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Caption: Large Indian Civet *Viverra zibetha*, Tricoloured Munia *Lonchura malacca* and *Hoya wightii* (Medium—pencil crayon on watercolour paper) © Supriya Samanta.

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COMMUNICATION

Ichthyofaunal diversity with relation to environmental variables in the snow-fed Tamor River of eastern Nepal

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Abstract: Tamor River in eastern Nepal supports diverse hill stream fishes. From winter, spring, summer, and autumn of 2020, we investigated the ichthyofaunal diversity with environmental variables in the snow-fed Tamor River covering four seasons (winter, spring, summer, and autumn) and field surveys were carried out in January, April, July, and October 2020. We used two cast nets of different sizes, one with a mesh size of 2 cm, 6 m diameter and 6 kg weight and another having 0.5 cm, 3 m diameter and 2 kg weight. In addition, monofilament gill nets with mesh sizes of 6, 8, and 10 were used for fish sampling. A total of 6,373 fish individuals representing 28 species belonging to three orders, seven families, and 16 genera were recorded. One-way permutational multivariate analysis of variance (perMANOVA) on the Non-metric Multidimensional Scaling (NMDS) showed no significant (P >0.05) difference between winter, spring, and autumn season but summer season showed significant (P <0.05) difference from winter, spring, and autumn seasons. Furthermore, one-way analysis of variance on redundancy analysis (RDA) vindicated that among the selected parameters, pH, air temperature and total hardness were the influencing factors (P <0.05) to determine the fish community structure in Tamor River.

Keywords: Field survey, fish diversity, hill-stream, multivariate, spatio-temporal.

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Author contributions: JT, JHL and DKL performed field surveys, collected data and prepared the manuscript. AP and BRS supervised the research and provided inputs on manuscript preparation. JHL analyzed the data.

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INTRODUCTION

Fish community structure, which is regionally diverse and seasonally varied, is often influenced by many environmental variables, as well as biotic interactions like competition and predation (Gorman 1988; Harvey & Stewart 1991; Grossmann et al. 1998; Frelat et al. 2018; He et al. 2020). Habitat variables such as water temperature, depth (Kadye et al. 2008; Hossain et al. 2012; Li et al. 2012), water velocity (Yu & Lee 2002; Arvendo & Ramirez 2017; Limbu et al. 2019), stream width (Gerhard et al. 2004), substrate, altitude, conductivity (Yu & Lee 2002; Kadye et al. 2008; Yan et al. 2010), dissolved oxygen, pH, free-carbon dioxide (Limbu et al. 2019; Prasad et al. 2020) and climate (Magalhaes et al. 2002) have all been shown to affect fish assemblages. However, changing environmental parameters can affect biotic communities in multiple ways and influence the function of ecosystems (McGill et al. 2006; Conversi et al. 2015). Environmental variables are reported to shape the spatial distribution of species (Perry et al. 2005; Vieira & Garro 2020) and influence the temporal variation of communities (Rouyer et al. 2008; Vieira & Garro 2020).

The spatial and temporal variations of the fish community structure in rivers and streams of eastern Nepal are poorly understood (Limbu et al. 2019; Adhikari et al. 2021). However, some of the important studies done in eastern Nepal's rivers and streams include (Shrestha 2009; Shrestha 2016; Shah 2016; Subba et al. 2017; Limbu & Prasad 2017, 2020; Limbu et al. 2018, 2019, 2020). Some outlook of the fisheries and fish ecological studies such as their diversity, spatial & seasonal distribution, and plenty in rivers of Nepal are needed (Mishra & Baniya 2017). To better understand, manage, and conserve (Ngor et al. 2018), and also to know the status (Limbu et al. 2019) of the fisheries, there is an urgent need to update the information on the spatial and temporal fish diversity, community structure and distribution patterns (Ngor et al. 2018).

Thus, the present study aimed to understand relationships among spatio-temporal variation in fish and environmental variables of Tamor River, to reduce the gap in the information and hence dilate the fish diversity profile of Nepal. The present study hypothesized that fish numbers in the Tamor River would be greater during the annual dry season when water current and volume are reduced. We also hypothesized that fish assemblage structure would vary between seasonal variation defined by environmental variables.

MATERIALS AND METHODS

Study area

Tamor River lies in eastern Nepal, which begins around Kanchenjunga. The Tamor and the Arun join the Sunkoshi at Tribeni Ghat to form the giant SaptaKoshi which flows through Mahabharat range (Shrestha 2009). It lies in the latitude and longitude co-ordinates of 26.913^{o} N and 87.157^{0} E respectively. The total length of this river is about 190 km with 5,817 km catchment area (Shrestha et al. 2009). The study area has connections with four districts, i.e., Taplejung, Panchthar, Terathum, and Dhankuta. Boulders, pebbles, sand, and gravels were the major characteristic features of this river.

Data collection, Identification and Preservation

Fish sampling was done in winter, spring, summer, and autumn (January, April, July, and October) of 2020. It started on the 15th and continued to the 30th of the selected months. We made 28 samples at seven stations, namely, (SA) Kabeli Dovan, (SB) Hewa Dovan, (SC) Nawa Khola Dovan, (SD) Chharuwa Dovan, (SE) Yakchana Ghat, (SF) Mulghat, and (SG) Triveni with fish sampling carried out between 0700 and 1100 h. We used two cast nets of different sizes, one with mesh size of 2 cm, 6 m diameter, and 6 kg weight and another with 0.5 cm mesh size, 3 m diameter, and 2 kg weight. Cast netting was carried out covering 150–200 m (Limbu et al. 2021) across each station and all possible habitats were covered. In addition, monofilament gill nets with mesh sizes of 6, 8, and 10 were used to capture the fish. In each station, nine gill nets were left late in the evening (1700–1800 h) and taken out early in the morning (0600–0700 h) in a sampling distance of 150–200 m.

The collected fish were photographed in a fresh condition and identified in the field and if not, then the voucher specimens were preserved in 10% formalin. After the photography, the remaining samples were returned to their own natural habitat from where they were captured. Fishes were identified with the help of standard literature (Talwar & Jhingran 1991; Jayaram 2010; Shrestha 2019) and other available standard literature. The environmental variables were examined during field visit following the standard methods of American Public Health Association (APHA 2012). Water temperature, dissolved Oxygen (DO), pH, total hardness, water velocity, conductivity, alkalinity, and free carbon-dioxide (CO). Water temperature (^{0}C) was measured with a digital thermometer by placing it in the water at a depth of 0.3 m. DO (mg/l) was measured by the Winkler titrimetric method. pH was measured using a pH meter

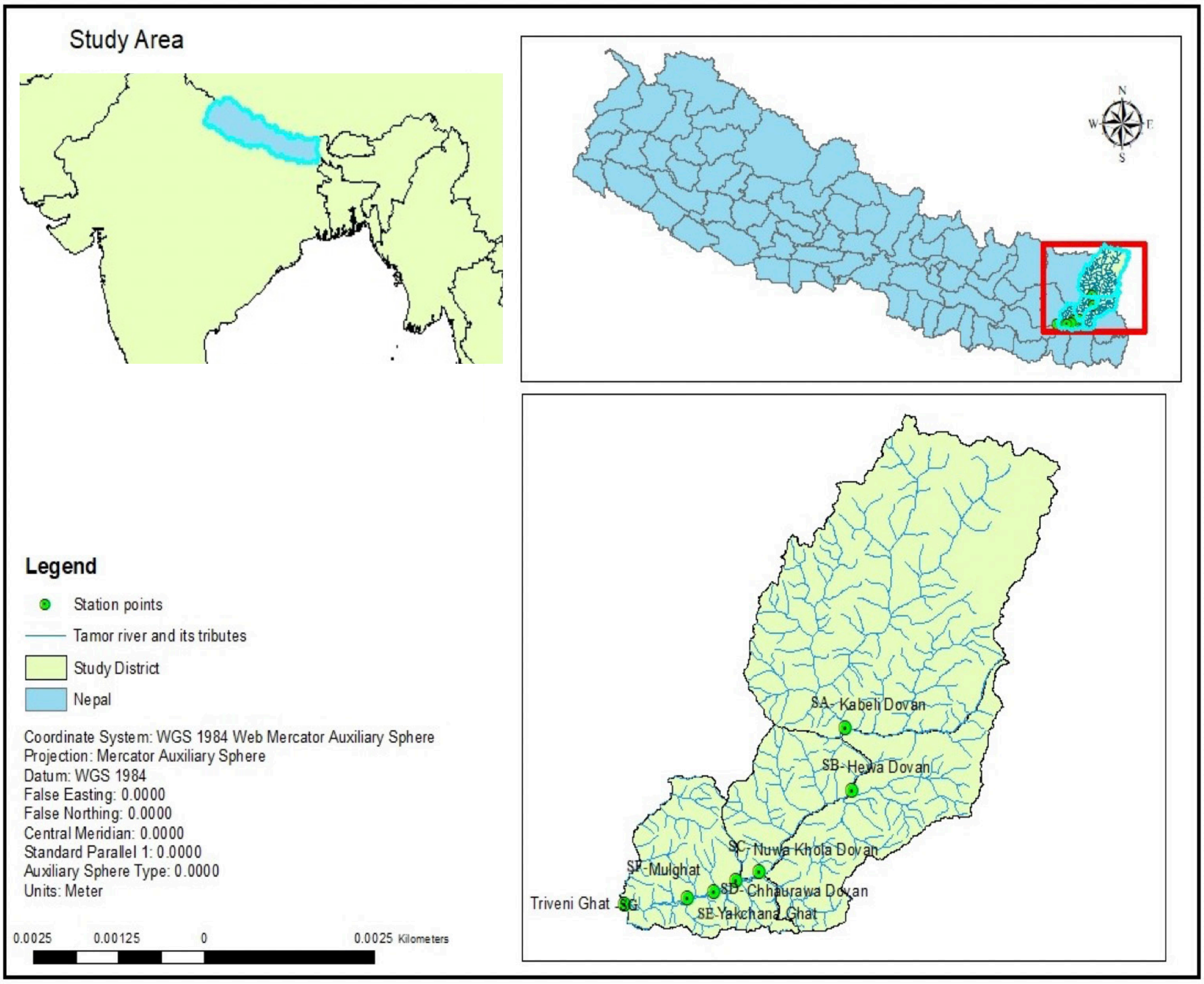

Figure 1. Location of map of study sites in Tamor River, eastern Nepal [SA–Kabeli Dovan; SB – Hewa Dovan; SC – Nuwa Khola Dovan; SD – Chhaurawa Dovan: SE – Yakchana Ghat; SF – Mulghat; SG – Triveni Ghat]

(HI 98107, HANNA Instrument). Total hardness (mg/l) was determined using EDTA titrimetric method. Water velocity (m/s) was measured by the float method with the help of a stop watch, small ball and measuring tape. Titration method was used to measure the alkalinity (mg/l). Free carbon dioxide (mg/l) was measured by the titrimetric method using phenolphthalein as an indicator.

Data analysis

One-way analysis of variance (ANOVA) was used for temperature, pH, dissolved oxygen, hardness and water velocity to calculate the existence of any differences between space and time spectrum. A post-hoc Tukey HSD test was used to test which means were significantly different at a 0.05 level of probability (Spjøtvoll & Stoline 1973). The diversity of the fish assemblage was quantified in the first step of data processing, and then statistical comparison was performed (Appendix I). Fish abundance data were subjected to various diversity indices (Shannon, Simpson, an evenness). All three diversity indices were generated using data from the four seasons (in each season seven samples were made, SA–SG) and seven stations (in each station four samples were made, winter, spring, summer, and autumn), and were used directly in the analysis (Yan et al. 2010) for each fish community sample according to Magurran (1988). Shannon diversity index (Shannon & Weaver 1963) considers both the number of species and the distribution of individuals among species. The Shannon diversity was calculated by following formula:

$$H = \sum_{i=1}^{s} Pi * logPi$$

where S is the total number of species and *Pi* is the relative cover of i_{th} of species.

The dominance index (Harper 1999) was calculated by using following formula:

$$D = \sum_{i} (\frac{ni}{n}) \ 2$$

where n_i is number of individuals of species *i*.

Evenness index (Pieleu 1966) was determined by the following equation:

E= H'/ log S

where, H'= Shannon-Weiner diversity index

S= Total number of species in the sample.

All of the sample (28) was used in the multivariate analysis, and no species or environmental variables were excluded (Appendix I & II). Collected fish abundance and determined environmental variables were used directly in the multivariate analysis (Yan et al. 2010; Hossain et al. 2012; Vieira et al. 2020)

One-way permutational multivariate analysis of variance (perMANOVA) (Clarke 1993) was used to test the significant difference among the spatial and temporal scales of the collected fish data. To visualize the major contributing species both to space and time, similarity percentage (SIMPER) (Clarke 1993) analysis was performed.

Detrended correspondence analysis (DCA) (Hill & Gouch 1983) was used to investigate the relationship between fish community structure and environmental variables. The eigen value (0.13) and axis length (1.17) obtained from DCA suggested that the linear model associated with RDA was more applicable. Therefore, a direct multivariate ordination method (Legendre & Legendrem 1998) based on a linear response of species to environmental gradients was applied. In addition, using non-metric multi-dimensional scaling analysis (NMDS), the relationships between assemblages from each station and seasons are graphically depicted (Clarke & Warwick 2001).

Table 1. List of fish collected from Tamor River.

Order	Family	Code	Species
Cypriniformes	Danionidae	C3	*Barilius barila* Hamilton, 1822
		C4	*Opsarius bendelisis* Hamilton, 1822
		C5	*Opsarius shacra* Hamilton, 1822
	Cyprinidae	C8	*Tarquilabeo latius* Hamilton, 1822
		C9	*Culpisoma garua* Hamilton, 1822
		C10	*Gara annandeli* Hora, 1921
		C11	*Garra gotyla* Gray, 1830
		C15	*Labeo angra* Hamilton, 1822
		C16	*Bangano dero* Hamilton-Buchanan, 1822
		C17	*Labeo gonius* Hamilton-Buchanan, 1822
		C18	*Neolissochilus hexagonolepis* McClelland, 1839
		C24	*Schizothorax labitus* McClelland, 1839
		C25	*Schizothorax progastus* McClelland, 1839
		C26	*Schizothorax richardsonii* Gray, 1832
		C27	*Tor putitora* Hamilton, 1822
		C28	*Tor tor* Hamilton, 1839
	Psilorhynchidae	C20	*Psilorhynchus pseudecheneis* Menon & Datta, 1964
	Botiidae	C6	*Botia almorhae* Gray, 1831
		C7	*Botia lohachata* Chaudhauri, 1912
	Cobitidae	C21	*Schistura beavani* Gunther, 1868
		C22	*Schistura horai* Menon, 1952
		C23	*Schistura savona* Hamilton-Buchanan, 1822
Siluriformes	Sisoridae	C2	*Bagarius bagarius* Hamilton-Buchanan, 1822
		C12	*Glyptothorax cavia* Hamilton-Buchanan, 1822
		C13	*Glyptothorax telchitta* Hamilton-Buchanan, 1822
		C14	*Glyptothorax pectinopterus* McClelland, 1842
		C14	*Pseudecheneis sulcatus* McClelland, 1842
Anguilliformes	Anguillidae	C1	*Anguilla bengalensis* Gray, 1832

RESULTS AND DISCUSSION

Fish Community structure

A total of 6,373 fish individuals representing 28 species belonged to three orders, seven families, and 16 genera were recorded during the investigation period (Table 1). Among these, Cypriniformes comprise most of the species with 78.57%, followed by Siluriformes 17.86%, and Anguilliformes with 3.57%. Cyprnidae was the most abundant family which contributed 46.14%, followed by Sisoridae 18%, Cobitidae 10.7%, Danionidae 10.7%, Botiidae 7.14%, Anguillidae 3.5%, and *Psilorhynchidae* 3.5% (Figure 2). The Cyprinidae was the most species rich family (13 species), followed by Sisoridae (5 species), Danionidae (3 species), Cobitidae (3 species), Botiidae (2 species), Psilorhynchidae and Anguillidae with single species. An environmental impact assessment (EIA) study for the Tamor Hydropower Project has reported the presence of 19 fish species in Tamor River (Swar & Shrestha 1998) while EIA study of Kabeli Hydropower Project has reported the presence of 21 fish species (Swar & Upadhaya 1998) and fish diversity study reported 30 species in Tamor River (Shrestha 2009). The diversity in terms of number (28 species) observed in the present study was nine species greater than Swar & Shrestha (1998), seven species greater than Swar & Upadhaya (1998). It's possible that this is due to the preceding report's limited scope of research. Furthermore, the species diversity may be influenced by fishing gear selectivity and survey efforts. As a result, the current investigation identified a greater number of fish species. But the present study reported two species lower than Shrestha et al. (2009). It might be due to riparian loss, deforestation, river corridor engineering, dams and water diversion, aquatic habitat loss and fragmentation (Dudgeon et al. 2006; Limbu et al. 2021). Ongoing road development, micro-hydropower generation, poisonous herbicide use, illegal electro-fishing, deforestation, and water diversion are all found to be major threats to the current fish species of Nepal's hillside rivers and streams, according to Limbu et al. (2021) and Adhikari et al. (2021).

Garra nasuta, Botia Dario, Schistura rupecula, Schistura multifaciata, and *Pseudecheneis crossicauda,* according to local fishermen, have suffered a serious drop in population and are not detected in our collection. The most abundant and species-rich order and family, respectively, were Cypriniformes and Cyprinidae. This is in line with the results of previous studies conducted in Nepal's various rivers and streams. For instance, Subba et al. (2017), Limbu et al. (2018, 2019, 2020), GC & Limbu (2020), Limbu & Prasad (2020), Prasad et al. (2020, 2021a,b), Chaudhary et al. (2020) from Tamor, Triyuga, Dewmai, Melamchi, Morang district, Damak, Ratuwa, eastern Nepal, Nuwa Babai River, River Andhi Khola, Seti Gandaki, West Rapti and Betani River. Nelson (2007) also stated that the majority of the fish in the river belong to the Cypriniformes order, which includes 2,422 species of freshwater fish.

Results from the similarity percentage analysis (SIMPER), 64.53% similarity were found among the seasons and major contributing species were *Labeo gonius* (9.72%), *Labeo angra* (8.46%), *Schizothorax richardsonii* (5.92%), *Opsarius shacra* (5.87%), *Garra gotyla* (5.55%), *Pseudecheneis sulcata* (5.48%), *Labeo dero* (5.36%), and *Botia lohachata* (5.30%). On the contrary, 50.33% similarity were found among the sites and major contributing species were *Labeo gonius* (7.54%), *Labeo angra* (6.69%), *Schizothorax richardsonii* (5.35%), *Psilorhynchus pseudecheneis* (5.30%), and *Pseudecheneis sulcata* (5.09%) (Table 2).

The present study reported two mahseer fishes (*Tor* spp.) representing an iconic genus of large-bodied species of the Cyprinidae family. Throughout southern and southeastern Asia, these species are revered for their religious and cultural significance (Pinder et al. 2019). Despite their economic and cultural importance, *Tor* fishes have seen their riverine habitats damaged

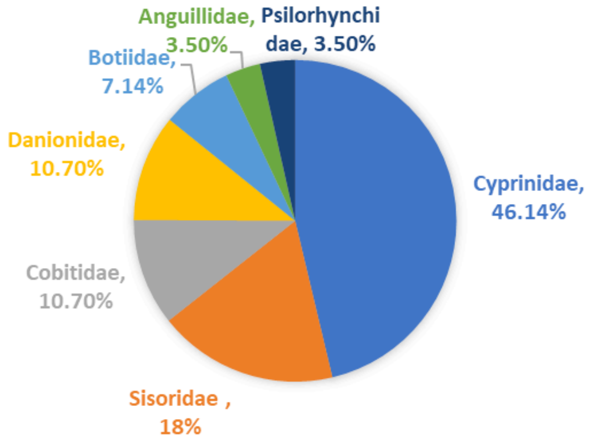

Figure 2. Family wise percentage composition.

Image 1. *Tor putitora*

Image 2. *Tot tor*

Table 2. Average similarity and discriminating fish in each season and station using SIMPER analysis.

Season (64.53%)	Contribution	Stations (50.33%)	Contribution
Contributory species	%	Contributory species	%
Labeo gonius	9.72	*Labeo gonius*	7.54
Labeo angra	8.46	*Labeo angra*	6.69
Schizothorax richardsonii	5.92	*Schizothorax richardsonii*	5.35
Opsarius shacra	5.87	*Psilirhynchus pseudecheneis*	5.30
Gara gotyla	5.55	*Pseudecheneis sulcata*	5.09
Pseudecheneis sulcate	5.48	*Neolissochilus hexagonolepis*	4.98
Bangano dero	5.36	*Opsarius shacra*	4.98
Botia lohachatta	5.30	*Gara gotyla*	4.95
Glyptothorax pectinopterus	4.70	*Glyptothorax telchitta*	4.78
Glyptothorax telchitta	4.51	*Labeo dero*	4.48
Barilius barila	4.13	*Botia lohachata*	4.47
Tarquilabeo latius	4.01	*Schizothorax progastus*	4.26
Psilorhynchus pseudecheneis	3.64	*Gara annandalei*	4.24
Schistura savana	3.51	*Glyptothorax pectinopterus*	4.00
Tor tor	3.18	*Schistura savana*	3.57
Schizothorax progastus	3.05	*Barilius barila*	3.55
Neolissochilus hexagonolepis	3.00	*Opsarius bendelisis*	3.5
Gara annandalei	3.00	*Botia almorhae*	3.49
Opsarius bendelisis	2.88	*Tarquilabeo latius*	3.33
Botia almorhae	2.53	*Glyptothorax cavia*	3.3
Schistura horai	2.12	*Tor tor*	2.5
Glyptothorax cavia	1.97	*Schistura horai*	2.01

by anthropogenic activities such as hydroelectric dam construction and exploitation, putting their survival in jeopardy. Furthermore, conservation attempts have been hampered by the fact that the genus' expertise is primarily bent toward aquaculture with significant knowledge gaps on their taphonomy (Bhatt & Pandit 2016; Pinder et al. 2019). The IUCN Red List has classified *Tor putitora* as an 'Endangered' species, whereas *Tor tor* has been classified as 'Data Deficient' (Image 1, 2). Urbanization, poaching, overfishing, and ecological changes in the natural environment's physical, chemical, and biological qualities, according to local fishermen and consent authority, have severely reduced the population of these species in their native habitat. As a result, the conservation of these species is critical.

Diversity status

The Shannon diversity index considers the richness and proportion of each species, while the Evenness and Dominance indices represent the sample's relative number of individuals and the proportion of common species, respectively (Hossain et al. 2012). Highest Shannon diversity index (2.88) was found at station SB and in summer (3.01) whereas lowest (2.63) was found at SE and in winter (2.56). In contrast, highest Simpson dominance index value was observed at station SA, SB, and SC (0.932, 0.93, 0.93) and in summer (0.94) whereas lowest value was observed at, SG (0.908) and in winter (0.90). Similarly, highest value of evenness index was observed at SB (0.69) and in summer (0.65) whereas lowest value of evenness index was observed at SG and in winter (0.62) (Table 4 & 5). According to Hossain et al. (2012), a high Shannon diversity index is associated with a small number of individuals, whereas a low Shannon diversity index is associated with a large number of individuals. A biodiversity index attempts to classify the diversity of a sample (Magurran 1988) and is easily affected by the number of specimens, sampling size, and ecological factors (Leonard et al. 2006).

Fish community structure vs. environmental variables

The result obtained after the redundancy analysis

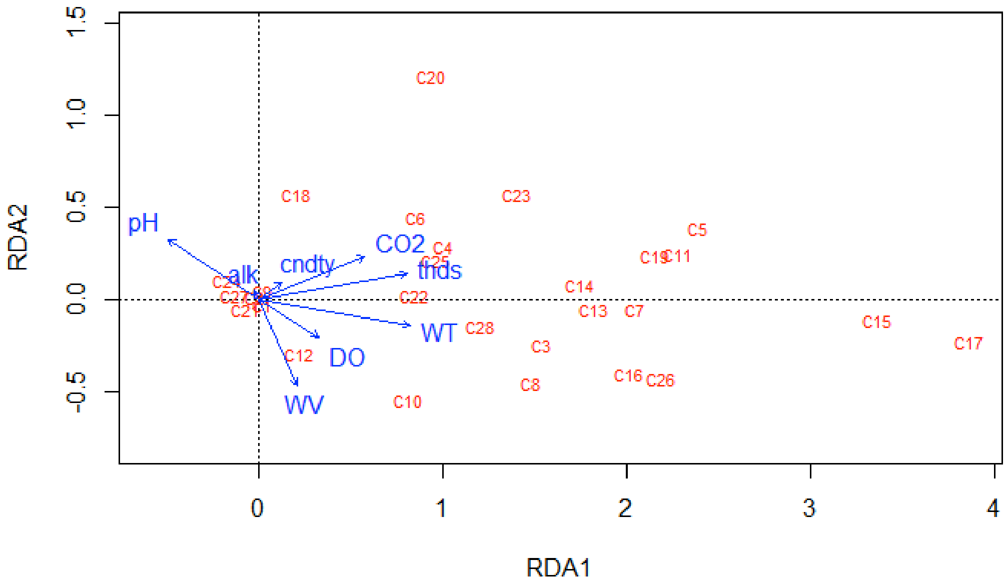

Figure 3. Redundancy analysis (RDA) ordination between fish community structure and environmental variables (for species code refer table 1). thds—total hardness, do dissolved oxygen | WT—water temperature | WV—water velocity | cndty—conductivity | alk—alkalinity | DO—dissolved oxygen | CO_2—free carbon-dioxide.

Table 4. Station-wise fish faunal diversity indices in the snow-fed Tamor River, Nepal.

Station	Shannon Weiner index (H)	Simpson index (D)	Evenness index (E)
SA- Kabeli Dovan	2.82±0.15	0.932±0.012	0.64±0.008
SB Hewa Dovan	2.88±0.13	0.93±0.012	0.646±0.008
SC– Nuwa Khola Dovan	2.87±0.126	0.93±0.01	0.64±0.0075
SD– Chhaurawa Dovan	2.66±0.25	0.91±0.026	0.63±0.018
SE– Yakchana Ghat	2.63±0.307	0.91±0.031	0.63±0.022
SF– Mulghat	2.74±0.209	0.924±0.018	0.63±0.012
SG– Triveni Ghat	2.66±0.29	0.908±0.038	0.62±0.026

(RDA) was plotted in Figure 3. The first and second axis of the RDA accounted for 76% and 5.6%, respectively. The fish species of *Glyptothorax cavia* (C12), *Garra annandalei* (C10), *Tor tor* (C28), *Tarquilabeo latius* (C8), *Barilius barila* (C3), *Glyptothorax pectinopterus* (C13), *Botia lohachata* (C7), *Bangana dero* (C16), *Schizothorax richardsonii* (C26), *Labeo angra* (C15), and *Labeo gonius* (C17) are positively related to water velocity, dissolved oxygen and water temperature but negatively related to pH and alkalinity. Fish species of *Bagarius bagarius* (C2) and *Schizothorax labiatus* (C24) are positively related to pH and alkalinity but negatively related to water velocity, DO, and water temperature. In contrast, species of *Anguilla bengalensis* (C1), *Neolissochilus hexagonolepis* (C18), *Botia almorhae* (C6), *Barilius bendelisis* (C4), *Schizothorax progastus* (C25), *Schistura horai* (C22), *Glyptothorax telchitta* (C14), *Schistura savana* (C23), *Psilorhynchus pseudecheneis* (C20), *Pseudecheneis sulcata* (C19), *Garra gotyla* (C11), and *Opsarius shacra* (C5) are positively related to conductivity, free carbon-dioxide and total hardness. One way analysis of variance on redundancy analysis (RDA) vindicated that among the selected parameters, pH, air temperature and total hardness were the influencing factors (P <0.05) to shape the fish community structure.

One-way permutational multivariate analysis of variance (perMANOVA) on the Non-metric Multidimensional Scaling (NMDS) showed no significant (P >0.05) difference between winter, spring, and autumn season but summer season showed significant (P <0.05) differences with winter, spring and autumn seasons. Furthermore, there was no substantial (P >0.05) difference in fish population structure of spatial variation between the various sampling stations.

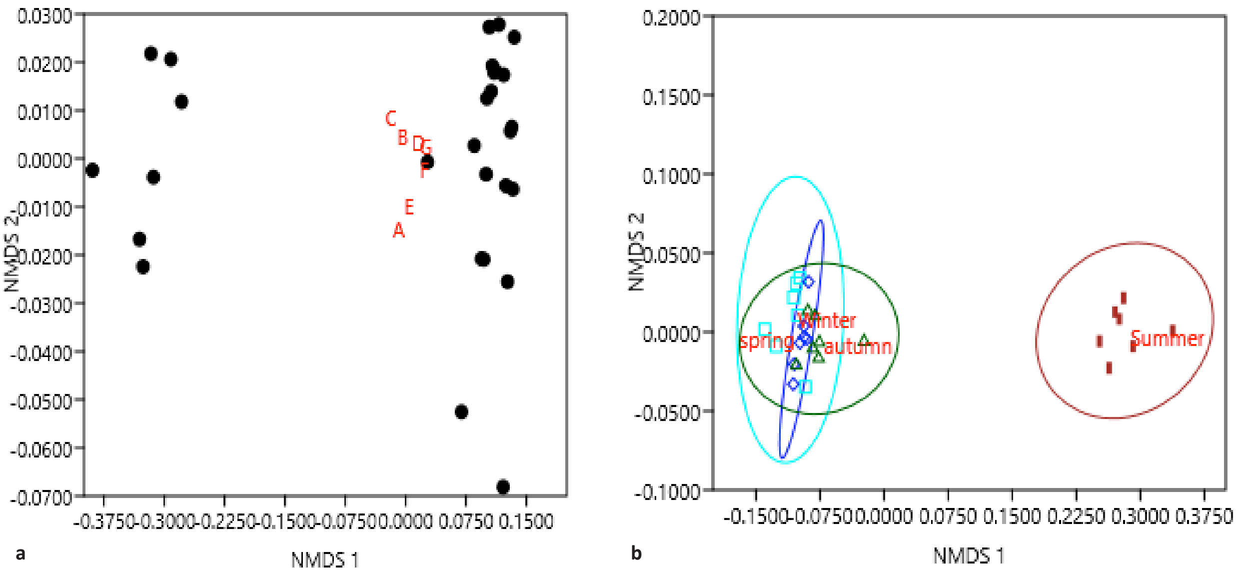

Figure 4. a—NMDS ordination of spatial variation of fish assemblage in the snow-fed Tamor River | b—NMDS ordination of temporal variation of fish assemblage in the snow-fed Tamor River.

Table 5. Season-wise fish faunal diversity indices in the snow-fed Tamor River, Nepal.

Season	Shannon Weiner index (H)	Simpson index (D)	Evenness index (E)
winter	2.56±0.21	0.90±0.02	0.62±0.01
spring	2.703±0.12	0.92±0.01	0.63±0.01
summer	3.01±0.02	0.94±0.003	0.65±0.002
autumn	2.74±0.16	0.92±0.01	0.63±0.01

Edds (1993) and Dubey et al. (2012) observed that the environmental variables such as conductivity, DO, pH, alkalinity, and salinity were most intensely correlated with the fish community composition of the Kali Gandaki River Basin, Nepal, and the Ganga River Basin, India. The most important environmental variables forming the fish assemblage in the Seti Gandaki River Basin were depth, width, conductivity, DO, F-CO2, SiO2 and chlorides. Some other variables such as, pH, PO4 3¡, chlorides and NO3–N were also important in structuring the fish communities (Pokhrel et al. 2018). The role of stream order in deciding the number and abundance of organisms has been clarified (Horwitz 1978; Payne 1986; Leveque 1997). Low temperature as well as other stressing physicochemical conditions are also usual in low order streams at high altitude (Bistoni & Hued 2002).

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Appendix I. Determined values of environmental variables in different seasons and stations.

Stations	Seasons	pH		WT	FCO2	DO	ALK	CD	WV	TH
A	Winter	7.1		17.6	7	8.6	17	55	1.9	34
B	Winter	7		17.8	6.5	9	18	55	2	32
C	Winter	6.5		17.5	7	8.7	18	56	1.8	31
D	Winter	7		17	5	8	16.5	52	2	29
E	Winter	7.4		17.5	6.5	7.9	16.6	53	2.2	23
F	Winter	7.1		17.8	6	8.2	16.6	52	2.1	27
G	Winter	6.5		17	7	8	15.5	51	1.9	28
A	spring	6.5		17.1	5.9	8.6	15.4	52	1.9	30
B	spring	7		17.6	6	9	15.4	51	2	36
C	spring	7.2		18	6	8.9	17	51.5	1.5	34
D	spring	6.5		19	6.4	8.4	17.5	54	1.8	35
E	spring	7.2		18.6	7	8	17.5	52.4	2	34
F	spring	7.4		18	6	8.4	16	50.1	1.9	36
G	spring	7		18.5	7.5	8.6	17	52.3	2	37
A	Summer	6.5		18.9	7	8.9	17.5	52	1.8	40
B	Summer	7.8		18.4	6	7.9	17.5	53.1	1.7	39
C	Summer	7.7		15.9	6.8	8	16.5	53	1.9	38
D	Summer	7.9		17	6.9	8.3	16.5	52	1.7	39
E	Summer	7.5		19	7	8.6	17	54	1.7	40
F	Summer	7.8		18.9	6.8	8.8	18	52	1.6	41
G	Summer	7.6		19	7	9	18	53	1.9	39
A	autumn	7.5		15	5	8	16	55	2	40
B	autumn	7		17	6	9	19	45	2.3	24
C	autumn	8		17.5	8	7	18	56	2.5	28
D	autumn	6		18	6	8	17	49	2.9	37
E	autumn	7		18.3	9	8	16	53	3	35
F	autumn	7.3		18	6	9	17	60	2.7	39
G	autumn	8		18.5	7	8	15	77	1.6	40

Appendix II. Fish species recorded from the Tamor River.

Stations	Seasons	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28
A	Winter	0	0	5	11	2	8	6	6	0	15	4	10	5	10	3	0	4	20	2	24	0	0	1	0	12	10	0	0
B	Winter	1	0	4	5	5	6	6	5	0	11	6	15	1	9	1	1	0	8	0	11	0	5	0	2	23	9	1	0
C	Winter	0	0	0	10	9	9	6	1	1	18	9	12	0	3	0	3	0	3	8	23	0	4	0	7	11	8	4	0
D	Winter	0	0	3	11	1	4	4	1	0	5	1	0	1	1	0	8	0	25	9	10	0	1	5	5	9	11	2	0
E	Winter	0	0	5	19	0	12	1	2	2	15	0	0	0	21	3	0	0	24	7	35	0	1	6	0	0	0	0	0
F	Winter	0	0	8	3	0	21	4	3	1	2	10	9	3	6	4	0	1	6	13	9	5	0	11	2	0	1	0	0
G	Winter	0	1	1	0	0	0	0	4	0	26	0	22	8	0	2	5	6	8	1	4	4	0	2	0	2	0	2	1
A	spring	0	0	9	24	0	9	9	8	0	28	8	11	2	19	0		0	22	16	19	0	1	0	1	16	15	0	8
B	spring	0	0	3	3	1	12	2	1	0	12	5	16	8	12	1	1	0	13	9	12	0	2	0	6	9	10	3	3
C	spring	0	0	1	7	4	9	14	6	2	9	0	8	6	9	2	6	0	7	13	9	0	0	0	3	12	6	7	12
D	spring	0	0	0	1	1	8	23	3	1	7	0	4	9	5	0	3	0	0	6	16	0	4	1	0	2	3	2	19
E	spring	0	0	3	6	3	1	12	8	0	12	3	8	3	12	0	0	0	12	12	5	0	1	0	0	4	9	0	10
F	spring	0	0	14	10	1	7	9	2	0	1	4	0	1	8	1	0	3	16	9	15	1	0	2	0	1	13	0	6
G	spring	0	0	9	1	1	11	0	3	0	9	2	1	6	9	4	0	1	11	2	9	6	2	6	0	0	25	0	11
A	Summer	0	0	19	13	19	14	25	17	0	13	21	8	20	15	39	29	30	13	27	18	0	8	13	0	11	31	0	13
B	Summer	0	0	24	19	20	12	22	21	0	24	21	12	15	18	23	22	34	12	26	13	0	7	7	0	9	31	0	12
C	Summer	0	0	20	20	20	10	26	20	0	32	23	12	22	25	44	28	37	20	16	18	0	9	15	0	17	31	0	15
D	Summer	0	0	18	19	18	19	25	18	0	24	24	14	20	35	26	22	39	20	22	25	0	12	17	0	21	26	0	18
E	Summer	0	0	20	20	31	15	24	19	0	18	36	8	21	24	55	23	60	9	30	35	0	12	24	0	20	26	0	9
F	Summer	0	0	18	19	35	20	26	15	0	20	30	17	25	22	29	23	33	14	30	32	0	11	26	0	24	24	0	14
G	Summer	0	0	18	18	34	23	24	20	0	24	28	15	22	30	29	14	45	19	36	28	0	9	16	0	17	28	0	7
A	autumn	1	0	9	12	13	12	9	11	0	12	22	15	7	17	17	12	13	14	34	12	0	0	1	0	11	12	0	0
B	autumn	2	0	6	9	5	9	16	9	0	3	9	13	12	12	5	8	4	18	12	9	0	1	2	1	9	11	1	0
C	autumn	0	0	1	4	9	15	6	5	0	8	5	9	9	9	2	3	7	0	9	6	0	0	0	0	3	9	4	9
D	autumn	0	0	2	14	1	23	3	12	0	12	1	18	4	19	0	2	12	1	4	10	0	0	0	0	1	3	0	8
E	autumn	0	0	9	8	1	9	9	19	0	2	0	2	1	12	0	5	2	4	1	8	0	0	3	0	7	2	0	6
F	autumn	0	1	0	0	6	1	11	3	0	13	0	17	9	9	1	0	8	9	0	4	1	0	1	0	4	16	0	5
G	autumn	0	4	2	1	3	2	14	0	0	16	1	9	4	14	8	0	11	12	6	9	0	0	2	0	0	12	0	1

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