authors would also like to express sincere gratitude to all staff members of G.L.A. College, Madninagar for their moral support.

REFERENCE

1. **APHA, 2005.** Standard methods for the examination of water and wastewater, 21st Edition. *Amer. Publ. Heal. Assoc., Amer*. Water Works Assoc. and Water Poll. Contr. Fed., Washington, D.C.

2. **Abhay Kumar Singh, Mondal GC, Singh PK, Singh S, Singh TB and Tewary BK. 2005.** Hydrochemistry of reservoirs of Damodar river basin, India: Weathering processes and Water quality assessment. *Environ Geol.* **48:** 1014-1028.

3. **Alam J, Md. MR Islam, Muyen Z, Mamun M and S Islam. 2007.** Water quality parameters along rivers. *Int J Environ Sci. Tech.* **4(1):** 159-167.

4. **Battul PN, Rao KR, Navale RA, Bagale MB and NV Shah. 2007.** Fish diversity from Ekrukh lake near Solapur, Maharashtra. *J Aqua Biol*. **22(2):** 68-72.

5. **Carol J, Benejam L, Alcaraz C, Vila--Gispert A, Zamora L, Navarro E, Armengol J and Garcia-Berthou E. 2006.** The effects of limnological features on fish assemblages of 14 Spanish reservoirs. *Ecol Freshwater Fish*. **15:** 66-77.

6. **Datta Munshi JS, and Srivastava MP. 1988.** Natural history of fishes and systematics of freshwater fishes in India. *Narendra Publishing Co. Delhi, India*.

7. **Fafioye OO, Olurin KB and Sowunmi AA. 2005**. Studies on the physico-chemical parameters of Omi waterbody of Ago--Iwoye, Nigeria, Afr. 1. *Biotechnol.* **4(9):** 1022-l024.

8. **Goldman C.R and Home AJ. 1983.** Limnology. *McGraw-Hill, Tokyo*.

9. **Hill MO. 1973.** Diversity and its evenness, a unifying notation and its consequences. *Ecology.* **54:** 427-432.

10. **IUCN. 1994.** Red List of Threatened Animals. IUCN, Gland.

11. **Jayaram KC. 1999.** The Freshwater Fishes of the Indian Region. *Narendra Publishing House, Delhi.*

12. **Lasne E, Bergerot B, Lek S, Laffaille P. 2007.** Fish zonation and indicator species for the evaluation of the ecological status of rivers: example of the Loire basin (France). *River Res Appl.* **23:**877-890.

13. **Margalef, R. 1958.** Temporal succession and spatial heterogeneity in phytoplankton. In Perspective in Marine Biology (*Buzzati-Traverso, A.A., ed*.), University of California Press. Berkeley, California, USA.

14. **Mwaura F. 2006.** Some aspects of water quality characteristics in small Shallow tropical man-made reservoirs in Kenya. *African Journal of Science and Technology*. **7(1):** 82-96.

15. **Patel RK. 1999.** Assessment of water quality of Pitamahal Dam. *Indian 1. Environ. Prot.* **19(6):** 437-439.

16. **Pisca Ravi Shankar, Saraladevi Band Divakara Chary K 2000.** The present status of Ibrahimbagh, a minor reservoir of Hyderabad. *Fishing Chimes*. **20(2):** 41-43.

17. **Salve BS and CJ Hiware. 2006.** Studies on water quality of Wanparakalpa reservoir, Nagpur, near Parli Vaijnath district Beed, Marathwada region. *J. Aqua BioI.* **21(2):** 113-117.

18. **Santosh M. A Mannavar and Shrihari S. 2008.** Evaluation of water quality index for drinking purposes for river Netravathi, Mangalore, South India. *Environ Monit Assess*. **143(1-3):** 279- 290.

19. **Shaikh HM, Kamble SM and Renge AB. 2011.** The study of ichthyofauna diversity in Upper Dudhna project water reservoir near Somthana in Jalna district (MS) India. *J of Fish and Aqua*. **2(1):** 08-10.

20. **Shannon CE and Weaver W. 1963.** The Mathematical Theory of Communication. *University of Illinois Press, Urbana, Illinois*.

21. **Simpson EH. 1949.** Measurement of diversity. *Nature* **163:** 688.

22. **Singh Gurucharan, 2001.** Status of development of fisheries of Pong reservoir, Himachal Pradesh. *Fishing Chimes.* **21(1):** 88-90.

23. **Talwar PK and Jhingran AG. 1991.** Inland fishes of India and adjacent countries. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

24. **Sakhare, V. B. 2001.** Ichthyofauna of Jawalgaon reservoir. Maharashtra, Fishing Chimes. **19(8):**45-47.

25. **Raj ADS and T Jayasekher. 2007.** Hydro geochemistry of the river basins of Kanyakumari district. *Indian 1. Environ. Prot*. **27(2):** 145-152.

26. **Vijaylaxmi CM, Rajshekhar & K Vijay Kumar. 2010.** Freshwater fishes distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka. *Int J of Syst BioI.* **2:**1-9.

27. **Carol J, L Benejam, C Alcaraz, A Vila-Gispert, L Zamora, E Navarro, J Armengol and E Garcia-Berthou. 2006.** The effects of limnological features on fish assemblages of 14 Spanish reservoirs. *Ecol. Freshwater Fish.* **15:** 66-77.

28. **Plafkin JL, Barbour MT, Porter K D, Gross, SK & Hughes RM. 1989.** Rapid Bioassessment protocols for use in streams and rivers: benthic macro invertebrates and fish. United States Environmental Protection Agency, Washington, D.C.

29. **Siligato S & Bohmer J. 2001.** Using indicators of fish health at multiple levels of biological organization to assess effects of stream pollution in southwest Germany. *J. Aquat. Ecosyst. Stress recovery.* **8:** 371-386.

30. **Singh Gurucharan. 2001.** Status of development of fisheries of Pong reservoir, Himachal Pradesh, *Fishing Chimes.* **21(1):** 88-90.

***