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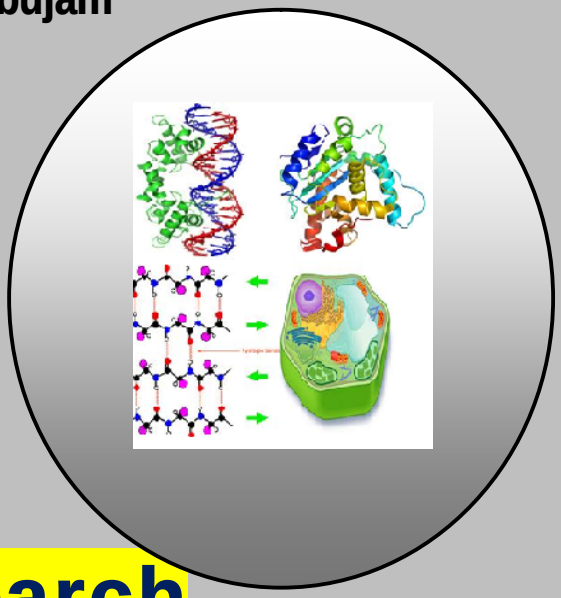

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Water Quality and Fish Diversity of a Hill Stream 'Sidzii'- A Tributary of Doyang River

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ABSTRACT

The bank of the 'Sidzii' hill stream in Senapati District, Manipur was U-shaped with mean stream width of 13.8 m. Again, certain physico-chemical parameters of a hill stream showed that the maximum water and atmospheric temperature are 24^0C and 26.5^0C while the minimum for both the temperature are 9^0C and 4^0C respectively. The pH varied between 8.2 and 8.8; transparency between 23 and 221 cm; current flow was ranged from 0.6 to 2.4 m/hr; DO between 8.4 and 12.13 mg/l; FCO_2 between 2.04 and 4.87mg/l; alkalinity between 53.7 and 61 mg/l; conductivity between 103.6 and 188.33 µ/mhos/cm; total suspended solid between 15 and 394 mg/l. The results reveal that a slight monthly variation occurs in physico-chemical parameters due to the surface run-off, mud slide etc. A total of 21 fish species were recorded from this hill stream. Cyprinidae were found to be the most dominant family followed by Balitoridae, Channidae and Sisoridae. Conservational status and abundance of the recorded species was also assessed.
Key words: Physico-chemical parameters, fish diversity, Sidzii, Senapati, Manipur.

INTRODUCTION

Hill streams or head waters play a very important role in shaping the major rivers both in terms of physico-chemical conditions and water resources as well. They are located in all latitudes and in all climatic conditions. They are formed under conditions where precipitation exceeds evaporation and infiltration. Perennial streams occur in humid climate. In these hill streams, the relationship between slope and stream flow rate provides an interesting insight into biologically significant properties of streams as large sized materials are located in steeper segments and finer materials in flat segments.

Besides these, the tropical streams are rich in iron oxides, aluminium, but poor in cations such as Ca, Mg, Na, K. The turbulent water flow in them also makes the O_2 concentration to be always high. However, conditions prevailing in streams are quite different and fluctuating as compared to the big water bodies. In streams everything released into solution moves down stream and cannot be totally recycled (Hynes, 1970). The narrow channels and seasonal fluctuations promote the survival of small organisms.

Sidzii (Cheherii as called by the local Mao community) is the biggest hill stream in the Mao, the sub-division of Senapati District, Manipur which later joins to Doyang, the largest and longest river of Nagaland, at Chakhabina below Kijiimetouma. It originates from Pforphe ($25^{o}29'30.66"$N $94^{o}08'04.72"$E, elevation- 1460 meter msl) the highest point on the Imphal–Dimapur NH no. 39, located between Mao and Tadubi. The stream is a perennial and has a length of about 37 km up to the point where it joins the Doyang River. As far as north-east India is concerned, there is very limited works on the hill streams. Although, there is also a report of 65 different species of fishes caught from the Barak drainage Kathoko, Karong of Senapati district, Manipur (Kar and Sen, 2004). Again, Nath and Dey, 1997, 2000 and Bagra *et al*. 2009, reviewed the fish fauna in Arunachal Pradesh; Choudhury *et al*. 2011a & b, also investigated certain physico-chemical parameters and fish diversity of Namdapha river in Arunachal Pradesh. However, so far, there is no report of any work done in Sidzii hill stream, though it is one of the important streams in terms of fish resources for the local people. Therefore, the present work has been undertaken to know the seasonal fluctuations in water quality and as well as fish diversity.

MATERIAL AND METHODS

Study was carried out from August, 2011 to September, 2012 and sampling was done at every month from two sampling sites ($25^{o}29'36'.97"$N $94^{o}10'44.39"$E, elevation 1193 m above msl and $25^{o}30'43.94"$N $94^{o}10'51.49"$E, elevation 1142m above msl) and the distance between the sites is about 500 m. The analysis of physico-chemical parameters like DO, pH, FCO_2, alkalinity, temperature, transparency, current flow, conductivity, TSS, etc. were carried out as per the standard methods (Trivedi and Goel, 1986 and APHA, 1998). The fishes caught from the different representative areas were preserved in 5% formalin and identification was also carried out simultaneously with the help of standard keys of (Jayaram, 1981, 1999, Datta Munshi and Srivastava, 1988, Talwar and Jhingran, 1991 and Vishwanath, 2002). The evaluation of abundance and status of the recorded fishes were carried out as per CAMP (1998) report.

RESULT AND DISCUSSION

The analysis of the monthly fluctuation in physico-chemical parameters of the Sidzii stream water were tabulated (Table 1).

Morphology of the study area: The bank of the Sidzii stream during the survey period was U-shaped with mean stream width of 13.8 m, while width at water level was 3.7m during dry months. The maximum depth recorded was 4.3 m with an average of 2.1 m.

The substrate was almost exclusively made up of boulders of varying sizes packed with cobble and pebbles. The sand deposited on the bank was very shallow and only at the places which were flooded in the recent past.

Temperature: In the present observation, the water temperature ranged from 9^{o}C (January) to 24^{o}C (August). There is a great fluctuation in temperature during the reporting period; this may be attributed to the immediate ambient atmospheric temperature. In case of atmospheric temperature, the highest value was observed in September (26.5^{o}C) and lowest in December (4^{o}C). Gradient in water temperature is closely associated with atmospheric temperature (Munawar, 1970) and it is one of the most important factors on the maturity, spawning period and development of fish (Bhatt *et al*., 1984).

pH: The pH values were ranging from 8.2 to 8.8. The maximum pH value (8.8) was recorded in March and minimum (8.2) in November. The change in temperature plus the reduced rate of photosynthesis reduces the assimilation of CO_2 and bicarbonates which are ultimately responsible for a little change in the pH value. Water bodies were remaining alkaline features and found within the permissible limit of 6.5 to 8.5 (BIS-1982). Higher pH value is normally associated with the high photosynthetic activity in water (Hujare, 2008).

Transparency: The value of transparency was found to be highest in January (221cm) and lowest in July (23 cm). The transparency of the stream water is greatly dependent on the dissolved and suspended particles. The measurement of transparency is done by Sachi Disc having a diameter of 20cm and divided into black and white quadrants.

Current Flow: Current flow usually in hill stream is high and the fastest was recorded as 2.4km/hr in July month and slowest in February-March measuring 0.6 m/hr. The high and low velocity may also be correlated with the torrential rain causing steeper and horizontal slopes during non rainy days respectively. High current affects the inhabitation of wide variety as well as the distribution of big fishes. The plankton density is still negligible probably due to faster current. According to Upadhya and Kunjur, 2010, high water velocity makes for all taxa intolerable in any drainage system.

Conductivity: Conductivity was found to be high (188.33 µ/mhos/cm) during July and low (103.6 µ/mhos/cm) during January. As a hilly stream, its conductivity is higher. Since specific conductivity, an index of dissolved solids, indicating the total concentration of soluble ions is a good conductor of productivity (Das *et al.*, 2001). High electrical conductivity was recorded during rainy season. This may be due to greater ionic concentration of the inlet flow (Jha, & Barat, 2003). Electrical conductivity (EC) of an aqueous solution is a measure of the ability to carry out an electric current (Oliveira *et al*., 2004).

Dissolved oxygen: The value of DO fluctuates from 8.40 mg/l (August) to 12.13 mg/l (January). DO was observed to be well above the tolerance limit (5 mg/l) prescribed by BIS, 1982. Higher DO in colder months as compared to warmer days may be due to lower temperature. The solubility of the O_2 is increased by low temperature and decreased by high salinity (Odum, *et al*., 2005). Oxygen also comes to water by diffusion from the air enhanced with the turbulence of the stream water (Hynes, 1970) and photosynthesis by aquatic plants for which the light penetration is again an all-important factor in the photosynthetic production of O_2.

Free carbon dioxide (FCO_2): The highest (4.87 mg/l) free CO_2 content was found in October and lowest (2.04 mg/l) was recorded in February. The variation of FCO_2 was due to the activity of other living organisms. Lower level of free CO_2 is mainly due to photosynthetic activity utilizing free CO_2.

Alkalinity: Alkalinity is a total measure of substance in water that has "acid-neutralizing" capacity. The alkalinity ranges from 53.7mg/l to 61mg/l. The maximum value was recorded in the month of July and minimum value in the month of December. Surface alkalinity may result from waste discharge from nearby. The similar observation was also reported by Hujare, 2008.

Total Suspended Solid (TSS): The value of Total Suspended Solids ranges from 15mg/l to 394mg/l. The maximum TSS value was recorded in the month of July and the minimum value in the month of February. The higher fluctuation in the value may be due to torrential rain which thoroughly washes down the top soil. This event stops once the rainy season is over leading to a drastic fall in the value.

Table 1. Average variations in physico-chemical parameters of Sidzii hill stream (two sites).

Months	Temp (^{0}C)		Transparency (cm)	Current Flow (m/hr)	Conductivity (µ/mhos/cm)	pH	DO (mg/l)	FCO_2 (mg/l)	Alkalinity (mg/l)	TSS (mg/l)
	Atmospheric	Water								
Aug'11	26.5	24	31	2.2	186.12	8.4	8.42	3.85	60	365
Sep.'11	20.5	22	67	1.7	168.23	8.6	8.72	4.01	56	227
Oct'11	17	15.3	92	1.0	127.3	8.2	8.1	4.87	58.2	23
Nov'11	14	10	176	1.2	112.9	8.1	11.53	2.78	5460	37
Dec'11	4	8.7	147	0.8	110.3	8.1	10.3	3.48	53.7	20
Jan'12	15	9	221	0.8	103.6	8.6	12.13	2.16	54	24
Feb'12	18.2	9.3	135	0.6	106.4	8.4	12.0	2.04	53.9	15
Mar'12	20.8	11	184	0.6	103.1	8.8	11.28	2.48	55	17
Apr'12	15.1	13.8	87	1.1	118.47	8.2	10.1	3.58	56.2	31
May'12	23.4	14	52	1.7	156.13	8.3	10.30	3.44	57	236
Jun'12	22.2	17.1	38	1.9	169.34	8.3	8.9	4.16	57.7	320
Jul'12	24.8	23	23	2.4	188.33	8.2	8.53	4.5	61	394

Fish diversity

Altogether 21 fish species belonging to 13 genera and 9 families were recorded from Sidzii hill stream (Table 2). The collected fish species were preserved in 5% formalin for further study. In the present study, Cyprinidae family formed the dominant group (38.1%) and representing 8 species. Next to Cyprinidae was found Balitoridae and Channidae (3 species each) with 14.29% each and followed by Sisoridae (2 species) with 9.52% each; Psilorhynchidae, Cobitidae, Mastacembelidae, Chandidae and Gobiidae (1 species each) with 4.76% each.

As far as abundance of the species is concerned, certain species like, *Puntius sophore*, *Puntius ticto*, *Esomus danricus* and *Parluciosoma daniconius* were mostly common and recorded during study period. While some species such as *Garra kempi*, *Acantophthalmus pangia*, *Glyptothorax manipurensis*, *Glyptothorax trilineatus*, *Macrognathus morenhensis*, *Chanda nama*, *Channa punctatus*, *Channa orientalis* and *Channa stewartii* were found occasionally. Species like *Danio naganensis*, *Puntius manipurensis*, *Garra naganensis*, *Psilorhynchoides homaloptera*, *Schistura manipurensis*, *Schistura naganensis*, *Schistura sikmaiensis* and *Glossogobius giuris* were rare and showed some degree of seasonality. Again, as per CAMP (1998) report 2 species were included in Endangered Category (EN); 6 species were in Vulnerable category (VU); 5 species were in Lower Risk near threatened (LR-nt); 1 species were in Lower Risk least concerned (LR-lc) and rest species has not been evaluated yet (NE).

CONCLUSION

Alkalinity, temperature, current flow and TSS are high in the summer season and lower in the winter season while DO and pH are high in winter and slightly low in summer season. This may indicate the favourable conditions for photosynthetic activity in the transparent and slower current flow. The O_2 diffusion rate might have also been assisted by the low water temperature and running condition of the water in the hill streams. In particular, hydrology, temperature and oxygen level impose important energetic constraints on individuals and influence the distribution of fish species in streams (Blanck *et al*., 2007).

In overall the water quality reveals that there are slightly monthly fluctuations in the physic-chemical parameters of the hill streams. Similar observation in certain parameters was also made by Choudhury, 2011a in the Namdapha River, hill stream of Arunachal Pradesh. However, the low diversity of the fishes in the stream may be due to little alkaline nature of the stream water which tends to support fewer species of fishes as compared to soft water streams (Patrick, 1970). Narrow channels and seasonal fluctuations promote the survival of small organisms and less diversity (Patrick, 1975). Besides these, the small size and fewer number of stream fishes may also probably be related to the conditions found in the smaller streams.

Table 2. Fish species abundance in Sidzii hill stream.

Scientific name	Abundance	Conservation status (CAMP-Report)
Family: Cyprinidae		
1. *Danio naganensis* (Ham-Buch)	+	VU
2. *Esomus danricus* (Ham-Buch)	+++	LR-lc
3. *Parluciosoma daniconius* (Ham)	+++	LR-nt
4. *Puntius manipurensis* (Menon, Rema & Vishwanath)	+	NE
5. *P. sophore* (Ham-Buch)	+++	LR-nt
6. *P. ticto* (Ham-Buch)	+++	LR-nt
7. *Garra kempi* (Hora)	++	VU
8. *G. naganensis* (Hora)	+	VU
Family: Psilorhynchidae		
9. *Psilorhynchoides homaloptera* (Hora & Mukherji)	+	VU
Family: Balitoridae		
10. *Schistura manipurensis* (Chaudhury)	+	VU
11. *S. naganensis* (Menon)	+	EN
12. *S. sikmaiensis* (Hora)	+	EN
Family: Cobitidae		
13. *Acantophthalmus pangia* (Ham-Buch)	++	NE
Family: Sisoridae		
14. *Glyptothorax manipurensis* (Menon)	++	NE
15. *G. trilineatus* (Blyth)	++	NE
Family: Mastacembelidae		
16. *Macrognathus morenhensis* (Arunkumar & Tombi)	++	NE
Family: Chandidae		
17. *Chanda nama* (Ham-Buch)	++	NE
Family: Gobiidae		
18. *Glossogobius giuris* (Ham-Buch)	+	LR-nt
Family: Channidae		
19. *Channa punctatus* (Bloch)	++	LR-nt
20. *C. orientalis* (Bloch & Schneider)	++	VU
21. *C. stewartii* (Playfair)	++	NE

Legend: + = Rare; ++ = Occasional; +++ = Common, EN= Endangered; VU = Vulnerable; LR-nt = Lower Risk near threatened; LR-lc = Lower Risk least concerned; NE = Not evaluated

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