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Certain Geomorphological Features and Fish Fauna of River Mara Bharali in Sonitpur District of Assam

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ABSTRACT

Background: Rapid industrialization, water abstraction and the extensive use of pesticides in agriculture have severe strains on rivers and resulted in deterioration of water quality. The present investigation on certain geomorphological aspects and fish fauna was conducted in the remnants of old channel of river Jia Bharali called as Mara Bharali at Tezpur in the Sonitpur district of Assam from December, 2017 to November, 2019.

Methods: Five sampling stations were selected that covers a stretch of 16.5 km. River width, river depth, bank type and riparian vegetation were assessed following Armantrout (1999) and statistical analysis were conducted. Fish species were collected and identified following Talwar and Jhingran (1991).

Result: Maximum value of river-width was found at site MB5 (12.821±6.067 m). Mean water current velocity was found to be maximum at site MB5 (0.645±0.056 ms^{-1}) followed by MB1 (0.433±0.045 ms^{-1}). The river depicts riffle-pool morphology and consisted of substrates in the form of pebbles, sand and silt. Thirty four fish species belonging to 25 genera, 08 orders and 17 families has been recorded. Moreover, random sampling analysis shows the presence of 14 rare species in Mara Bharali.

Key words: Cypriniformes, Fish abundance, Riffle-pool, Riparian vegetation, Water velocity, Width depth ratio.

INTRODUCTION

Rivers and streams characterized by flowing waters have four dimensions: a longitudinal dimension with pronounced zonation of chemical, physical and biological factors; a lateral dimension involving exchanges of organic matter, nutrients and biota between the stream channel and adjacent floodplain; a vertical dimension consisting of a hydraulic connection linking the river channel with groundwater and a fourth dimension of time which pertains to the velocity of the water flow.

Rivers borrow a great part of their character from the terrestrial ecosystem that is the catchment through which they flow. Indeed, if the landscape is in a good condition, then the river is too and if the landscape is badly treated, then the river flowing through it will magnify and mirror that abuse (Davies and Day, 1998). Globally, climate change and human activities have strongly influenced the world in terms of land use, soil characteristics, hydrological regime, water quality and biota in aquatic ecosystems (Xu, 2015). Environmental variation can exert direct or indirect effects on species arranged along a gradient from proximal to distal attributes (Austin, 2002; Guisan and Thuiller, 2005).

Freshwater habitats harbour diverse fauna, with fish serving as prime indicators of ecosystem status (Karr *et al.* 1986). Riverine fauna show a high degree of endemism, with most endemic fish species living in headwater streams and/or short stretches of river (Groombridge 1992; Kottelat and Whitten 1997). The present investigation was carried out with the objective to analyze certain geomorphological features and fish fauna of river Mara Bharali as no such work on the river system has been conducted so far.

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MATERIALS AND METHODS

The river morphology, bank type and riparian vegetation were assessed following Rosgen (1996) and Armantrout (1999). A total area of 500 m^2 was taken into consideration from each sampling site. Width of the channel was measured with simple measuring tape. Width-depth ratio was estimated as the bankful width divided by the depth at each site. The water current velocity of the river was calculated in the field by float method using the formula.

$$V = D/t$$

Where;
D= Distance covered by the float.
t= Time taken.

Substrate and channel types were analyzed by visual observations and were classified after Armantrout (1999). Altitude, latitude and longitude were measured on the spot with the help of Garmin eTrex-20X GPS.

The mean values of different parameters of Mara Bharali river from different locations in different seasons were statistically analyzed by using one way ANOVA in Statistical Package for the Social Sciences (SPSS, Version 20).

Cast nets and gill nets were predominant fishing gears in the study area. Fish specimens from study sites were mostly collected directly from fishermen operating in the area. Collection of fish specimens were also done following Singh and Agarwal (2014) and Agarwal *et al* (2019). Fish specimens were identified following Talwar and Jhingran (1991). Frequency of abundance was calculated (Biswas, 1993) on monthly basis of random sampling of the fish catch from ten fishermen. Accordingly, in a sample of ten replications, the fish species were classified (Gupta Choudhury, 2011) as rare (<2), occasional (2-4), common (5-6) and abundant (>7).

Description of the area of study

The present investigation was conducted in the remnants of old channel of Jia Bharali called as Mara Bharali at Tezpur in the Sonitpur district of Assam during the period from December, 2017 to November, 2019. Five sampling stations were selected and demarcated as MB1 (Pumpani village, N-26°45′10.52″ and E-92°50′07.93″), MB2 (Amlopam village, N-26°41′16.84″ and E-92°48′58.88″), MB3 (Dolabari village, N-26°40′00.65″ and E-92°49′43.64″), MB4 (Porowa Bridge, N-26°39′10.05″ and E-92°47′49.28″) and MB5 (Maithan, N-26°37’05.69″ and E-92°49′34.34″) that covers a stretch of 16.5 km (Fig 1).

RESULTS AND DISCUSSION

Geomorphological features of river mara bharali

The river is perennial with mean river depth found maximum at site MB5 (12.821±6.067 m) followed by MB4 (8.038±5.364 m) and MB2 (6.810±2.381 m) respectively. Sites MB1 and MB3 were found to have the least river width. The mean depth was found maximum at site MB5 (1.074±0.595 m) followed by MB2 (1.040±0.394m) and MB4 (0.903±0.463 m). The mean width-depth ratio was found maximum at site MB5 (12.586±1.854) followed by MB4 (8.281±1.59) and MB2 (6.701±0.726) respectively. Sites MB1 and MB3 were found to have the least mean width-depth ratio (Table 1). Mean water velocity was maximum at site MB5 (0.645±0.056 ms^{-1}) followed by MB1 (0.433±0.045 ms^{-1}). Least mean velocity was recorded at MB3 (0.278±0.042 ms^{-1}).

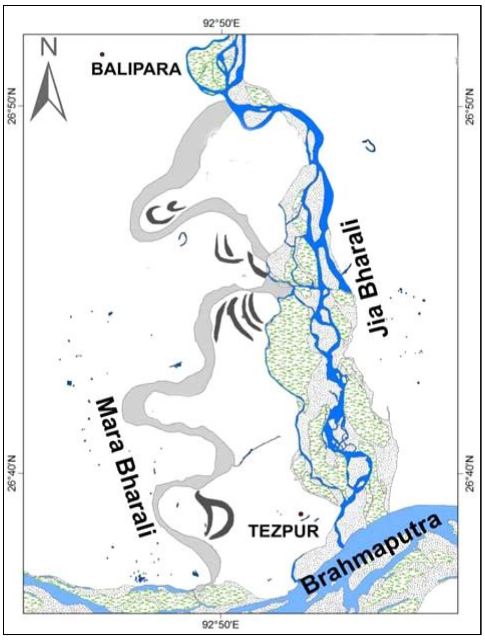

Fig 1: Present courses of river Jia Bharali and the Mara Bharali.

Substrate and channel type

Site MB1 situated at a higher altitude (61 masl) consisted of cascading profile with small boulders as dominating substrate along with other substrates like gravel, sand, silt, clay and organic matter. Site MB1 consists of narrow water flow area and almost no flood plain area. Site MB2 consists of a stable bank and bed profile. It consisted of substrates in the form of cobbles, pebbles, sand, silt and clay. Site MB3 consisted of typical riffle-pool morphology and consisted substrates in the form of pebbles, sand, silt and clay. Site MB4 shows meandering pattern and consisted substrates in the form of sand, silt and clay. Site MB5 also shows riffle-pool morphology and consisted substrates in the form of sand, silt and clay. In the present study there was high variability in stream flow velocity (0.278 ms^{-1} to 0.645 ms^{-1}) temporally as well as spatially which emphasizes the dynamic nature of Mara Bharali. The mean water velocity at different study sites even in the same season was different probably because of the differences in river gradient. Similar observation was also reported by Hussain and Pandit (2011) in Dooghganga stream in Kashmir Himalaya, India. Leopold and Maddock (1953) suggested that steepness of the slope or the altitude is influenced by variation in width-depth ratio. At higher altitudes the width-depth ratio is generally low whereas at places of lower altitude the width-depth ratio is usually high. Similarly, in the present investigation, width-depth ratio at MB1(located at high altitude) was found to lower (6.614), whereas the ratio was found to be higher (12.586) at lower altitude at MB5.

Moreover, in the catchment areas of river Mara Bharali, the riparian zone has developed into agricultural areas and settlement area for small scale industries, thus resulting in intensive human interference accompanied by industrial waste water discharge. The aquatic habitat has deteriorated due to the agricultural non-point pollution and waste water discharge. Similar results were also found in the work of river habitat assessment of Wei river basin, China (Yang *et al.*, 2018).

Statistical analysis using one way ANOVA

The mean values of different parameters of Mara Bharali from different locations in different seasons were statistically analyzed. Comparison between mean values of the water velocity from location MB1 and MB5 in different seasons indicates that there is no significant difference among water velocity of different seasons during the year. At location MB2, the mean value of water velocity (0.44^{b}±0.014) in monsoon season was found significantly higher (p<0.01). At MB3 the water velocity in monsoon (0.32^{b}±0.011) was significantly higher (p<0.05) than winter and pre monsoon. In MB4, the mean water current velocity (0.38^{a}±0.012) in pre monsoon was significantly lower (p<0.01) in comparison to the other seasons (Table 2).

The river width in MB1 remains significantly higher (p<0.01) in monsoon (8.09^{b}±0.988) and highest in post monsoon (9.22^{b}±0.853) in comparison to winter and pre monsoon seasons. In MB2 the river width remained significantly highest (p<0.01) in post monsoon (9.75^{c}±0.382) in comparison to all other seasons. In MB3 the river width was found highest in monsoon (7.83^{b}±1.125). In MB4, the river width remained significantly highest (p<0.01) in post monsoon (14.92^{c}±1.004) in comparison to all other seasons of the year (Table 3). In MB5, river width remained significantly higher (p<0.01) in monsoon (15.66^{b}±3.099) and post monsoon (18.21^{b}±2.088) in comparison to the winter and pre monsoon seasons.

River depth of location MB1 was found significantly higher (p<0.01) in monsoon (1.18^{b}±0.135) and post monsoon (1.29^{b}±0.124) than winter and pre monsoon seasons. Similar pattern was also observed in location MB2, MB3, MB4 and MB5. All differences were found to be statistically significant (p<0.01) (Table 4).

The river width and depth ratio in MB1 was found significantly higher (p<0.01) in post monsoon (7.15^{b}±0.170) and monsoon (6.80^{b}±0.099) in comparison to the winter and pre monsoon values. The ratio in location MB2 was found to be higher in pre monsoon (7.23^{b}±0.088) as compared to all other seasonal values but these differences were not

Table 1: Geo-morphological features and water current velocity of perennial river Mara Bharali.

Sampling station	Altitude (masl)	River width (m±SD)	River depth (m±SD)	Width-depth ratio	Water-current Velocity (ms^{-1})
MB1	61	6.081 (±3.072)	0.899 (±0.410)	6.614 (±0.496)	0.433 (±0.045)
MB2	55	6.810 (±2.381)	1.040 (±0.394)	6.710 (±0.726)	0.377 (±0.050)
MB3	53	5.223 (±3.097)	0.810 (±0.308)	6.064 (±1.639)	0.278 (±0.042)
MB4	51	8.038 (±5.346)	0.903 (±0.463)	8.281 (±1.590)	0.418 (±0.040)
MB5	50.5	12.821 (±6.067)	1.074 (±0.595)	12.586 (±1.854)	0.645 (±0.056)

masl: Mean above sea level; m: Meter; ms^{-1}: Meter per second.

Table 2: Seasonal comparison of water current velocity at sampling sites.

	Winter	Pre monsoon	Monsoon	Post monsoon	P value
MB1	0.41^{a}±0.015	0.42^{a}±0.017	0.47^{a}±0.013	0.44^{a}±0.023	0.139
MB2	0.34^{a}±0.005	0.35^{a}±0.014	0.44^{b}±0.014	0.38^{a}±0.020	0.001
MB3	0.26^{a}±0.014	0.25^{a}±0.011	0.32^{b}±0.011	0.29^{ab}±0.019	0.013
MB4	0.42^{b}±0.009	0.38^{a}±0.012	0.45^{b}±0.013	0.42^{b}±0.017	0.006
MB5	0.64^{a}±0.029	0.61^{a}±0.019	0.66^{a}±0.006	0.67^{a}±0.027	0.234

N.B: Values bearing superscripts a, b, c, in a row differs significantly (P<0.05 and P<0.01).

Table 3: Seasonal comparison of river width at sampling sites.

	Winter	Pre monsoon	Monsoon	Post monsoon	P value
MB1	3.46^{a}±0.227	3.56^{a}±0.234	8.09^{b}±0.988	9.22^{b}±0.853	0.000
MB2	5.17^{a}±0.217	4.58^{a}±0.112	7.75^{b}±0.834	9.75^{c}±0.382	0.000
MB3	2.78^{a}±0.173	2.65^{a}±0.045	7.83^{b}±1.125	7.63^{b}±1.004	0.000
MB4	3.99^{a}±0.369	3.55^{a}±0.086	9.69^{b}±1.857	14.92^{c}±1.004	0.000
MB5	8.64^{a}±0.188	8.77^{a}±0.151	15.66^{b}±3.099	18.21^{b}±2.088	0.003

N.B: Values bearing superscripts a, b, c, in a row differs significantly (P<0.05 and P<0.01).

Table 4: Seasonal comparison of river depth at sampling sites.

	Winter	Pre monsoon	Monsoon	Post monsoon	P value
MB1	0.54^{a}±0.025	0.54^{a}±0.040	1.18^{b}±0.135	1.29^{b}±0.124	0.000
MB2	0.78^{a}±0.090	0.63^{a}±0.017	1.26^{b}±0.116	1.48^{b}±0.042	0.000
MB3	0.57^{a}±0.061	0.58^{a}±0.028	1.08^{b}±0.095	1.02^{b}±0.113	0.000
MB4	0.54^{a}±0.065	0.53^{a}±0.021	1.03^{b}±0.131	1.52^{c}±0.095	0.000
MB5	0.70^{a}±0.091	0.63^{a}±0.015	1.28^{b}±0.287	1.68 ^{b}±0.181	0.001

N.B: Values bearing superscripts a, b, c, in a row differs significantly (P<0.05 and P<0.01).

statistically significant ($p>0.05$). In MB3 the ratio was significantly higher ($p<0.01$) in monsoon ($7.08^{b}\pm0.642$) and post monsoon ($7.43^{b}\pm0.554$) seasons compared to winter and pre monsoon. The ratio in location MB4 was also found to be significantly higher ($p<0.01$) in monsoon ($9.03^{b}\pm0.756$) and post monsoon ($9.83^{b}\pm0.314$) (Table 5). In MB5 the river width depth ratio differed significantly ($p<0.05$) between pre monsoon ($13.86^{b}\pm0.285$) and post monsoon ($10.97^{a}\pm0.705$).

Substrate, water depth and current velocity constitute the microhabitat (Maddock, 1999) of the river ecosystem; a good substrate composition is an important indicator of river ecosystem health and essential in the implementation of

Table 5: Seasonal comparison of width-depth ratio at sampling sites.

	Winter	Pre monsoon	Monsoon	Post monsoon	P value
MB1	$6.40^{a}\pm0.125$	$6.12^{a}\pm0.095$	$6.80^{b}\pm0.099$	$7.15^{b}\pm0.170$	0.000
MB2	$6.82^{ab}\pm0.395$	$7.23^{b}\pm0.088$	$6.19^{a}\pm0.347$	$6.57^{ab}\pm0.081$	0.082
MB3	$5.04^{a}\pm0.293$	$4.66^{a}\pm0.202$	$7.08^{b}\pm0.642$	$7.43^{b}\pm0.554$	0.000
MB4	$7.47^{a}\pm0.245$	$6.79^{a}\pm0.203$	$9.03^{b}\pm0.756$	$9.83^{b}\pm0.314$	0.000
MB5	$12.90^{ab}\pm0.964$	$13.86^{b}\pm0.285$	$12.61^{ab}\pm0.505$	$10.97^{a}\pm0.705$	0.042

N.B. Values bearing superscripts a, b, c, in a row differs significantly ($P<0.05$ and $P<0.01$).

Table 6: Fish species recorded from Mara Bharali.

Order/Family	Scientific name	Frequency of abundance
Cypriniformes/Cyprinidae	*Labeo rohita*	A
	Labeo gonius	A
	Labeo calbasu	C
	Cirrhinus mrigala	A
	Cabdio morar	O
	Chela atpar	R
	Amblypharyngodon mola	C
	Puntius sophore	C
	Pethia sarana	C
	Esomus danrica	O
	Rasbora elanga	R
Cypriniformes/Cobitidae	*Lepidocephalus guntea*	R
Siluriformes/Bagridae	*Mystus bleekeri*	O
	Mystus cavasius	O
	Mystus vittatus	C
Siluriformes/Siluridae	*Wallago attu*	O
Siluriformes/Clariidae	*Clarias magur*	C
Siluriformes/Heteropneustidae	*Heteropneustes fossilis*	C
Synbranchiformes/Synbranchidae	*Monopterus cuchia*	O
Perciformes/Nandidae	*Nandus nandus*	R
Perciformes/Centropomidae	*Chanda nama*	R
Perciformes/Anabantidae	*Anabas testudineus*	O
	Trichogaster fasciatus	R
Perciformes/Channidae	*Channa gachua*	O
	Channa marulius	R
	Channa punctata	C
	Channa striata	R
Perciformes/Gobiidae	*Glossogobius giuris*	R
Tetradontiformes/Tetradontidae	*Leiodon cutcutia*	R
Anguilliformes/Anguillidae	*Anguilla bengalensis*	R
Clupeifomes/Notopteridae	*Notopterus notopterus*	O
Beloniformes/Belonidae	*Xenentodon cancila*	R
Beloniformes/Mastacembelidae	*Macrognathus pancalus*	R
	Macrognathus aral	R

*R= Rare, *O= Occasional, *C= Common and *A= Abundant.

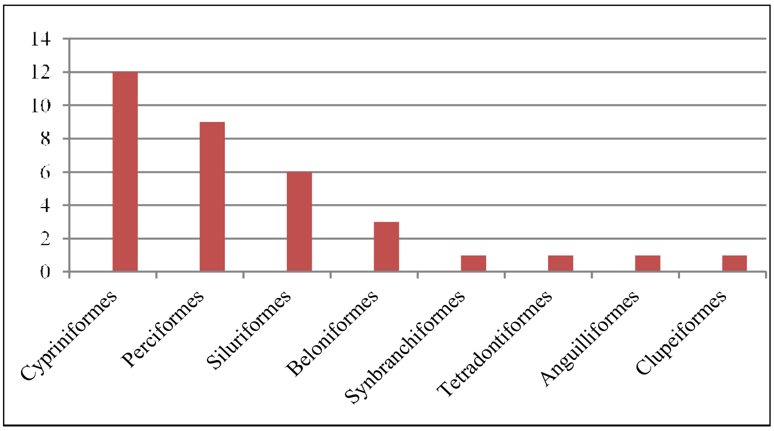

Fig 2: Fish species abundance of river Mara bharali.

river ecosystem management (Yang *et al.*, 2013). Tactics for river habitat remediation in the Mara Bharali river basin should therefore, involve a decrease in agricultural development intensity, an increase in vegetation buffer width in the riparian zone and an increase in habitat complexity in the downstream.

Fish fauna of mara bharali river

A total of 34 species belonging to 25 genera, 08 orders and 17 families has been identified during the period of investigation. The fish fauna of the river belongs to the order Cypriniformes, Siluriformes, Synbranchiformes, Perciformes, Tetradontiformes, Anguilliformes, Clupeiformes and Beloniformes. Cyprinids were the most dominant group with total species contribution of 35.3% followed by Perciformes 09 species (26.47%), Siluriformes 06 species (17.65%) and Beloniformes 03 species (8.82%). The rest of the orders that is, Synbranchiformes, Tetradontiformes, Anguilliformes and Clupeiformes were represented by 01 species each with a species share of 2.94% (Fig 2).

Many species of aquatic lives such as fish (Harris and Silveira, 1999; Belpaire *et al.*, 2000), algae (Stevenson and Smol, 2003), plankton (Reynolds, 2003) and benthic macroinvertebrates (Yoon *et al.*, 1992; Brain *et al.*, 2002; Silvera *et al.*, 2005) are common biologic indicators of water pollution in stream. In the present investigation, it was found that the aquatic system is rich in fish diversity and habitat restoration can further improve the biotic potential of the riverine system. Moreover, out of the 34 species of fish identified in the study area 03 were found to be abundant, 08 common, 09 occasional and 14 rare (Table 6).

CONCLUSION

The Mara Bharali river bed consisted of cascading profile with small boulders as dominating substrate along with other substrates like gravel, sand, silt, clay and organic matter. Presence of silt, clay and organic matter enrich the productivity of R. Mara Bharali. Habitat remediation in the Mara Bharali river basin should therefore, involve a decrease in agricultural intensity, an increase in vegetation buffer width in the riparian zone and an increase in habitat complexity in the downstream.

Conflict of interest: None.

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