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Aquatic health assessment of the Gambhar stream (H.P.) through analysis of water quality parameters, plankton and fish diversity

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ABSTRACT

Present study was conducted to assess the relationship between water quality, fish diversity and plankton diversity of Gambhar stream, which flows in Solan district of Himachal Pradesh, India.Physico-chemical parameters including air and water temperature, pH, DO, TDS, conductivity, total alkalinity, total hardness, Ca^{2+} and Mg^{2+} hardness, concentration of nitrates and phosphates were analysed. Weighed Arithmetic Water Quality Index (WAWQI= 53.31438) showed poor water quality of the stream. Ten fish species belonging to two orders (Cypriniformes and Siluriformes) and four families (Cyprinidae, Danionidae, Nemacheilidae, Sisoridae) were documented during investigation.Cypriniformes was recorded as the most dominant order. Additionally, a total of 11 genera of phytoplankton belonging to Bacillariophyceae and Chlorophyceae were recorded. Canonical correspondence analysis (CCA) between environmental variables, plankton diversity and fish diversity indicate the influence of physico-chemical parameters and plankton distribution on fishdiversity.

Figures : 02 References : 26 Tables : 04
KEY WORDS : Aquatic health, Gambhar stream, Solan, Water quality

Introduction

India ranks ninth in terms of freshwater diversity and constitute one of the world's biggest biodiversity hub[5], possesses an extensive network of open inland waters, in terms of rivers, canals, estuaries, and lakes. Essential components of a riverine ecosystem are streams, which serve as valuable sources of drinking water, fishing, industry, agriculture, and other recreational activities[3]. Since, the majority of streams and rivers in Himachal Pradesh originate from the Himalayas, therefore the region has an abundance of inland water resources. The distribution and abundance of fish species in Himalayan streams is influenced by flow rate, substratum type, water temperature, and food availability[13]. Himachal Pradesh is an integral part of Western Himalayas and attracts the attention of ichthyologists since very beginning. The important contributors are[8,10,11,19,20]. Despite making up only 1.7% of the nation's total land area, Himachal Pradesh is home to 110 fish species[9].

Phytoplanktons are the most significant group of living organisms present on the Earth, as it generates most of oxygen and vegetative matter needed at multiple food chain links.They are considered as important biological indicators of water quality as their population largely depends on the physico-chemical properties of water body. Moreover, they serve as basis of food chain in the aquatic ecosystem maintaining ecological integrity of aquatic ecosystem[21].

The current study aims at Gambhar stream, a tributary of Sutlej River in Himachal Pradesh. As there is no detailed scientific information on the current stream's ecological features, including its fish diversity, therefore, the goal of the current study is to fill the existing gaps.

Area of study

Present study was aimed at Gambhar stream in

TABLE-1 : GPS coordinates of sampling sites selected for survey in Gambhar stream

Sampling Sites	Location	Latitude	Longitude	Altitude (m)
Site □ (Upstream)	**At Gamberpul**	31°01´88ºN	76°96´44ºE	823
Site □ (Downstream)	**At Gamjun**	31°02´47ºN	76°95´95ºE	812

Solan district of Himachal Pradesh. The Gambhar is the left bank tributary of river Sutlej, which originates from Tara Devi hills near Shimla town (H.P.). The stream flows through Solan district and finally enters the Bilaspur district, where it ultimately joins the Govind Sagar reservoir (on the Sutlej river) near Bilaspur town.During current study, sampling was carried out at two distinct locations (Table-1).

Materials and Methods

The survey was conducted during 2024 to 2025 in the stream.Stream morphology was thoroughly examined using the standards[2,16, 17.] Water quality analysis of the stream was done by selecting different abiotic parameters such as Temperature, pH, EC (Electrical Conductivity), TDS (Total Dissolved Solids), DO (Dissolved oxygen), total alkalinity, total hardness, Mg^{2+} and Ca^{2+} hardness and concentration of phosphates and nitrates.The water samples from the stream were collected in 1 litre sterilized plastic bottles and brought to the laboratory for further analysis. Digital probes were used to monitor several physicochemical parameters in the field, such as water temperature, pH, TDS, EC and DO within the stream, while total alkalinity and total hardness, Ca^{2+} and Mg^{2+} hardness and concentration of nitrates and phosphates were analysed in the laboratory[1]. Water quality of the stream was analysed using WAWQI method[4].

Fish specimens were primarily collected using cast and gill nets run by local licensed fishermen. Depending on their size, the collected specimens were stored in varied concentration of formalin (5-10%). Fishes were identified using keys[6,7,24].

Planktons were collected by filtering 100L of water through plankton net and allowed to settle down for 24-28hrs. The samples were preserved in 2-4% formalin. Plankton were identified with the help of keys[25,26.]

The CCA (Canonical Correspondence Analysis) multivariate approach was used to determine the relationship between physicochemical parameters and ichthyofaunal diversity and plankton and fish diversity.PAST software (version 4.03) was used for all the statistical analyses.

Results and Discussion

Gambhar is a spring fed perennial stream, which falls in “B” category due to its moderate gradient. Bed material was dominated by cobbles, boulders and gravels. Riffles,runs and pools were principal habitat present,rapids were mostly observed during rainy season.Water quality assessment of the stream was done by variety of physicochemical parameters including water temperature, air temperature, pH, TDS, alkalinity, DO, conductivity,$Ca^{2+}$and Mg^{2+}hardness, phosphates and nitrates.

In current study, the average temperature of the water body ranged from 20.1ºC in November to 31.7ºC in April. Water temperature depends on season, time of the day, water depth and day length. Low water temperature during winter months was due to low sunlight availability and presence of short days.The value of pH was minimum (8.4) in November as post-monsoon runoff bring decaying organic matter into the stream. Their decomposition releases organic acids, lowering pH.Maximum value of pH (9.3) was recorded in May month as warmer temperatures increase algal photosynthesis, which consumes CO_2, reducing acidity and raising pH. Some workers[22] also reported low pH (7.3)during November month in the Beas River. Conductivity was found to be minimum in October (300µS/cm), as rainwater leads to dilution of ions present in water, lowering conductivity. Investigation[14] reported high conductivity in summer months in Pandoh River due to low water level. The alkalinity was minimum (102mg/l) in December as cooler temperatures reduced chemical weathering and the release of alkaline substances from rocks and soil[12]and maximum(392 mg/l) in May, as high temperature leads to increased evaporation, concentrating dissolved minerals like bicarbonates and carbonates in the water. Total hardness is the measure of calcium and magnesium ions in water. Total hardnesswas minimum(162mg/l) in October as cooler post-monsoon weather reduces evaporation, so mineral concentration remain low and maximum (331 mg/l) in May as high evaporation concentrates dissolved minerals like Ca^{2+} and Mg^{2+} ,results in increased hardness.The value of TDS in Gambhar stream ranged

TABLE-2 : Showing different physicochemical parameters, their mean values and calculations of WAWQI

PARAMETER	S_n(BIS)	Range	1\Sn	K=1/(©1/Sn)	Wn=k/Sn	V_0	Vn	Vn/Sn	Vn/Sn *100=Qn	Wn*Qn
pH	8.5	8.4-9.3	0.12	0.09614	0.0113	7	8.6111	1.074	107.4	1.214714
TDS (mg/l)	500	127-217	0	0.09614	0.0002	0	171	0.342	34.2	0.006576
Alkalinity(mg/l)	200	102-392	0.01	0.09614	0.0005	0	255.88	1.2794	127.94	0.061499
Total hardness (mg/l)	200	162-331	0.01	0.09614	0.0005	0	245.88	1.2294	122.94	0.059095
Ca^{2+}hardness (mg/l)	75	100-248	0.01	0.09614	0.0013	0	167.77	2.23693	223.6933	0.286735
Mg^{2+} hardness (mg/l)	30	30-308	0.03	0.09614	0.0032	0	150.33	5.011	501.1	1.605801
Nitrate (mg/l)	45	0.67-4.74	0.02	0.09614	0.0021	0	2.135	0.04744	4.744444	0.010136
DO (mg/l)	5	7-12.2	0.2	0.09614	0.0192	14.6	9.55	0.52	52	0.99982
Phosphate (mg/l)	0.1	0.07-1.12	10	0.09614	0.9614	0	0.62	0.51	51	49.02965
Conductivity (µS/cm)	300	300-450	0	0.09614	0.0003	0	377.77	1.25923	125.9233	0.040353
			©1/Sn=10.4		1					53.31438

TABLE-3 : Systematic list of fish fauna of Gambhar stream, District Solan (H.P.)

	FISH SPECIES	IUCN STATUS
	Order: Cypriniformes	
	Family: Cyprinidae	
1.	*Tor putitora*	EN
2.	*Schizothorax richardsonii*	VU
3.	*Tariqilabeo diplochilus*	LC
4.	*Pethia ticto*	LC
5.	*Garra gotyla*	LC
	Family: Danionidae	
6.	*Opsarius barna*	LC
7.	*Opsarius bendelisis*	LC
8.	*Barilius barila*	LC
	Family: Nemacheilidae	
9.	*Schistura horai*	LC
	Order: Siluriformes	
	Family: Sisoridae	
10.	*Glyptothorax brevipinnis*	DD

Abbreviations : EN= endangered, VU = Vulnerable, LC = Least concern, DD = Data deficit

from 127mg/l in October to 217 mg/l in May. Earlier workers[22] also reported high TDS value *i.e.*,303 mg/l in the BeasRiver during summers, which was significantly higher than our observations. DO is critical for the survival of aquatic organisms. Its high level indicate good water quality. The DO level in the Gambhar stream was consistently high, ranging from 7 mg/l to 12.2 mg/l, indicated well oxygenated water. Minimum DO was recorded in April (7 mg/l) as warm water holds less oxygen than cold water and maximum (12.2 mg/l) in November. The nitrate level in the Gambhar stream varied from0.67 mg/l in October to 4.74 mg/l in April. Phosphate is one of the limiting factors for phytoplankton productivity. Generally, major sources of phosphate in water are domestic sewage, agricultural effluents and industrial waste waters[23]. The phosphate concentration in the present stream varied from 0.07 mg/l in October to 1.12 mg/l in December.

Water Quality Index: During the study, the water quality index recorded as 53.314 (Table 2),which indicates the poor water quality of the stream as per[4],

TABLE-4 : Diversity indices of fish fauna found in the Gambhar stream, District Solan (H.P.)

	October	November	December	January	February	March	April	May
Dominance_D	0.34	0.3296	0.3281	0.8277	1	0.5703	0.4422	0.6187
Simpson_1-D	0.66	0.6704	0.6719	0.1723	0	0.4297	0.5578	0.3813
Shannon_H´	1.221	1.279	1.321	0.3145	0	0.6211	1.036	0.8252
Evenness_e^H/S	0.4565	0.8473	0.7186	0.7493	0.6848	1	0.9305	0.7043

which may be due to pollution, sedimentation or other environmental factors. Scientists[18]evaluated the water quality of Gola and Ramganga rivers of Uttarakhand and recorded the WQI to be 64.6 and 59.3 respectively, which indicates the poor water quality of these Himalayan streams.

Fish diversity

Present study documented 10 fish species (Table 3.) in Gambhar stream, represented by 2 orders (Cypriniformes and Siluriformes) and 4 families (Cyprinidae, Danionidae, Nemacheilidae, Sisoridae). Cypriniformes was the dominant order consisting of 3 families *viz.,* Cyprinidae, Danionidae, Nemacheilidae with 5, 3 and1 species, respectively, followed by Siluriformesconsisting of only 1 species. Workers[15] documented the highest diversity of Cypriniformes and Siluriformes in Vaishav stream of Kashmir Himalayas.The current study revealed that the stream is home to a substantial amount of commercially important fishes including *Schizothorax richardsonii* and *Tor putitora*. This determines the stream's economic significance in relation to fishing. Additionally, it is home to a large number of other fishes, such as *Opsariusbendelisis*, *Tariqilabeo diplochilus*,*Pethia ticto etc.* which are equally essential for the proper operation of the stream's ecosystem.

Fish diversity was analysed on monthly basis using varied diversity indices (Table-4). Simpson index of diversity (1-D=0.6719) and Shannon-Weiner index (H´=1.321) reflects maximum fish diversity in December month and minimum in February month(where there is a dominance of single species *i.e., Opsarius bendelisis*. Evenness index shows even distribution of individuals of different species in the month of March.

Relationship between fish species and physicochemical parameters

Canonical Correspondence Analysis (CCA) acts as a valuable tool for analysing the relationship between physicochemical factors and fish communities. In the plot, the length of arrows represents the importance of variables, the longer arrows signify a stronger correlation with the axes.From the plot (Fig.1), it was observed that occurrence of *Schizothorax richardsonii,Schistura horai and Garra gotyla* is positively correlated with DO& water temperature and negatively with total alkalinity, total hardness, Ca^{2+} and Mg^{2+} hardness, TDS, conductivity and nitrates. In contrast,*Pethia tict*ois positively correlated to total hardness, total alkalinity, Ca^{2+} and Mg^{2+} hardness, TDS, conductivity and nitrates and negatively to DO and water temperature. *Tor putitora, Opsarius barna* and *Tariqilabeo diplochilus* are positively linked to air temperature and pH and negatively to phosphates.*Opsarius bendelisis*, *Barilius barila* and *Glyptothorax brevipinnis* are positively correlated with phosphates, and negatively with pH and air temperature.

Phytoplankton

A total of 11 genera of phytoplankton under two major groups Bacillariophyceae (*Cymbella, Navicula,Gomphonema, Nitzschia, Pinnularia*, *Meridion, Diatoma, Fragilaria, and Synedra)*and Chlorophyceae (*Spirogyra and Cosmarium*) were recorded in Gambhar stream during the study period. This primary production supports various trophic levels and contributes to the overall productivity of the stream's ecosystem.Fish rely on phytoplankton, either directly or indirectly, as a food source, making phytoplankton essential for fish survival and overall ecosystem health.

CCA plot (Fig.2) shows that*Schizothorax richardsonii, Garra gotyla* and *Schistura horai* showed a positive relationship with *Navicula, Nitzschia, Pinnularia*, *Meridion, Diatoma, Fragilaria, Synedra*, *Spirogyra* and *Cosmarium*. In contrast, *Pethia ticto* showed a negative relationship with these planktonic genera. *Tor putitora, Tariqilabeo diplochilus* and *Opsarius*

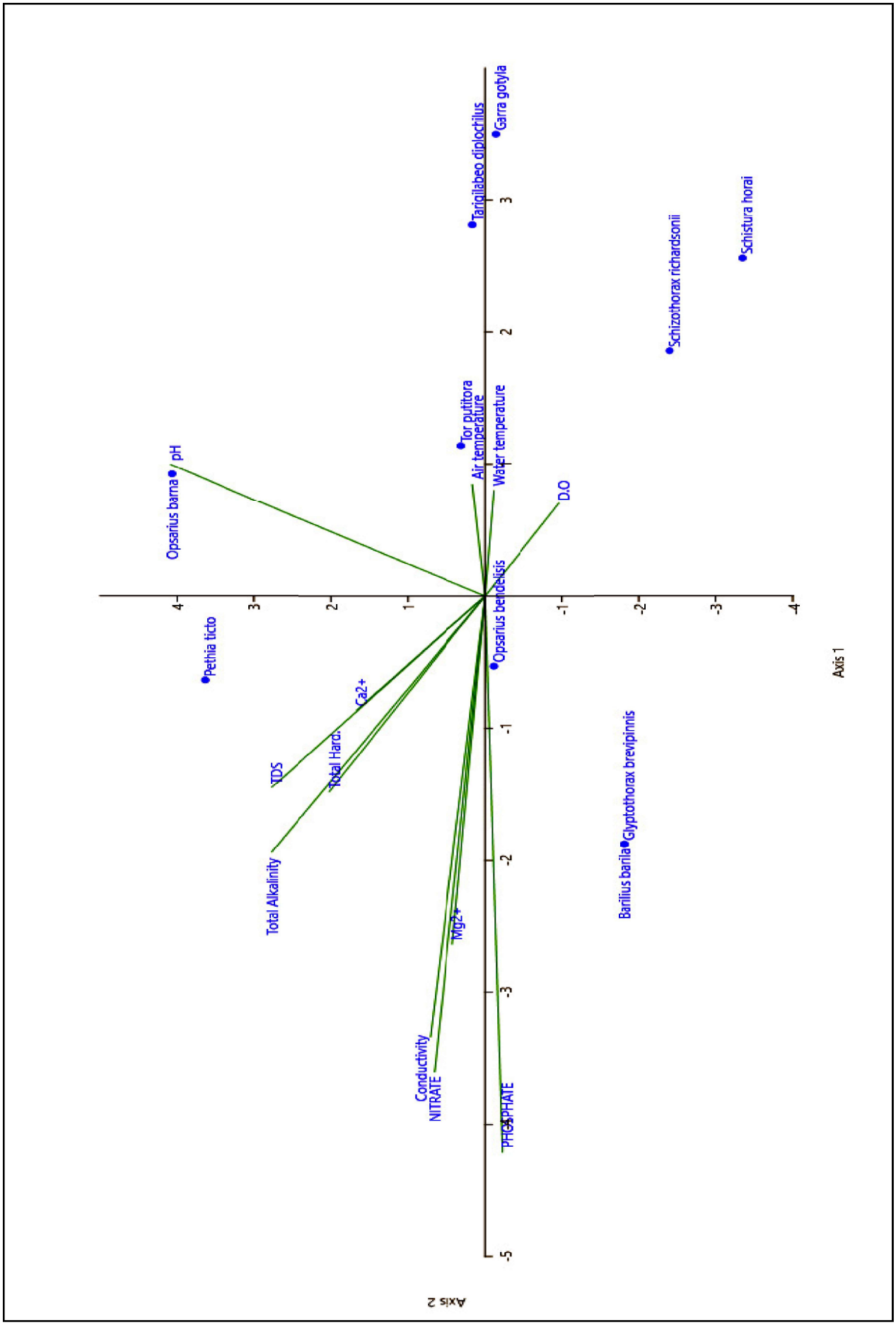

Fig. 1 : CCA biplot showing the correlation between fish species and physicochemical parameters

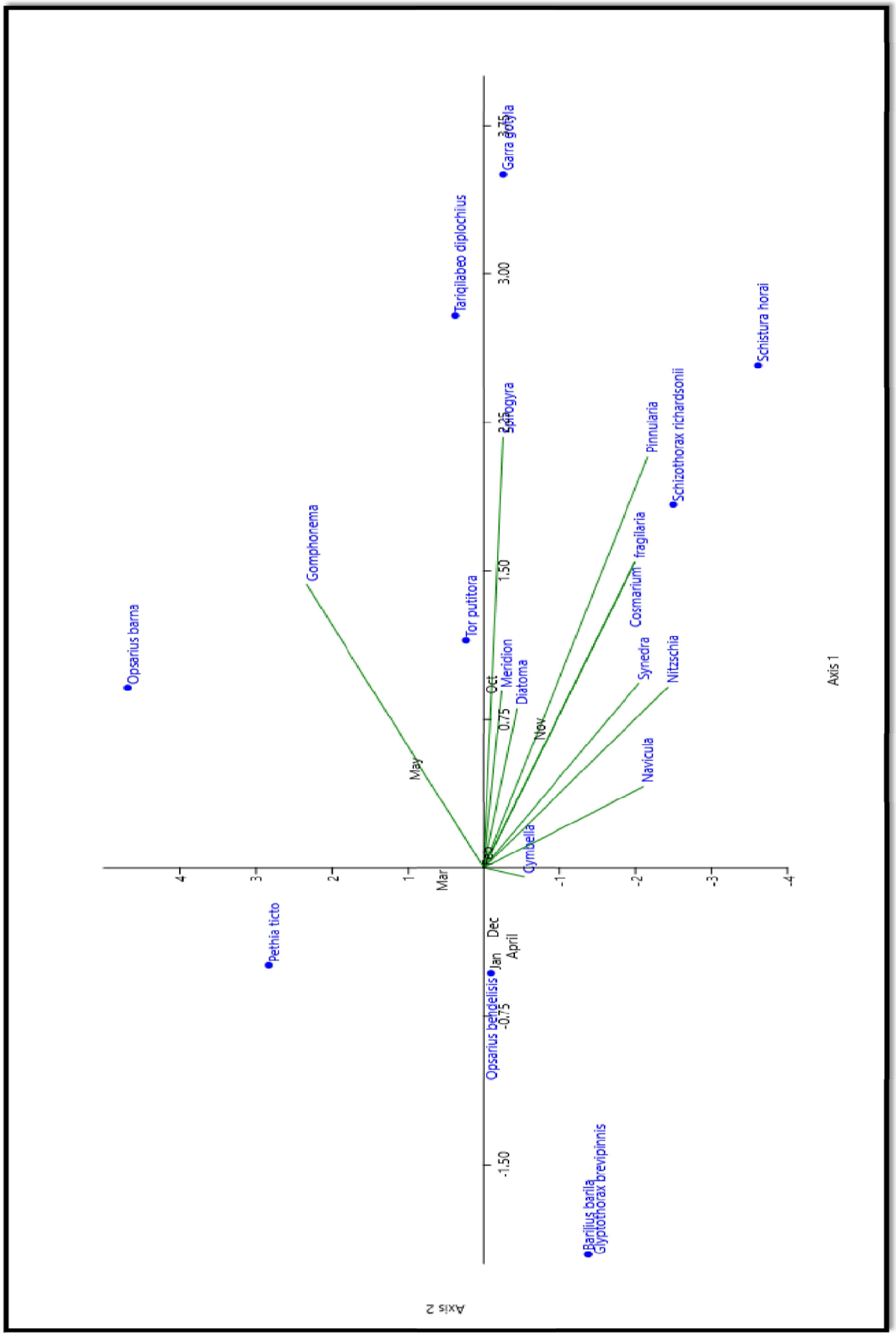

Fig 2. CCA biplot showing the correlation between fish species and plankton diversity

barna exhibited a positive correlation with *Gomphonema* and negative with *Cymbella*. In contrast, *Barilius barila, Opsarius bendelisis* and *Glyptothorax brevipinnis* exhibited negative relationship with *Gomphonema* and positive with *Cymbella*.

Conclusion

Thorough examination of relationship between the water quality, fish diversity and plankton dynamics in the stream revealed that the stream is quite healthy and productive. However, a number of illicit human activities such as washing clothes, bathing, dumping off trash *etc.,* are some of the anthropogenic activities that are observed as the main factors that could seriously jeopardize the stream's ichthyofaunal diversity. The limited plankton diversity and abundance in the Gambhar stream might be caused by low temperature, high water currents or low nutrient availability, all of which have an impact on the stream's fish diversity.In order to preserve the diversity in Gambhar stream, a long-term management strategy should be created and implemented.

References

1. APHA. *Standard Methods for the Examination of water and wastewater.* 20th ed. American Public Health Association, Washington, D.C. 1998.
2. Armantrout NB. *Glossary of aquatic habitat inventory Technology*. American Fisheries Society. 1999; p. 150.
3. BraunsM, Allen DC, Boëchat IG, CrossWF, Ferreira V, GraeberD, … & GückerB. A global synthesis of human impacts on the multifunctionality of streams and rivers. *Glob. Chang. Biol.* 2022; **28**(16): 4783-4793.
4. BrownRM, McClellandNI, Deininger, RA, O¹Connor MF. A water quality index – crashing the psychological barrier. In: *Indicators of environmental quality*, Springer Boston MS.1972; pp. 173 – 182.
5. Dwivedi A, De K. Bridging gaps in the Indian freshwater biodiversity conservation science-based and policy-backed recommendations, *Ecohydrol. Hydrobiol*. 2022; **24**(1): 169-177.
6. Froese, R, PaulyD. Editors. FishBase. *World Wide Web electronic publication.*2024; www.fish base.org.
7. Jayaram KC.*The Freshwater Fishes of the Indian region.* Narendra Publishing House,Delhi India, 1999.
8. Johal MS. Ecology of hillstreams of Himachal Pradesh and Garhwal region with special reference to fish community. Final report submitted to U.S. Fish and Wildlife Service, (U.S.A.), 2002; pp. 1-18.
9. KosyginL, Mohapatra A, Bineesh KK, SharmaI, Jadhav, SS, Khynriam D. Fauna of India Checklist: Pisces. Version 1.0. Zool. Surv. India.2024; 1-97.
10. Mehta HS and Uniyal DP. Pisces. In: *Fauna of WesternHimalaya* (Part-2), Published by Zool. Surv. India,Kolkata. 2005; pp. 255-268.
11. Mehta HS and Sharma I. Pisces, Fauna of Pin Valley National Park.*In Conservation Area Series – 34.*Published by Zool.Surv. India, Kolkata. 2008; p 147.
12. Nayak NP, KudapaVK, BhanU, Goswami L, KumarS, KushwahaA. Impacts of Climate Change on Weathering and Erosion of Rock Types Exposed on Earths Surface*. In Weathering and Erosion Processes in the Natural Environment,*2023; pp. 359-373. https://doi.org/10.1002/9781394157365.ch15.
13. NegiR, Banyal HS. Ichthyofaunal Study in Trans-Himalayan Rakchham-Chhitkul Wildlife Sanctuary in Baspa (Single) Valley, District Kinnaur, Himachal Pradesh, India. *Int. J. Biol.*2016; **9**(1): 36-40.
14. PrakasamC, RavindranS, SharmaMK, Kanwar VS. Assessment and distribution of water quality of Pandoh river basin, H.P, India. *Appl. Water Sci.* 2021; **11**(8): 1-9.
15. RashidG, SinghR, KumarA, Paramasivam P. Spatiotemporal variation infish species distribution and abundance in theVaishav stream, Kashmir Himalaya–India. *PLoSONE*2025*;* **20**(2): 1-27.
16. Rosgen DL. A classification of natural rivers. *Catena*, 1194; **22**: 169–199.
17. Rosgen DL.*Applied River Morphology*. Wildland Hydrology,Colorado, U.S.A., 1996.

18. SethR, MohanM, SinghP. Water quality evaluation of Himalayan rivers of Kumaun region, Uttarakhand, India. *Appl. Water Sci.*2016;**6**:137-147.

19. SharmaI, Sidhu, AK. Faunal Diversity of All Vertebrates (excluding Aves) of Himachal Pradesh. *Biol. Forum – An Int. J*. 2016; **8**(1):1-26.

20. Sharma I, ChandraK. Pisces.In: *Fauna of Himachal Pradesh, State fauna Series*, *26*. Published by Zool. Surv.India, Kolkata. 2021; pp. 393-423.

21. Sharma J, ParasharA, BagareP,Qayoom I. Phytoplanktonic diversity and its relation to physicochemical parameters of water at Dogarwadaghat of River Narmada. *Curr.World Environ,* 2015;**10**(1): 206-214.

22. Sharma S, Walia YK. Assessment of River Beas Water Quality during Summer Season in Himachal Pradesh, India. *Biol. Forum- Int. J.* 2016;**8**(1): 363-371.

23. Sumathi M, VasudevanN. Role of phosphate in eutrophication of water bodies and its remediation. *Journal of Chennai Academy of Sciences*, 2019; **1**(1): 65-86.

24. TalwarPK, JhingranAG. *Inland fishes of India and adjacent Countries*. Vol.1 & 2, Oxford publication, New Delhi.1991; pp. 1-1158.

25. Ward HB, WhippleGC.*Fresh water biology*(2nd ed.)John Wiley and Sons. Inc. New York, 1959; pp. 1-1248.

26. Welch, P.S. *Limnology.*2nd ed. McGraw Hill Book Co., New York.1952; pp. 1-538.