The Clarion Volume 1 Number1 (2012) PP 37-45

Ecological status and fishery potential of Deopani - a coldwater stream of Arunachal Pradesh, India

P.C.Mahanta[1], Debajit Sarma[1] and Rajdeep Dutta[2]
[1]Directorate of Coldwater Fisheries Research, ICAR, Bhimtal, Nainital, Uttarakhand, India
[2]Krishi Vigyan Kendra, Arunachal Pradesh, India

Abstract

Deopani stream, originates in Lower Dibang Valley district of Arunachal Pradesh at a longitude of 95°51′12.96″ E and latitude of 28°09′31.58″ N at an altitude of 475m msl. Deopani river originates at the confluence point of two small streams Eze and Eme at a longitude 95°51′16.00″ E and latitude of 28°09′34.60″. In the present study, physico-chemical regime of Deopani stream was investigated in four different stations from October, 2008 till September, 2009 at an interval of two moths. Stream water with fast current showed water velocity (0.53-5.88 msec-1), temperature (16.3-2.540C), pH (7.0-8.0), alkalinity (32.0-65.0 mg/liter), DO (3.2-14.8 mg/liter) and carbon dioxide (0.32-12.0 mg/liter.) The major fish groups recorded during the study were Glyptothorax (Glyptothorax spp.), Mahseers (Tor putitora, Neolissocheilus hexagonolepis) and Barils (Barilius bendelensis, B. teleo). Among all these fish species, Glyptothorax spp. were to found to be the most common species recorded in all the seasons. The rocky substratum of the stream favors the occurrence of this species. The study reflected that the physico-chemical condition of the stream was in general conducive for aquatic habitat and it harbors very important hill stream fishes like Glyptothorax, Mahseer and Barils.

KEYWORDS : Ecology, Deopani stream,Fishery potential, Arunachal Pradesh.

1. Introduction

Arunachal Pradesh is very rich in its riverine resources. The state has 2000km of rivers and streams suitable for fish culture of which only 5% (about 100km) is utilized for fish culture (Mahanta & Sarma, 2010). The present average productivity of these rivers is 50-400kg/km. (Nath & Dey, 2000).

Deopani stream of Lower Dibang Valley district of Arunachal Pradesh is located at a longitude of 95°51′12.96″ E and latitude of 28°09′31.58″ N. The stream originates at the confluence point of two small streams Eze and Eme at a longitude 95°51′16.00″ E and latitude of 28°09′34.60″N at an altitude of 475m msl. This perennial stream with rocky substratum traverses a course of 12 km before it debouches into the Dibang river at a longitude of 95°44′14.83″ E and latitude of 28°10′26.60″N at an altitude of 217m msl.

2. Materials and methods

The present investigation was carried out for one year starting from October, 2008 till September, 2009. During this period fish and water samples were collected from the stream at an interval of two months

Corresponding author : pcmahanta@rediffmail.com

for six times viz. October'08, November'08, January'09, April'09, June'09 and September'09. These samples were collected from four different stations of the stream selected based on their altitude. Station 1 is the point of origin of Deopani stream, the confluence point of two small streams Eze (Ezengo in local language) and Eme located at a longitude of 95°51'16.00" E and latitude of 28°09'34.60"N at an altitude of 475m msl, Station 2 is located near the Roing(district headquarter of Lower Dibang valley district) and Anini (district headquarter of Dibang valley district) connecting bridge at a distance of about 1.14 km from station 1 at a longitude of 95°50,34.27" E and latitude of 28°09'35.50"N at an altitude of 431m msl. Station 3 is about 600m distance from station 2 at a longitude of 95050/12.35// E and latitude of 28°09'42.98"N at an altitude of 413m msl. The fourth station was fixed at a distance of about 1.6km from Station 3 at a longitude of 95°49'24.93" E and latitude of 28°09'49.08"N at an altitude of 379m msl.

Water samples were collected six times at an interval of two months from the four stations during 2008-09. The parameters like air temperature, water temperature, pH and water velocity were recorded at the spot. Water samples were collected in bottles with specific precaution and brought to the laboratory for the analysis of other features like dissolved oxygen, total alkalinity and free carbon dioxide. The analytical procedure for the above mentioned parameters was followed as described by APHA (1989). Fish samples were caught using a cast net of mesh size 17mm. The net was operated for forty times in every station during each sampling and the length and weight of the fishes caught were recorded. The fish samples were preserved using alcohol, packed in plastic containers and labeled properly. The collected fishes were identified following Talwar & Jhingran (1991), Nath & Dey (2000) and Mahanta et al. (2011).

3. Results and discussion

The river substratum is mainly composed of stones, rock girders and large boulders. Gravelly sand is deposited where the water flows serenely in sheltered bays in the rocks and corner reaches of the river. River bed is marked by the conspicuous absence of many-rooted plants.

The seasonal variation of different physico-chemical parameters of the stream water in Stations 1, 2, 3 and 4 are presented in table 1, 2, 3 and 4 respectively.

3.1 Water Temperature

Water temperature is one of the most important factors, which influence the development of aquatic microorganisms and the fish. All the metabolic and physical activities and life processes of aquatic organisms are influenced by water temperature. The solubility of oxygen in water is inversely related to water temperature. The rate of decomposition of organic matter in the bottom zone of a water body is also regulated by temperature to a great extent. Water temperature depends generally on climate, sunlight and depth of water.

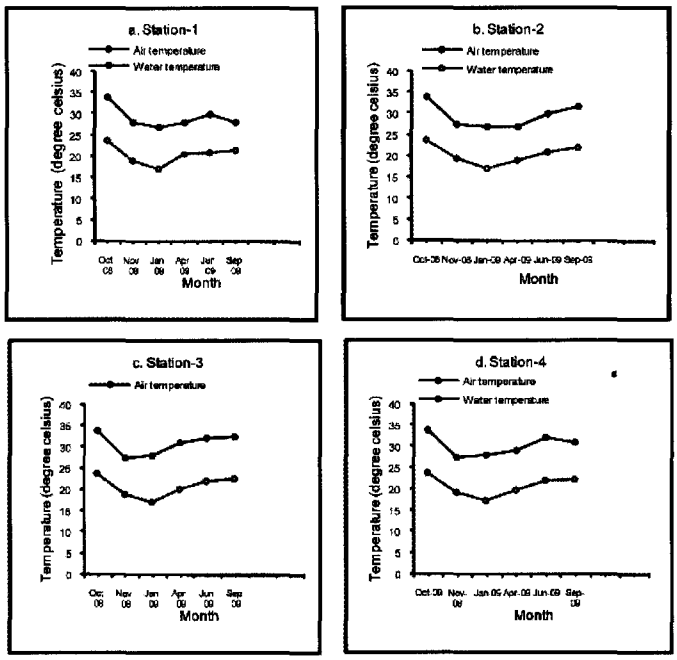


Fig. 1(a-d). Monthly variations in air and surface water temperature at Stations 1 to 4

Water temperature ranged between 17 and 24 0C, minimum during winter and maximum in the monsoon in all the stations indicating clear-cut seasonal variations (Fig.1,a-d).

Table 2: Seasonal variation of different physico-chemical parameters at Station 2

Sl. No.	Parameters	First Sampling (Oct'08)	Second Sampling (Nov'08)	Third Sampling (Jan'09)	Fourth Sampling (Apr'09)	Fifth Sampling (Jun'09)	Sixth Sampling (Sep'09)
1.	Water Temperatures(°C)	24	19.5	17	19	21	22
2	Water pH	7.0	7.0	7.0	7.0	7.0	8.0
3	Water velocity (m/sec)	5.66	0.89	0.60	1.49	0.81	1.17
4	Dissolved oxy gen (mg/l)	9.66	6.8	9.4	10.8	5.2	6.8
5	Total Alkalinity (mg/l)	30	65	46	55	30	20
6	Carbondioxide as CO 2 (mg/l)	2.64	3	4	7	9	4

Table 3: Seasonal variation of different physico-chemical parameters at Station 3

Sl. No.	Parameters	First Sampling (Oct'08)	Second Sampling (Nov'08)	Third Sampling (Jan'09)	Fourth Sampling (Apr'09)	Fifth Sampling (Jun'09)	Sixth Sampling (Sep'09)
1.	Water Temperatures(°C)	24	19	17	20	22	22.5
2	Water pH	7.0	7.0	7.0	7.0	7.0	7.5
3	Water velocity (m/sec)	4.28	0.83	0.56	2.01	0.82	0.69
4	Dissolved oxygen (mg/l)	10.12	4.4	9.4	8.4	5.6	10.8
5	Total Alkalinity (mg/l)	32	60	46	55	30	40
6	Carbondioxide as CO 2 (mg/l)	2.66	1	3	0.35	0.55	4

Table 4: Seasonal variation of different physico -chemical parameters at Station 4

Sl. No.	Parameters	First Sampling (Oct'08)	Second Sampling (Nov'08)	Third Sampling (Jan'09)	Fourth Sampling (Apr'09)	Fifth Sampling (Jun'09)	Sixth Sampling (Sep'09)
1.	Water Temperatures(°C)	24	19.5	17.5	20	22	22.5
2.	Water pH	7.0	7.0	7.0	7.0	7.0	7.0
3.	Water velocity (m/sec)	3.75	0.78	0.53	0.82	0.64	2.04
4.	Dissolved oxygen (mg/l)	10.35	6.8	10.2	8.4	3.2	14.8
5.	Total Alkalinity (mg/l)	32	60	46	60	50	30
6.	Carbondioxide as CO 2 (mg/l)	4.40	3	3	8	6	6

Variation in water temperature in relation to seasonal changes is a common phenomenon in aquatic ecosystem and is also observed by many workers in other major rivers of India (Laal *et al.*, 1986; Pathak *et al.*, 2001a and Nath, 2001). Choudhury (2002) observed the fluctuation of water temperature (7.0-22.0°C) in relation to seasonal changes in the rivers of Arunachal Pradesh during pre-monsoon, retreating monsoon and winter. The fluctuation of water temperature in different seasons is corroborated with the earlier findings of Nath & Dey (2000) in the rivers Kameng (13.0 -23.° 0C), Dikrang (16.0- 24.° 0C), Ranga (9.0-24.0°C) and Subansiri (10.0-16.0°C).

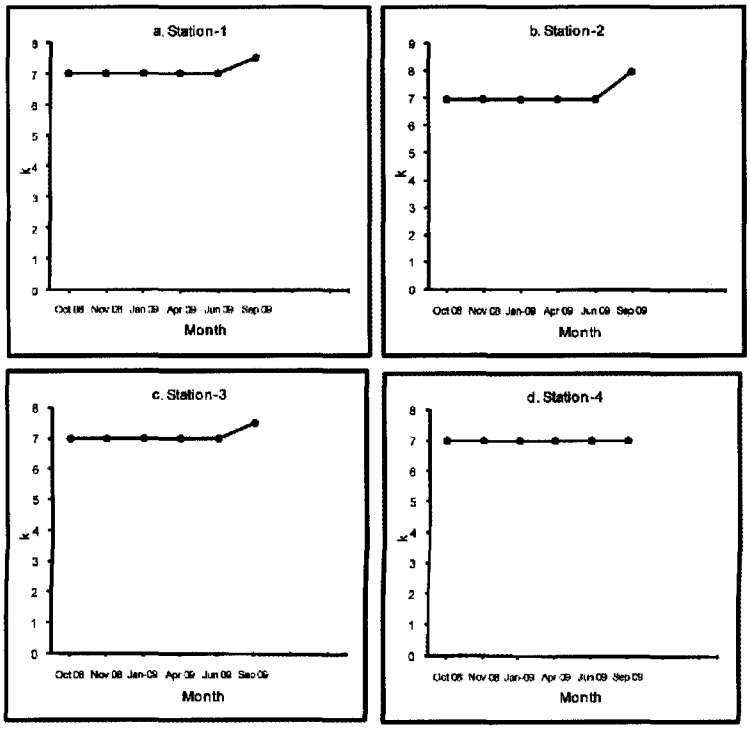


Fig. 2(a-d). Monthly variations in pH at Stations 1 to 4

3.2 pH

No marked seasonal variation in the pH of the stream water was observed during the study period. pH was found to be neutral to slightly (pH 7.0-8.0) alkaline in all the stations (Fig.2,a-d). Weak alkaline reaction (pH 7.0-8.0) is considered most suitable for fish production due to availability of various nutrient elements in the aquatic environment and physiological activity of fish remains optimum at this point. The present finding revealed the productive nature of Deopani stream. pH values earlier observed by Nath & Dey (2000) in four rivers of Arunachal Pradesh ranged (6.2-7.2) in Kameng, (6.2-7.5) in Dikrang, (6.2-7.0) in Ranga and (6.5-7.5) in Subansiri. Different pH values observed by Choudhury (2002) in the rivers of Arunachal Pradesh ranged from 6.8-8.1.

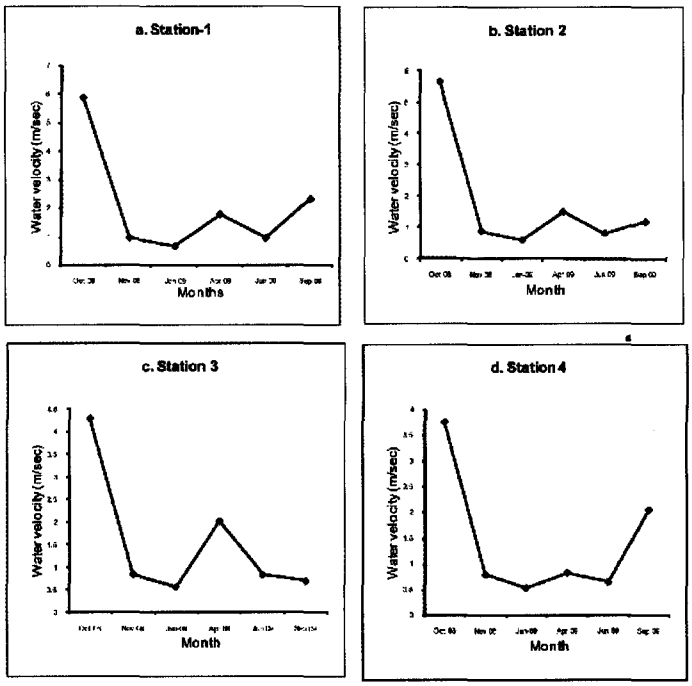


Fig. 3(a-d). Monthly variations in water velocity at Stations 1 to 4

3.3 Water velocity

Water velocity is one of the important environmental factors that affect the organisms of running waters. Water velocity influences the size of the particles of the substrate. Current affects food resources via the delivery and removal of nutrients and food items. Water velocity present a direct physical force that organism experience within the water column as well as at the substrate surface and current as a force strongly determine the ecological distribution, shape, anatomical and behavioural adaptations.

Water velocity of the stream ranged between 0.53-5.88 m.sec^{-1} (Fig.3,a-d). In all the stations higher velocity was recorded during monsoon (June to September) and retreating monsoon (October-November) seasons whereas lower values were recorded during winter season (December- February). Previous studies made by Nath & Dey (2000) in different streams of Arunachal Pradesh reported water velocity range of (0.9-1.3 m.sec^{-1}) in Kameng, (0.6-1.5 m.sec^{-1}) in Dikrang, (0.4-1.0 m.sec^{-1}) in Ranga and (0.6-0.9 m.sec^{-1}) in Subansiri.

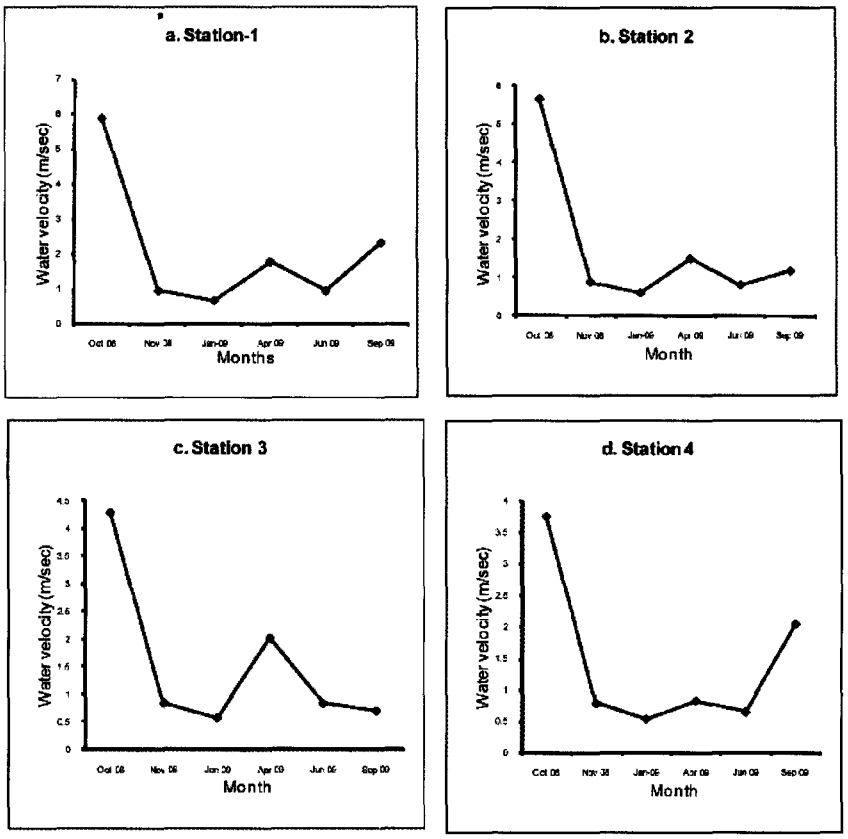


Fig 4 (a-d) Monthly variation in Dissolved Oxygen at Stations 1 to 4

3.4 Dissolved Oxygen

Dissolved oxygen content of a water body is considered as the most critical water quality parameter. It also acts as an indicator of water condition. For rivers and streams, dissolved oxygen is not a limiting factor as there is natural replacement of dissolved oxygen through ambient environment and other primary producers. Besides supplying respiratory oxygen to aquatic life, dissolved oxygen plays an important role in aerobic decomposition of bottom organic matter. At low dissolved oxygen level anaerobic decomposition products accumulate resulting in an unfavourable environment. The optimal range of dissolved oxygen for survival, growth and reproduction of fish vary from (5-8 mgl^{-1}) (Boyd & Tucker, 1998).

Rich dissolved oxygen was observed in Deopani stream and the value fluctuated from 3.2 to 14.8 mgl-1 (Fig.4,a-d). The dissolved oxygen content may be considered as conducive for aquatic habitat. Reid (1961) stated that solubility of oxygen in water increases with decreasing temperature and is corroborated with the present finding of high dissolved oxygen concentration during the retreating

monsoon and winter season (November- February), which reflects a stable ecosystem. High dissolved oxygen content is a characteristic feature of hilly streams. Pathak et al. (2000) reported high DO values from Siang (10 mgl^{-1}), Dibang (9.02 mgl-1) and Lohit (9.73 mgl^{-1}) rivers of Arunachal Pradesh. Choudhury (2000) also reported high DO values (7.6-15.2 mgl^{-1}) in the rivers of Arunachal Pardesh.

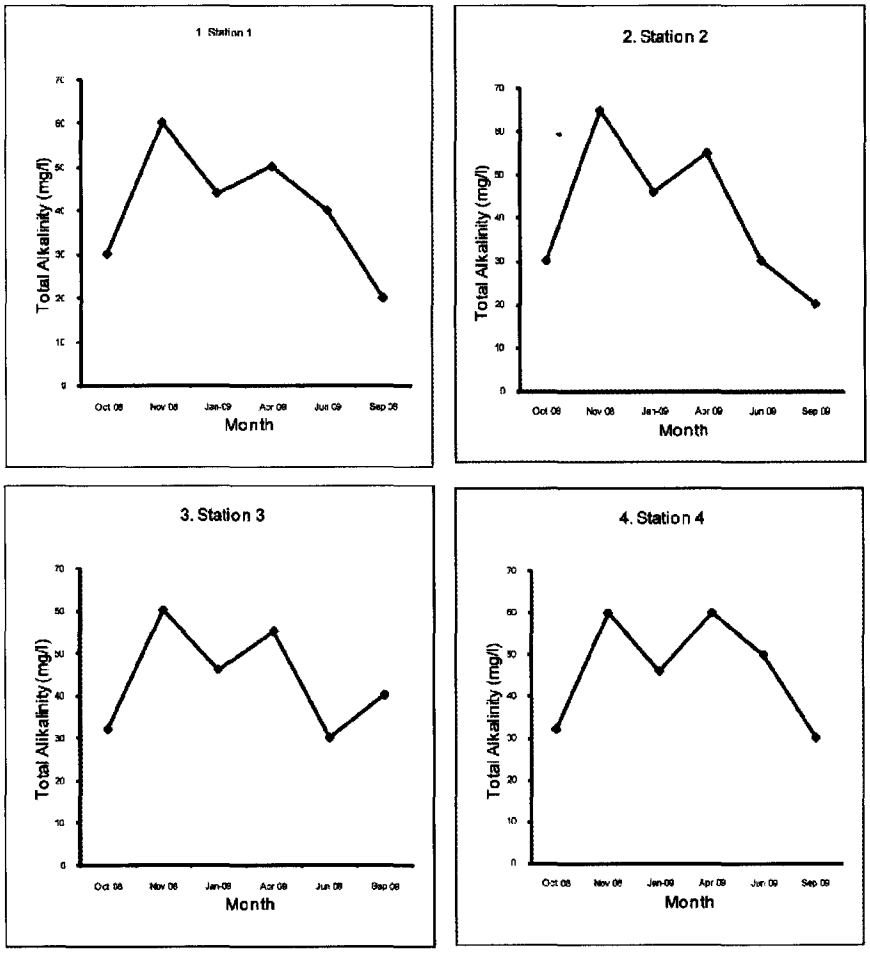


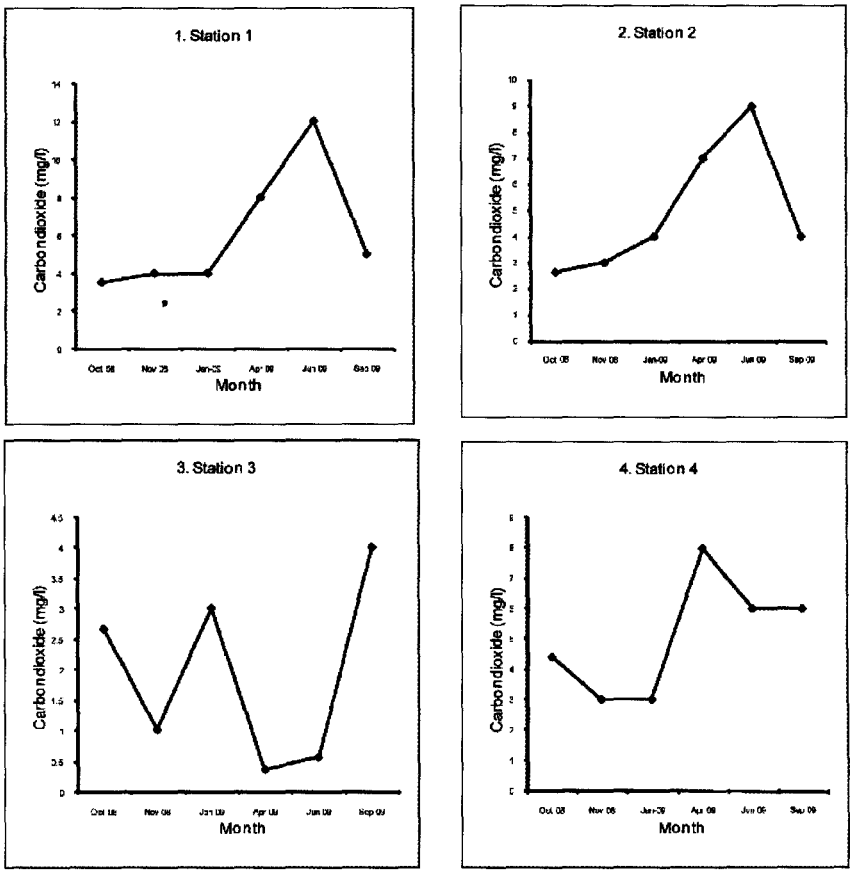
Fig. 5 (a-d) Monthly variations in Total alkalinity at stations 1 to 4

3.5 Alkalinity

Alkalinity is the buffering capacity of a water body. It measures the ability of water bodies to neutralize acids and bases thereby maintaining a fairly stable pH. The carbonates, bicarbonates and hydroxides are mainly responsible for alkalinity. Because of the relative abundance of carbonate minerals and availability of the carbon dioxide that enters into the equilibrium with them in water solution, most neutral water contains bicarbonate and carbonate only. Alkalinity along with dissolved CO_2 in water form equilibrium, which is of primary importance in the ecology of aquatic environment.

Alkalinity values were found to be low, the maxima was recorded during retreating monsoon (October- November) (65 mgl^{-1}) while the minima was observed in monsoon (June to September) (20 mgl^{-1}) (Fig.5,a-d). Lower alkalinity value of hilly streams was also reported by earlier workers. Gurumayum et al. (2000) observed a range of 15- 82.60 mgl^{-1} in some selected rivers of Meghalaya. Pathak et al. (2001b) recorded an average alkalinity of 62.67 mgl-1 and 35.72 mgl^{-1} in rivers Siang and Dibang of Arunchal Pradesh respectively. An alkalinity range of 33.98-66.7 mgl^{-1} was recorded in the river Subansiri by Daimari et al. (2005). According to Boyd & Tucker (1998), alkalinity range of 20-40 mgl^{-1} favour medium level of fish production while a range of 40-90 mgl^{-1} favour high fish production. In light of this, in the

present context the alkalinity values of Namsang stream indicate that it can sustain medium to high level of fish production. According to Unni (2003), Indian rivers with an alkalinity range of 50-100 mgl^{-1} can be considered as low or unpolluted and the present finding revealed unpolluted status of Deopani stream.



3.6 Free CO_2

It is a normal component of all natural waters. It dissolves in water in varying amounts and the dissolution depends on partial pressure and temperature. It plays an important role in water bodies by producing calcium bicarbonate from calcium carbonate and by maintaining the pH of the water more or less constant through the buffering system of CO_2-$CaHCO_3$-$CaCO_3$. But presence of free Co_2 is more than 15 mgl-1 for a long duration is detrimental to fish. At low dissolved oxygen concentration, presence of high Co_2 hinders oxygen uptake. Water that supports good fish population normally contains less than 5mgl-1 of free carbon dioxide.

Free CO_2 content did not show any distinct trend in seasonal variation in all the stations. The values ranged between 0.35 to 12 mgl-1 during the period of study (Fig.6,a-d). Higher Co_2 were generally recorded during Pre-monsoon and Monsoon seasons (April- June) which may be due to increase in decayed organic matters brought by flood and rainwater. Choudhury (2002) observed Co_2 values within the range of (0.9-3.8 mgl-1) in the rivers of Arunachal Pradesh during premonsoon, retreating monsoon and winter season.

3.7 Fishery

The eastern Himalyan region encompassing the Northeast is considered as one of the hot spots of freshwater fish biodiversity in the world (Kottelat & Whitten, 1996). The mixing of drainages and their fish fauna in the geological past has rendered the eastern Himalayas very important from faunistic point of view. The region shares its fish genetic resources with that of the Indo-Gangetic plains and to a lesser extent with the Myanmar and South Chinese fauna. So far, 267 fish species belonging to 114 genera under 38 families and 10 orders has been recorded and reported from the region. This is approximately 33.13% of total Indian freshwater fishes (Sen, 2000). Among the states, Assam has the largest number of ichthyospecies numbering 216 (Bhattacharjya et al., 2003) followed by Arunachal Pradesh (167), Meghalaya (165), Tripura (134), Manipur (121), Nagaland (68) and Mizoram (48 species) (Sen, 2000).

These include 31 species endemic to the region.

From the state of Arunachal Pradesh, Nath & Dey (2000) have reported the occurrence of 132 fish species belonging to 10 orders and 27 families. During the present study, the major fish groups recorded were Glyptothorax (Glyptothorax horai), Mahseers (Tor putitora, Neolissocheilus hexagonolepis) and Barils (Barilius bendelensis, B. teleo). Among all these fish species, Glyptothorax horai were to found to be the most common species recorded in all the seasons. The rocky substratum of the river favours the occurrence of this species.

4. Conclusion

The study revealed that Deopani is a healthy hill stream free from any pollution and the physico-chemical parameters are mostly found to be in the favourable ranges for the aquatic organisms. The stream water and sediment quality of Deopani stream also satisfies the special requirements like favourable temperature regime, high dissolved oxygen values, presence of gravels etc. indispensable for growth and propagation of hill stream fishes. Further, the ranges of different physico-chemical parameters also reflected moderate productive nature of the stream. In general, it is seen that most of the streams of Arunachal Pradesh are oligotrophic in nature (Gurumayum et al. 2000 and Daimari et al.2003). But, the present findings indicated that Deopani stream can sustain medium to high level of fish production and it harbors very important fishes like Glyptothorax, Mahseer & Barils which occur only in hill streams and comprised an important fishery for the local people for their livelihood. It is therefore necessary to protect the pristine water resources of Deopani stream and its important faunistic diversity.

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