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Research Article

Habitat predilection of *Amblyceps apangi* from the streams of Arunachal Pradesh, India.

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***Abstract*:** This is the pioneer study on the detailed Habitat preferences of the soft-headed endemic hill catish *Amblyceps apangi* Nath & Dey, 1989, from the streams of Arunachal Pradesh, India. Analysis of habitat parameters for *A. apangi* confirmed that they have the specialized and distinguishable habitat predilection in lotic system. The mean variation of the certain physico-chemical parameters shows that a clear fluctuation in all seasons. Air and water temperature recorded maximum values during monsoon.The temperature was positively correlated with conductivity and CO2 whereas negative relationship with DO, pH, TDS and Alkalinity. The pH of water was recorded near neutral to slightly alkaline in the lotic system of Tumru village. The variation in CO2 concentration was negligible during different season and its maximum value was recorded in post monsoon. Conductivity was found to be maximum in monsoon whereas maximum value on TDS in post-monsoon. Water current was recorded its maximum velocity in monsoon and minimum during pre-monsoon. The substrate composition of this fish habitat was dominated by pebblesfollowed by cobbles, gravel, boulder devoid of clay. The habitat had a good cover of riparian vegetation with shrubsdominating the vegetation types and the vegetation stage in matured stage.

***Keywords*:** Habitat, Stream, Tumru, Physico-chemical.

I. Introduction

Habitat predilection of a fish is an important factor as its determines the survivality, growth and reproductive success of that particular species. The diversity in fish population is very large and accordingly with this large diversified population each fish species have their own unique reproductive strategy and have special preference for some habitat and environment cues for spawning and for the early development of their newly hatched offspring. A congenial environment is the pre-requisite for any organism, since continuity of life depends upon the proper exchange of essential substances and energies between the organisms and its surroundings (Welch, 1952). This interaction between the biotic and abiotic factors to that of the fish plays a significant role in its composition, distribution and abundance. The reproductive success and processes in fishes are controlled by endogenous biological rhythms and these rhythms are influenced by environmental factors which act as stimulant for maintaining those endogenous factors (Munro, 1990). This environmental factors act in a different way for the fish reproduction, some factors influence the offspring survival and growth whereas

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some others factors helps in coordinating the gonadal cycles with the environment so as to increase the potential fecundity and reproductive fitness of that particular species. Since the environment of fish is circulated around water, the component of water must have a good composition of biotic and abiotic factors required for their optimal growth and development (Ehiagbonare & Qgundiran, 2010).

In fishery science survival, growth, reproduction, production, mortality of fish is regarded as water quality characteristics, in many a cases water quality is being judged as good quality by this evident factor. As the entire fabric of life of fish is woven around water, any alteration in the physical, chemical and biological factor in their environment directly affects the biology and physiology of the fish population. It has been found that teleost have an inherent mechanism for correlating gonadal growth and function with that of the environmental factors. According to Peter and Yu, 1997, this relationship between the environment and reproduction is regulated through the neuroendocrine system, which perceives environmental cues and transduce the signal, this signal transduction and respectively their action is reflected upon the gonad morphology and in their function. This correlation between environment and reproduction on the other hand helps the species to precisely time their breeding period , so that to achieve maximum survivality of fry in that particular environmental condition. According to Nikolsky (1980) every fishes have their own share of reproductive peculiarities (embryos, fries, fingerlings and adults) and extreme adaptation to reproduce under most variable condition, which are highly related to the environment. In the Indian subcontinent freshwater fish breeding coincides with the monsoon season when temperature is moderate and rainfall is at its peak, giving the fish the necessary environmental stimulant (Jhingran, 1975). The endogeneous periodicity of physiological process are responsible for the seasonality in reproduction (Sundararaj, 1978) and fish integrate their physiological functions with environmental cues. Therefore this cyclic changes in the environmental cues such as the physical, chemical and biological parameter of water can also be used as an indicator in predicting the reproductive seasonality of a fish (Neelakantan et al., 1989). Environmental cues regulating spawning periodicity in fishes have been a centre of attraction for many researchers (Jhingran 1975; Vasal and Sundararaj 1976; Jobling 1995).

II. Materials and Methods

General survey and selection of site: Selection of site for understanding the habitat predilection is an important as most of factor has to be taken into account such as sufficient amount of the sample fish, accessibility etc. So, for this extensive field survey was done by performing sequential field trips and occasional fishing during 2020 and 2021. For the quantitative assessment of the abundance of this fish population, sampling in the streams and rivers of papum pare district of Arunachal Pradesh was conducted following all indigenous and available scientific methods used for catching hill stream fishes. Tumru is a small

village situated at a distance of 30 km from the state capital (Itanagar) under Doimukh revenue circle at a latitude of 27º09/ 43.94// N and longitude 93º46/ 40.7// E. The streams of this area have a good cover of overhanging riparian vegetation and it drains into the river Dikrong river.

Temperature: The atmospheric and water temperature were recorded with the help of thermometer (Mercury graduated upto 100ºC). Also digital thermometer (systonic water analyzer 361) was also used during the study period.

pH, TDS, Conductivity and Salinity : The diurnal and monthly changes in the pH, Total dissolved solids (TDS), electrical conductivity (EC) was measured digitally using systronic water analyzer 361 kit.

DO, FCO2, Alkalinity, Hardness: Dissolved oxygen (DO, mgl-1), Free carbon dioxide (FCO2, mgl-1), Total alkalinity (TA, mgl-1), Total hardness (TH, mgl-1) of the water samples were assessed by titration following standard protocol prescribed in APHA (2005). Water samples were collected from different sites during early hours of the day, packed and labeled in different sampling bottles for further analyis. For DO the water samples were collected in BOD bottles, the samples were fixed with 2 ml of manganeous sulphate solution and 2 ml of alkaline –iodide - azide solution.

Riparian vegetation: For studying the riparian vegetation of the sampling standard datasheets were prepared based on standard protocol (Mills and Stevenson 1999) and manual on habitat inventory (NBFGR 2000). The parameters considered for the study were vegetation type, vegetation stage, land use, sign of erosion and bank shape.

Substrate composition: The substrate composition of the stream bed was assessed by line quadrate method. A two meter rope with 20 cm. sections painted in contrasting colour was used for the study. The substrate encountered in each 20 cm. segment of the rope was considered as the substrate of that particular segment. The assessment technique followed Cummins (1962)

Analysis of data: To establish the degree of association between various physical and chemical parameter Pearson's correlation matrix was calculated using SPSS vers. 16 software. Kruskal-wallis test was performed using the statistical software Past 3x to see if there was significant seasonal variation within the physical chemical parameter.

Table.1.Classification of substrate types by size

Substrate type	**Particle size range (mm)**	**Sample codes**
Boulder	>256	5
Cobble	64-256	4

Pebble	16-63	3
Gravel	2-15	2
Sand	0.06-1	1
Silt and Clay	<0.059	0

5 = Boulder, 4 = Cobble, 3 = Pebble, 2 = Gravel, 1 = Sand, 0 = Silt and Clay, + = Low, ++ = Medium, +++ = High, --- = Nil

III. Results and Discussion

Seasonal variation in the physical and chemical parameters of the stream of Tumru basti are presented in Table 2

Air temperature

Air temperature recorded during the sampling period ranged 16.89°C- 33.50°C. The mean temperature recorded showed maximum values during monsoon (28.37 ± 1.60 °C) and minimum values in pre-monsoon (20.83 ± 2.74 °C). Air temperature showed significant variation during different season of the year ($P < 0.01$). The Seasonal variation between 2020 and 2021 is depicted in Table 2, reveal that there was no much variation between the year in air temperature. Statistical analysis (Table. 3) showed a positive correlation with water temperature (r = 0.965**) Conductivity (r = 0.475**) CO2 (r = 0.213) and a negative relation with DO (r = -0.573**), pH (r = -0.536**), TDS (r = -0.160), Alkalinity (r = 0.809**).

Water temperature

Corresponding with air temperature, water temperature also showed maximum value during Monsoon (23.74 ± 2.8°C) and minimum in pre-monsoon (17.67 ± 3.02°C). Their seasonal variation was significant ($P < 0.01$) and also the seasonal variation as that of air temperature between 2020 and 2021 didn't reflect any marked difference (Table 2). Air temperature (r = 0.965**), (CO2 (r = 0.198), Conductivity (r = 0.417) were positively correlated whereas DO (r = -0.542), pH (-0.467**), Alkalinity (-0.800**), TDS (-0.169) were negatively correlated (Table.3).

Dissloved Oxygen (DO)

DO having significant variation ($P <0.01$) between different season during the survey period showed maximum concentration during post monsoon (8.66 ± 0.37 mg/l) and minimum in monsoon (7.47 ± 0.75 mg/l).

As mentioned above Air, water temperature had negative correlation. A negative correlation also existed between Do and CO2 (r = -0.132), on the other hand a positive correlation was encountered with that of pH (0.502**), TDS (0.411**), Alkalinity (r = 0.189) (Table.3). Also a negligible variation was observed between 2020 and 2021 seasonal data (Table 2).

pH

pH showed significant seasonal variation (P < 0.01) with maximum value (7.54 ± 0.20) encountered in pre-monsoon and minimum value (6.9 ± 0.31) in monsoon (Table 2). The yearly variation (i.e 2020 and 2021) in pH also showed a similar trend (Table 2). It established a inverse relationship with air temperature (r = -0.536**), water temperature (r = -0.467**), conductivity (r = -0.168) and CO2 (r = -0.096) whereas a positive correlation exist with that of DO (r = 0.502**), TDS (r = 0.144), Alkalinity (r = 0.273*) (Table.3.)

Conductivity

Conductivity recorded maximum value (226.29 ± 76.71 µS /cm) in monsoon and minimum value (168. 83 ± 45.52 µS /cm) in pre –monsoon (Table 2). Observation of the data reveal a slight fluctuation in conductivity between 2020 and 2021 (Table 2). A significant variation (P < 0.01) in conductivity was observed between different season during the sampling period. Conductivity (Table. 3) seems to have a positive correlation with Air temperature (r = 0.475**), water temperature (r = 0.417**) , DO (r = 0.13) , TDS (r = 0.343**) and negative relation with that of pH (r = -0.168), Alkalinity (r = -0.516**) and CO2 (r = -0.106).

Total Dissolved Solids (TDS)

TDS which established maximum correlation (Table.3 with DO (r = 0.411**) and Conductivity (r = 0.343**) recorded maximum TDS during post monsoon (66.40 ± 19.88 mg/l) and minimum (47.47 ± 3.41 mg/l) in monsoon. The yearly variation as depicted in (Table 2) showed slight variation during different season. The variation resulted in significant difference (P < 0.01) during different season of the year.

Alkalinity

With significant seasonal variation (P < 0.01) the average alkalinity of two years recorded maximum value (78.87 ± 4.49 mg/l) in pre-monsoon and minimum (66.07 ± 6.00 mg/l) in monsoon. A slight fluctuation of alkalinity was noticed in the season in the tabulated data of different year (Table 2). Alkalinity showed positive correlation (Table..3) with DO (r = 0.189), pH (r = 0.273), TDS (r = 0.045) and negative correlation with that of Air Temperature (r = -0.809**), water temperature (r = -0.800**)and conductivity(r = -0.516**)

Carbon dioxide (CO2)

CO2 having negative correlation with most of the enumerated parameter except air (r = 0.213) and water temperature (r = 0.198). The experiment data recorded 2.24 ± 0.12 mg/l , 2.39 ± 0.68 mg/ l , 2.50± .84 mg/l during pre-monsoon, monsoon and post – monsoon respectively (Table 2) . The observed data did not show

much fluctuation between (Table 2) year and season. Although statistical analysis have a different view, which showed significant seasonal variation ($P < 0.05$)

Water velocity (m/s)

Water velocity ranged 0.88-1.98 m/s, with maximum velocity recorded (Table 2) during monsoon (1.04 m/s) and minimum value recorded during pre monsoon (0.88 m/s). The difference in velocity of water during different year is represented in (Table 2). statistical enumeration reveal a significant variation in the water velocity ($p < 0.01$) during different season of the year.

Substrate composition

The percentage composition of substrate found in the stream of Tumru basti is depicted in Figure 1. The substrate taken into consideration were boulders, cobbles, pebbles, gravels, sand and silts. The data enumerated reveal the stream bed to be dominated by pebbles 35 % cobbles (28%) gravel (22%), boulder 8%, sand 6% and silts 1%.

Riparian vegetation

Vegetation types, vegetation stages, dominant land uses and bank shapes were taken into consideration for the riparian study of the sampling site. The percentage dominance is represented in Figure.2. Accordingly it was noticed that shrubs (13.40%) dominated in vegetation types, in vegetation stage mature stages (13.30%) dominated followed by Shrubs (10.50%). Agriculture (12.10%) dominated in term of dominant land use. The bank shape of the stream was basically sloping type (15.32%).

Table. 2. Mean physical chemical parameter of the stream of Tumru basti (n = 5)

Parameter	Pre-monsoon	Monsoon	Post Monsoon
Air Temperature (°C)	20.83 ± 2.76	28.37 ± 1.60	25.54 ± 3.20
	16.89-24.67	26.76-33.50	20.48-30.58
Water Temperature (°C)	17.67 ± 3.02	23.74 ± 3.8	22.03 ± 3.18
	14.27-21.74	21.73-25.26	16.73-25.78
Conductivity (μScm^{-1})	168.83 ± 45.52	226.29 ± 76.71	222.29 ± 39.35
	110-238	146-382	129-274
TDS (mgl^{-1})	47.47 ± 3.41	49.38 ± 5.75	66.40 ± 18.26

	41.10-52.00	40.00-60.00	41.60-96.00
pH	7.54 ± 0.20	6.91 ± 0.31	7.49 ± 0.22
	7.10-7.81	6.31-7.45	7.05-7.80
Dissolved Oxygen(mgl^{-1})	8.21 ± 1.58	7.47 ± 0.75	8.66 ± 0.37
	7.82-9.34	5.60-8.10	8.17-9.29
Carbon dioxide (mgl^{-1})	2.24 ± 0.12	2.39 ± 0.68	2.50 ± 0.84
	2.20-2.60	2.10-4.80	2.20-5.20
Alkalinity(mgl^{-1})	78.87 ± 4.49	66.07 ± 6.00	68.57 ± 7.56
	74.40-82.02	59.15-76.15	58.60-79.36
Water velocity (m/s)	1.04 ± 0.10	1.37 ± 0.24	1.12 ± 0.17
	0.94-1.24	0.96-1.98	0.88-1.47

Table.3 . Correlation matrix between various physical and chemical parameter of the stream of tumru basti.

Parameter	AT	WT	DO	PH	CON	TDS	AL	CO
AT	1							
WT	.965**	1						
DO	-.573**	-.542**	1					
PH	-.536**	-.467**	.502**	1				
CON	.475**	.417**	.013	-.168	1			
TDS	-.160	-.169	.411**	.144	.343**	1		
AL	-.809**	-.800**	.189	.273*	-.516**	.045	1	
CO	.213	.198	-.132	-.096	-.106	-.202	-.173	1

** Correlation is significant at 0.01 level (2-tailed)

* Correlation is significant at 0.05 level

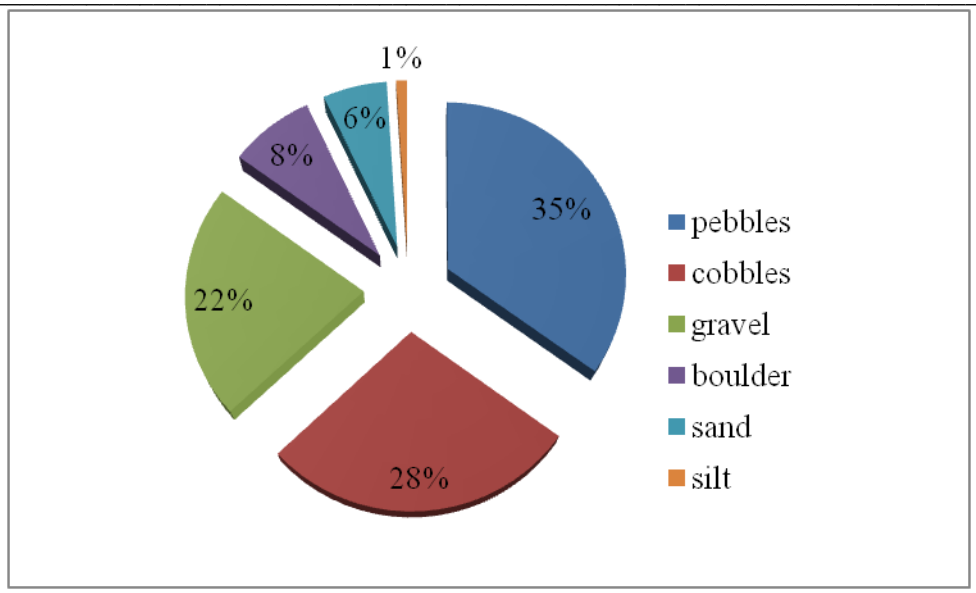

Figure.1 . Substrate composition of the stream of tumru basti

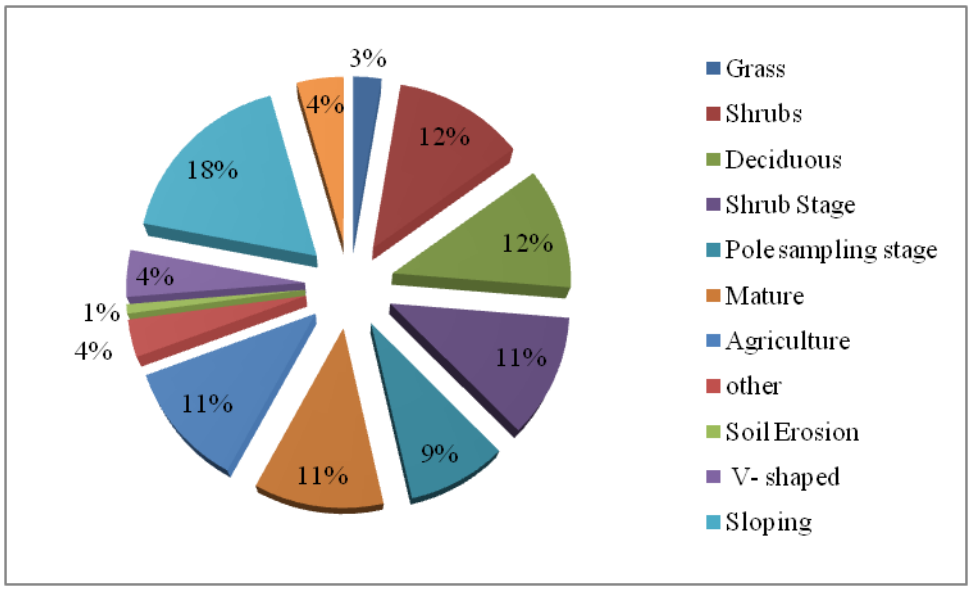

Figure.2 . Dominance of different riparian composition in the stream of tumru basti

IV. Discussion

Understanding the habitat of an organism is a necessity as every organism has its own unique set of preference from the ecosystem, this specific preference of habitat is where the basic needs of that particular organism are fulfilled (viz. feeding habits, protection from predator, breeding place etc.). The life of aquatic organism lies in the body of water and proper enumeration of the physical and chemical characteristic of water gives an insight of the quality of water of a water body. This functioning and interaction of the water body and its geomorphology is what influence the faunal diversity of a system (Heede and Rime 1990). In order to

portray the habitat preference a rapid bench mark population survey was carried out through random search of sizeable population of A. apangi in the stream and rivers of Arunachal Pradesh. Accordingly based on the highest catch frequency and citing the feasibility from almost every aspect stream of Tumru basti was selected for habitat study. Although a marked anthrophogenic activities was noticed at the present site but a comparative account of occurrence level and rapid investigation of the visible habitat feature provided an insight or preliminary clues (Table.2) for habit selection of this species in that particular geomorphic condition .The mean seasonal variation in the physical chemical parameter of water during different season for a period of two years is presented in Table.3 and the statistical implication of those data clearly shows the fluctuation or significant variation ($P < 0.05$) during different season.

Temperature of water is known to be an important factor as optimal growths of aquatic life forms are dependent on temperature, it influences all biological and chemical processes directly or indirectly in all aspects of stream ecology (Buttner et al., 1993). The air and water temperature investigated during the period followed identical annual trend showing maximum values during monsoon and minimum values during pre-monsoon. Variation in temperature of this stream was seen to commensurate with the changes in season. Being the running waters, seasonal and daily variations were caused among different locations probably due to climate, elevation, extent of streamside vegetation and the relative importance of the ground water inputs (Allan 1995). Temperature of water has a negative correlation with DO, pH, Alkalinity and a positive correlation with CO2. This results tally up with the findings of Ramachandra and Solanki (2007), who was of the opined that temperature influence the water chemistry.

The pH of a water body governed the water quality of the streams since it affects other chemical reactions such as solubility and toxicity (Fakayode 2005). Boyd & Lichkoppler (1979) has revealed that pH ranging from 6.09 to 8.45 as ideal for supporting aquatic life forms including fish. The pH value obtained during the study was within the acceptable limit which was almost neutral with slight acidic during pre-monsoon and almost neutral to slightly alkaline during post and pre-monsoon during the whole period of study. This type of seasonality in pH is a characteristic feature of hill stream (Bagra and Das 2010; Dutta and Dutta 2011; Valentina 2015). Biologist have long believe that water as medium and current as a force strongly determine ecological distributions and shape the anatomical and behavioural adaptations inhabitating life forms (Allan 1995). Observations made by researcher (Gorman and Kar 1978; Moyle and Vondracek 1985; Arunachalam 2000; Joha et al., 2002) reveal water velocity as one of the major factors for the distribution of fish species in the different habitats.

The water current in Tumru stream was found to differ from slow (pre-monsoon) to highly turbulent (Monsoon) during different season of the year. Being perennial and high gradient riffle surface runoff from the

nearby area contribute to the turbulence during monsoon whereas during pre-monsoon the only source of stream flow is its origin. Being hill stream catfish water current may facilitates building of nest by removing fine particles such as silt and also decreases egg mortality by continuous supply of oxygen, similar findings has been reported by (Ito and Yanagisawa 2000; Vinyoles 2002).

Electrical conductivity (EC) of water indicated the total dissolved ions and directly related to the total dissolved solids (Bhatt et al., 1999) where conductivity values of water were recorded maximum during monsoon and minimum during pre-monsoon. TDS values were also comparatively lower in general mostly with clear water, the highest levels were recorded during monsoon and the lowest during pre monsoon. The low level of EC and TDS indicated the lower concentration of dissolved ions and were within the permissible limits (Moore et al., 2008). The dissolved oxygen (DO) being very essential for many metabolic processes (Ahmad 1995) showed maximum value during pre and post monsoon and minimum during monsoon, indicating a very congenial habitat for hill stream fishes. The DO values of this hill streams were comparatively high, the high value recorded in this stream may be probably due to large surface exposed to air, constant movement of water, less depth and photosynthesis by algae (Haque et al., 2010; Sharma and Choudhary 2011). Temperature had a negative correlation with DO which implies that during monsoon when the temperature is high DO concentration was low. Similar finding has also been reported by previous worker (Dudgeon 2008; Singh and Jangde 2013) who were of the view that this low concentration in riverine system during this season might be due to high metabolic rate of aquatic organism.

A positive correlation was enumerated between CO2 and temperature but the present findings reveal that CO2 concentration to be highest during post monsoon when the temperature was low. Although maximum value was recorded at post monsoon but their fluctuation in the concentration was negligible and almost a similar concentration of CO2 was tabulated during the whole study period. The average concentration recorded during the survey period was slightly above 2mg/l which was comparatively low. The low concentration of CO2 at this stream might be due to the absence of aquatic macrophytes which are mostly responsible for regulating the higher concentration of CO2. Further the fact that being a lotic water system there is this continuous flow of water and also the minimal detrital deposits except the dropped off leaf liters from the riparian vegetations hardly contribute to the generation of CO2 in the present stream. Freshwater bodies having low CO2 concentration has also been reported by Dwivedi and Sonar 2004. According to Michael (1984) DO seems to have a negative correlation with CO2, the present findings are in concert and justify the same.

Alkalinity determines the buffering capacity or ability to neutralize acid. Well buffered waters are often productive for fish (Bain 1999). The United States environment protection agency (1991) specifies a minimum alkalinity of 20 mg/l as quality criteria for maintaining healthy aquatic biota. The present findings were within

the permissible limit (USEPA 1999) that classified the stream into moderately buffered to highly buffered (Lind 1974). Alkalinity showed a positive correlation with pH of water i.e why the recorded alkalinity was high during pre-monsoon. The high alkaline value in Pre monsoon may be in association with high pH during winter (Mishra et al., 1999) and low value during monsoon may be due to the dilution effect (Bishop 1973).

The substrates were dominated by pebbles and being devoid of clay and negligible detrital deposits facilitated hideout and micro habitats for various aquatic insects, insect larvae and crustaceans which might have formed preferred trophic niche of this catfish and may be one of the reasons for making this stream habitat more ideal for this bottom dweller fish.

Further, the habitat as a whole is a complex product of the surrounding land and climate (Likens and Bormann 1974) skewed by a good cover of riparian vegetations signifying the suitability of the habitat for the fish and other interacting aquatic organisms (Karr & Schlosser 1979; Swamon et al., 1976). In the context of population structure of the fish, tumru stream showed an optimum microhabitat quality where pattern of age structure and sex ratios were normally maintained whereas rest other streams population structure itself indicated a stress situation with very fragmented and small population either of monosex or having disparity in age and sexes of the fish. The explanation against such critical condition is not available as there exists hardly any evidence of exogenous chemicals in those streams except microhabitat degradation. The present investigation demonstrated that A. apangi have the specialized and distinguishable habitat predilection in lotic system.

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