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Habitat Preference of an Endangered Hill Stream Catfish *Olyra longicaudata* (McClelland) From Arunachal Pradesh, India

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ABSTRACT
Habitat predilection of *Olyra longicaudata*, was studied systematically in a mountain stream of Dengka village of papumpare district Arunachal Pradesh, India. The enumeration of habitat parameters *in-situ* revealed that this catfish has the specialized and distinguishable habitat fondness in lotic system. This fish is basically bottom dweller and prefers the places with rocky stream beds, devoid of clay and detrital deposits, surrounding areas enriched with larval and aquatic insects, crustaceans, annelids, molluscs etc. The fish prefers shallower and clear running water but cool, soft, slightly alkaline with high level of dissolved oxygen and under a good cover of riparian vegetation. The population properties of the species showed a dismal picture with adult count going remarkably down.

Keywords: *Olyra longicaudata*, Dengka, lotic system, endangered.

1. Introduction

North- east India is considered as one of the hot spots of freshwater fish biodiversity in the world [32]. Arunachal Pradesh (AP) is the largest state in North east India both in geographical area and having river drainage networks and harbours innumerable rivers and rivulets which are the home to diverse species of freshwater fishes having numbers of species endemic to this region. AP is regarded as the unique type locality for more than 11 freshwater fish species in the world [6]. The drainage system traverse through steep mountains to foothills flood plains forming environmentally variable segments of stream habitats facilitating mosaic of microhabitat complexes and assemblages of fishes in different stages of the life cycle.

Human demands on freshwater ecosystem have risen steeply over the past century, leading to increasing threat to biodiversity around the world [17]. Many fish species are on the verge of extinction, the reason behind human proclivity to shape and modify the environment leading to loss of habitat and degradation of environment .Freshwater fish are one of the most threatened taxonomic groups [15] because of their high sensitivity to the quantitative and qualitative alteration of aquatic habits [33, 28, 47]. The loss of fish diversity is undesirable on the basis of aesthetic, ecological, economical and ethical arguments [19] and aquatic habitat management becomes a great challenge [17] which requires detail characterization of habitat based on the target species to be conserved. Such approaches of conservation and management of freshwater fish are very scanty and whatever studies have been conducted so far is limited only to food fishes of the major river systems [39, 44].

On the view point of conservation, the habitat provides the foundation upon which the biological processes of organisms, structure of population and communities occur [49]. The assemblage of any fish in any water bodies is directly influenced by physical habitat, effects of disturbance on the environment [30] being bio indicator through its water quality, geomorphology, water connectivity or flow regime [12]. Understanding all those habitat relationship is essential for proper management and development of conservation strategies of a particular fish species [31, 55]. With this backdrops the present research aims to habitat predilection of *Olyra longicaudata* one of the most endangered endemic catfish inhabiting mountain streams of eastern Himalaya has been under taken aiming to assess their natural status of richness, habitat ecology, threats and conservation possibilities in particular.

2. Materials and methodology

2.1 General survey and selection of site:

For the selection of habitat study site intensive field survey was done by performing sequential field trips (Table 1) and occasional fishing. For quantitative assessment of the population status, sampling in rivers and streams of Papum Pare was conducted following all indigenous and available scientific methods used for catching fishes from hill streams. The primary investigation revealed that the distribution of *Olyra longicaudata* population is sparse and mostly restricted to some streams of the foothills region. So, keeping in view the abundance, accessibility and feasibility from every aspect the streams of Dengka village was selected for the study of habitat ecology. Dengka is a small village situated at a distance of 45 km from Itanagar town under Doimukh revenue circle at a latitude of 27^{0}11’38.6’’N and longitude 93^{0}52’38.7’’ E. The streams of this area have good cover of riparian vegetations and drains into a small rivers namely Patiya or Dhekia river (Figure 1), which flows through middle of this village. This small river originates from the dense forested and mountainous region of Ranga reserve forest and flows through different stretches of Arunachal Pradesh and finally drains into the Ranga River (one of the major tributary of Subansiri River). In Assam Patiya or Dhekia River is known as Pabha River which covers a distance of 102 km before meeting river Ranga.

Table 1: Co-ordinates of the random sampling sites along with their Visible Parameters

S. No	Random sampling sites	coordinates		Visible Parameter			
		Latitude	Longitude	Substrate Dominance	Riparian cover	Human interference	Catch frequency
1	Dikrong river (Banderdewa)	27º06′44.31″N	93º49′33.89″E	1	+	+++	+
2	Karsingsa Nalla	27º06′55.28″N	93º48′26.05″ E	4	++	+++	+
3	Nirjuli A sector nalla	27º07′06.7″N	93º47′56.40″ E	4	++	+++	+
4	Poma Nadi	27º04′01.43″N	93º31′25.75″ E	5	++	++	+
5	Poma Nalla	27º03′42.34″N	93º31′15.69″ E	5	+++	+	+
6	Chimpu Nalla	27º04′47.10″ N	93º36′33.13″E	5	++	++	+
7	Nirupjuli Nalla	27º07′55.14″ N	93º44′49.75″ E	4	+	+++	+
8	Dikrong river (Doimukh)	27º08′20.95″ N	93º44′52.32″ E	4	+	+++	+
9	EMCHI Nallah	27º08′32.35″N	93º46′03.22″ E	4	++	++	+
10	Hati Nallah	27º08′45.04″N	93º46′28.35″E	4	+++	++	+
11	Tulan Nallah	27º08′42.44″ N	93º46′54.05″ E	4	+++	++	+
12	Gumto Nallah	27º08′58.04″N	93º47′23.13″ E	4	++	++	+
13	Nyortha Nallah (Yupia)	27º08′50.23″N	93º42′41.50″ E	5	+++	++	+
14	Rono Basti	27º09′14.18″ N	93º45′34.05″ E	4	++	+++	+
15	Tumru Basti	27º09′43.94″ N	93º46′40.7″E	4	++	+++	+
16	Midphu	27º10′35.53″ N	93º47′10.19″E	4	+	+++	+
17	Kimin	27º18′12.14″ N	93º58′32.34″E	5	++	++	+
18	Deb Nadi (Segalee)	27º14′52.26″ N	93º29′57.03″E	5	++	+	+
19	Dengka	27^{0}11’38.6’’N	93^{0}52’38.7’’ E	3	+++	+	+++

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

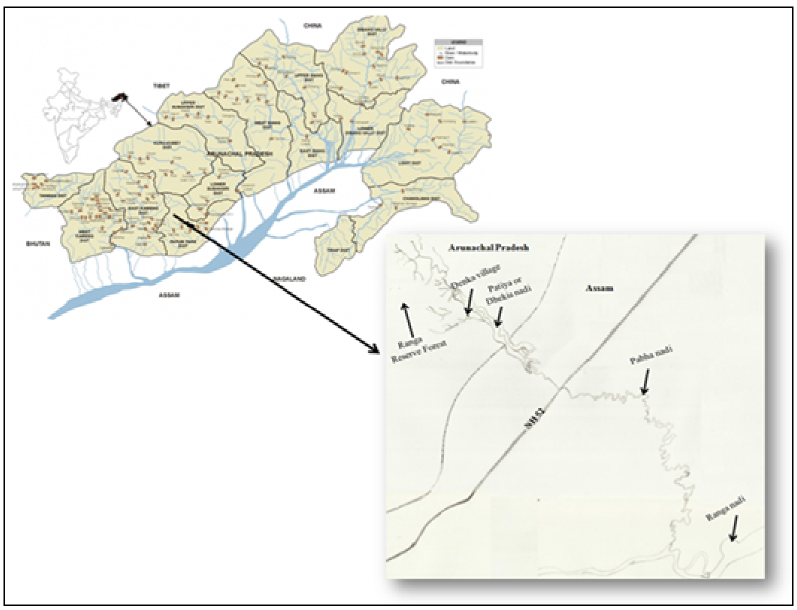

Fig 1: Map of the sampling site along with route of Patiya or Dhekia river

2.2 Biotic and Abiotic parameters:

The collection of samples and analysis of the water parameter of the streams were assessed maintaining all standard protocols. The altitudinal and co-ordinate variations were recorded with global positioning system (GPS, Garmin eTrex Legend). Both atmospheric and water temperature was measured with the help of Mercury thermometer graduated upto 100 ºC. The pH, dissolved oxygen (DO), total dissolved solids (TDS), electrical conductivity (EC), salinity was assessed using systronic water analyzer 361. Total alkalinity

(TA) mgl^{-1} [4], free carbon dioxide (FCO_2) mgl^{-1} [51], total hardness (TH) mgl^{-1} [4] of samples was estimated titrimatically following standard methodology. The sampling of plankton was done following standard method [4] and identified upto genus level using standard literatures [18, 8, 3]. The substrate composition of the stream bed was assessed [13] by line quadrate method. Standard data sheets were prepared based on standard protocols [38] and habitat inventory manual [41] for studying the riparian vegetation of the study site. The parameters considered for study were vegetation type, vegetation stage, dominant land use and sign of soil erosion

3. Results

3.1 Physical and chemical parameters

Seasonal variation in physical and chemical attributes has been presented in Table 2. The pH recorded at the study sites varied from 6.8±0.42 to 7.6±0.04. The maximum was recorded during pre-monsoon and the minimum during post-monsoon. While others physical parameters such as air temperature, water temperature, water current, TDS, conductivity were evaluated that respectively ranged from 22.8 ± 3.54 to 28.6±2.34 (°C); 19.8±3.63 to 24.8±1.18 (°C); 0.94±0.03 to 1.07±0.14 (m/s); 45.13±6.86 to 66.24±31.01 (ppt) and 202.5±53.72 to 240±32.37 (µ mhos cm^{-2}) at the stream sites. Chemical parameters of the stream included dissolved oxygen (DO), dissolved carbon dioxide (DCO_2), alkalinity, hardness and salinity. The DO recorded ranged from 6.4±1.35 to 8.4±0.51 (mg/l) having maximum DO during pre-monsoon and minimum during monsoon. While other chemical parameters showed significant variation during each of the sampling in the stream which were between 2.2±0 to 3.3±1.27 (mg/l); 31.5±9.19 to 76.94±1.21 (mg/l); 6±1.14 to 6.7±1.5 (mg/l) respectively for DCO_2, alkalinity, hardness and salinity. Being freshwater stream, the salinity ranging 11±0.01 to 0.14±0.07 (ppt) was almost uniform throughout the whole study period between Nov 2011 to Oct 2012 (Figure 2).

Table 2: Seasonal variation in physical and chemical parameters from Dengka stream during November 2011 – October 2012

Parameter	Pre- Monsoon	Monsoon	Post- Monsoon
Physical and chemical			
pH	7.6 ± 0.04 (7.63 – 7.73)	7.5 ± 0.35 (7.05 – 7.8)	6.8 ± 0.42 (6.41 – 6.9)
Air temp. (°C)	22.8 ± 3.54 (19.7 – 26.3)	28.6 ± 2.34 (26.7 – 31.4)	25.9 ± 3.23 (22.5 – 29.8)
Water temp. (°C)	19.8 ± 3.63 (16.6 – 24.5)	24.8 ± 1.18 (23.8 – 26.5)	22 ± 2.52 (18.4 – 23.8)
Water current (m/s)	0.94 ± 0.03 (0.88 – 0.94)	1.07 ± 0.14 (0.96 – 1.29)	1.04 ± 0.14 (0.89 – 1.20)
TDS (ppt)	45.13 ± 6.86 (41.26 – 55.39)	66.24 ± 31.01 (41.66 – 106.2)	63.7 ± 26.88 (48.62 – 104)
Conductivity (µ mhos cm^{-2})	202.5 ± 53.72 (146 – 274)	240 ± 32.37 (201 – 274)	206.25 ± 123.21 (114 – 382)
DO (mg/l)	8.4 ± 0.51 (8.04 – 9.2)	6.4 ± 1.35 (5.6 – 8.5)	8.3 ± 0.73 (7.6 – 9.2)
DCO_2 (mg/l)	2.2 ± 0 (2.2)	2.7 ± 1.1 (2.2 – 2.4)	3.3 ± 1.27 (2.2 – 2.4)
Alkalinity (mg/l)	76.94 ± 1.21 (75.69 – 78.6)	31.5 ± 9.19 (60.21 – 75.18)	41.95 ± 35.90 (59.6 – 76.65)
Hardness (mg/l)	6 ± 1.14 (5 – 8)	6.7 ± 1.5 (5 – 8)	6.25 ± 1.25 (5 – 8)
Salinity (ppt)	0.12 ± 0.01 (0.05 – 0.3)	0.11 ± 0.01 (0.1 – 0.13)	0.14 ± 0.07 (0.05 – 0.23)

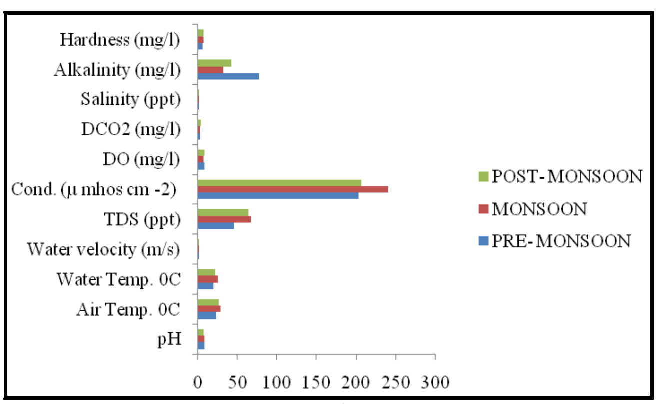

Fig 2: Seasonal variation in physical and chemical parameters from Dengka stream during November 2011 – October 2012

3.2. Biological Parameter:

Zooplankton counts were comparatively low in comparison to Phytoplankton. Phytoplankton counts ranged from 59 to 90 (units/l) whereas Zooplankton ranged between 8 to 13 (units/l) Zooplankton. The maximum count was recorded during post-monsoon and minimum during monsoon for both the planktonic life forms (Figure 3). 7 genera of Bacillariophyceae, 9 genera of chlorophyceae and 6 genera Zooplankton were sampled from the stream (Table 3).

Table 3: Planktonic community sampled from Dengka stream during November 2011 – October 2012

S. No	Family	Genus
Phytoplankton		
1	Bacillariophyceae	*Navicula*
		Pinnularia
		Gomphonema
		Melosira
		Tabellaria
		Surirella
		fragillaria
2.	chlorophyceae	*Closterium*
		Euastrum
		Cosmarium
		Spirogyra
		Zygnema
		Ulothrix
		Microspora
		Oedogonium
		Netrium
Zooplankton		
3	Copepod	*Diaptomus*
		Epischura
4	Tubillaria	*Microstomum*
		Bothrioplana
5	Cladocera	*Daphnia*
6	Rotifera	*Asplancha*

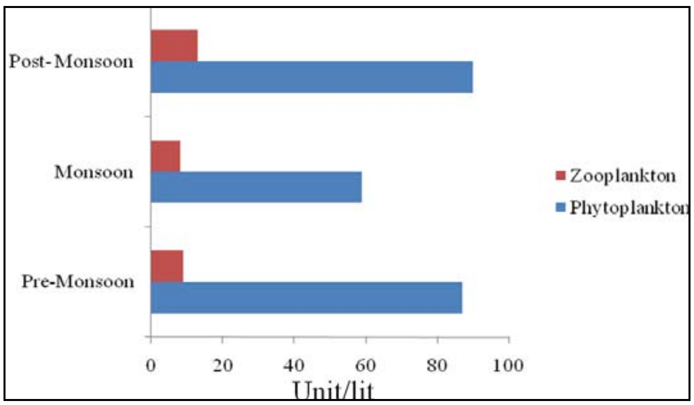

Fig 3: Seasonal variation of planktonic community from Dengka stream during November 2011 – October 2012

3.3. Substrate composition

Substrate components studied (Figure 4) were Boulders, Cobbles, Pebbles, Gravels, Sands and silts. The stream sites were dominated with pebbles having 34% of the total substrate followed by cobble (29 %), gravel (23 %) boulder (8 %), sand (5%), silt and clay (1 %) composition was remarkably low.

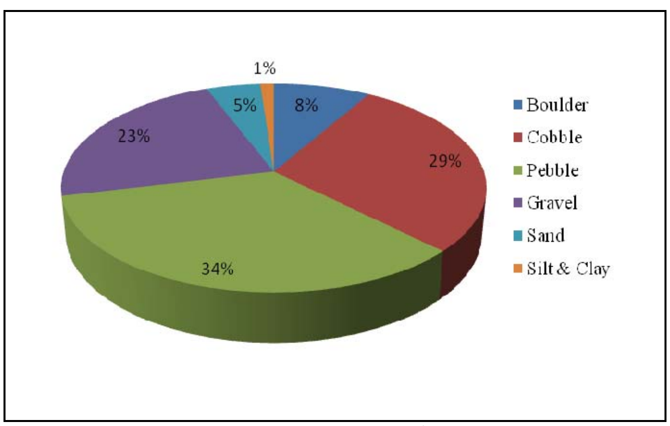

Fig 4: Substrate composition (%) of the study site

3.4. Riparian vegetation:

The study was focused on the vegetation types, vegetation stages, dominant land uses and bank shapes of the site. The findings (figure 5) revealed the dominance of shrubs (12.28%) in vegetation types, shrubs (11.4%) and mature (11.4%) stages dominating the vegetation stages, land used for agriculture (11.4%) was recorded as the most dominant form of land use and bank shapes was found mostly sloping (17.54%).

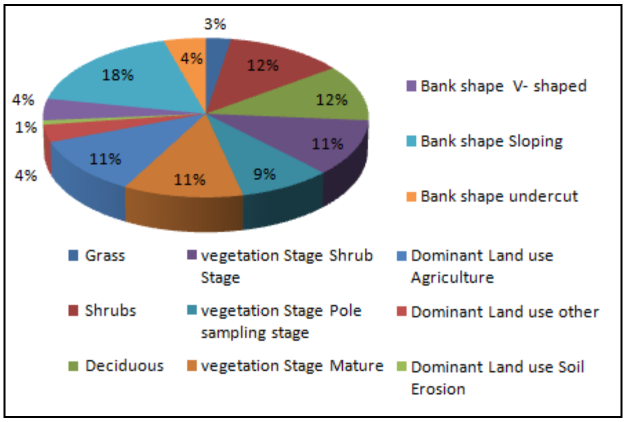

Fig 5: Riparian composition (%) of the sampling site

3.5. Population status and size frequency:

Population distribution (Figure 6) of *Olyra longicaudata* showed larval stages dominating the pre-monsoon and post-monsoon period while adult stages dominated in the monsoon season. Percentile population (Figure 7) frequency of this species during sampling season showed that the size group (7.6–8.5 cm) was dominant followed by the group (6.6-7.5 cm) size.

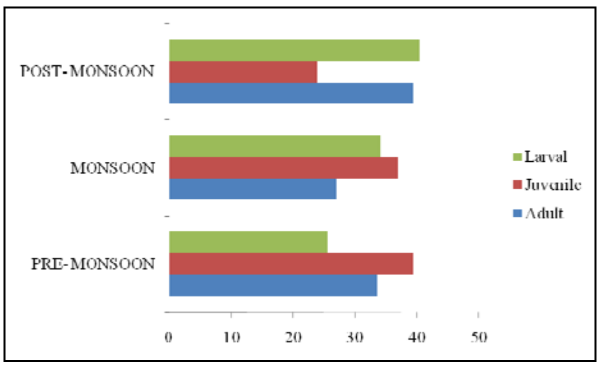

Fig 6: Population distribution of *Olyra longicaudata* during different season

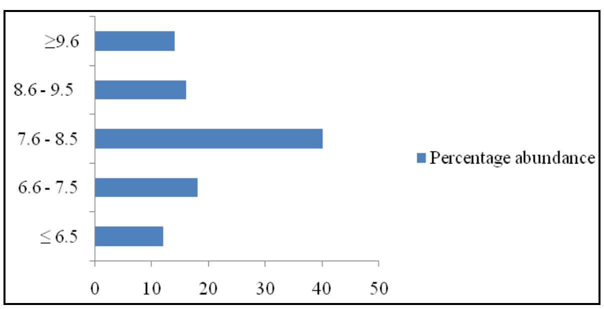

Fig 7: Size frequency distribution of *Olyra longicaudata* during November 2011- October 2012

4. Discussion

The selection of study sites for portraying habitat parameters is one of the most crucial aspects and was performed through random search of sizable population of the target species in various streams and rivers of Arunachal Pradesh, India. A rapid bench mark population survey was under taken in the year of 2011-12 and accordingly study site was selected based on highest catch frequency of the target fish in the streams of Dengka village compared to that of the other sites. The habitat analysis of different sites provided the preliminary clues for habitat selectivity of *Olyra longicaudata* in that particular stream of Dengka village, despite certain anthropogenic activities were also found there common to like that of other such locations. A comparative account of occurrence level (Table 1) of the species and rapid habitat features indicate the differences clearly.

Water temperature plays an important factor influencing all biological and chemical processes directly or indirectly in all aspects of stream ecology [11]. The optimal growths of aquatic life forms are influenced by temperature [11]. In the present findings, both air and water temperature showed maximum values during monsoon and minimum values during pre-monsoon. Being the running waters, seasonal and daily variations were caused among different locations probably due to climate, elevation, extent of streamside vegetations and the relative importance of the ground water inputs [2]. The pH of a water body governed the water quality of the streams since it affects other chemical reactions such as solubility and toxicity [20]. Study [10] 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 mild alkalinity during the pre-monsoon period and the fluctuations were also negligible during the whole period of study. Biologist have long believe that water as medium and current as a force strongly determine ecological distributions and shape the anatomical and behavioural adaptations inhabiting life forms [2]. Observations made by researcher [22, 40, 5, 26, 42] reveal water velocity as one of the major factors for the distribution of fish species in the different habitats. The water current in Dengka 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 in *Rhinogobius sp.* [25] and *Salaria fluviatilis* [53]. Electrical conductivity (EC) of water indicated the total dissolved ions and directly related to the total dissolved solids [9] 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. The dissolved oxygen (DO) being very essential for many metabolic processes [1] showed maximum value during pre-monsoon and minimum during monsoon, indicating a very congenial habitat for hill stream fishes. CO_2 content showed maximum value during post monsoon, there was no much fluctuation observed during the whole study period. Low CO_2 was resulted due to absence of aquatic macrophytes which are mostly responsible for higher CO_2 concentration. Further being lotic water detrital deposits were hardly been noticed except the dropped off leaf liters from the riparian vegetations. Alkalinity determines the buffering capacity or ability to neutralize acid. Well buffered waters are often productive for fish [7]. The United States environment protection agency [52] specifies a minimum alkalinity of 20 mg/l as quality criteria for maintaining healthy aquatic biota. The present findings were within the permissible limit [52] that classified the stream into moderately buffered to highly buffered [35]. Hardness comprised of calcium and magnesium ions, indicating total hardness. The hardness value recorded was comparatively lower during the whole survey period, which might have resulted due to low concentration of dissolved ions. The salinity count was low and also found to be uniform during the whole survey period supporting the characteristic features of inland freshwater [21]. Planktonic communities play a key role in such freshwater streams by maintaining all the essential ecological functions of all the available aquatic life forms. Physicochemical factors probably influenced the growth of planktons [16] that were in conformity with many other mountain streams as studied by many authors [36,48].The planktonic counts (phytoplankton and zooplankton) were indicative of the general trend [24, 43, 23, 14, 48] that displayed maximum population during post monsoon and minimum abundance during monsoon season. The higher counts of planktonic life forms during post monsoon and pre monsoon compared to monsoon was probably because of moderate water temperature and optimum levels required growth parameters available in the stream [27, 46]. Broadly the climate and geomorphology of the stream might have influenced intricate nature of such aquatic habitats through hydrology, nutrient dynamics and temperature regimes, substrates qualities as well as quantities along with dynamic stream morphology [37]. 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 [34] skewed by a good cover of riparian vegetations signifying the suitability of the habitat for the fish and other interacting aquatic organisms [29, 50]. In the context of population structure of the fish, Dengka 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 due to physical reasons.

The present investigation demonstrated that *Olyra longicaudata* have the specialized and distinguishable habitat predilection in lotic system. The field enumeration also revealed that environment stressors like habitat degradation, effect of global warming and anthropocentric as well as anthropogenic intervention in the recent past might have caused decrease in their reproductive potential which needs further investigation and which might be causing decline of their population in wild. The conservation of any declining aquatic species may be possible either through *in-situ* habitat conservation or by induced breeding in captivity followed by ranching in natural habitat [45, 54]. For designing a conservation strategy it is mandatory to generate basic information of its life cycle strategy, habitat ecology as well as sexual dimorphism including *in-situ* pattern of reproduction. In this context the findings of this study will provide baseline information regarding the habitat ecology of this fish and will help future researcher in designing conservation strategy for the fish.

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