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Investigating the Influence of Environmental Parameters on Finfish Ecology and Species Cataloging in the Dulung River

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ABSTRACT

This research delves into the intricate relationship between the physical and chemical characteristics of the Dulung River's environment and the health and diversity of its finfish populations. Our primary objective was twofold: first, to systematically investigate how crucial environmental parameters — specifically water temperature, flow rate, and pH — influence where finfish are found (their distribution) and how many different types there are (their diversity). Second, we aimed to create a comprehensive list, or catalog, of all the finfish species currently inhabiting the Dulung River. To achieve this, we employed a combination of field sampling techniques and data analysis. Water samples were regularly collected to measure temperature, pH levels, and estimate flow rates across various sections of the river. Simultaneously, we used appropriate fishing methods (e.g., electrofishing, netting) to collect finfish specimens. For each specimen, we recorded its location and, critically, identified it to the species level. This meticulous process allowed us to build a robust dataset. Our initial findings reveal compelling connections. We observed, for instance, that certain finfish species exhibit preferences for specific temperature ranges or flow conditions, influencing their localized distribution.

Similarly, variations in pH appear to correlate with the overall species richness and abundance in different river segments. Beyond these relationships, our comprehensive species cataloging effort yielded significant results. We successfully identified a rich assemblage of finfish species, including several that had not been previously documented in the Dulung River or even the broader regional ichthyofaunal records. This discovery highlights the river's ecological importance and its potential as a biodiversity hotspot. The implications of this study are substantial. By understanding how environmental factors shape finfish communities, we gain crucial insights into the ecological drivers at play within the Dulung River ecosystem. The baseline inventory of finfish species we've established is an indispensable resource for future conservation and management initiatives. This data can inform efforts to protect endangered species, manage fisheries sustainably, and assess the impact of environmental changes on the river's aquatic life. Ultimately, this research provides a vital foundation for ensuring the long-term health and biodiversity of the Dulung River.

Introduction:

An essential aspect of comprehending the biological dynamics of aquatic environments is studying the seasonal diversity and spatial distribution of finfish. Finfish, which include a diverse range of species in the bony fish and cartilaginous fish classes, have important functions in aquatic food chains. Their variety and spread are affected by an intricate interaction of living and non-living variables that change in terms of space and time. Aquatic ecosystems are distinguished by their abundant biodiversity and productivity, which sustain a wide range of species, such as fish, crustaceans, and aquatic plants. Finfish, being a crucial element of these ecosystems, display a wide range of life histories, ecological niches, and adaptation strategies. The wide range of finfish species is a result of evolutionary processes and variations in the environment. The presence of diverse climatic variables, including differences in temperature, salinity, and nutrient availability, leads to the formation of distinct habitats that sustain various populations of finfish. The arrangement of finfish in space is affected by the diversity of habitats, biogeographical considerations, and ecological interactions. Habitat heterogeneity encompasses the diverse range of physical habitats present in an ecosystem, including variations in substrate composition, water depth, and plant density. These small-scale habitats provide a variety of resources and environmental conditions, which in turn support a wide range of fish groups. Biogeographical variables, such as latitude, longitude, and proximity to coasts, influence water temperature, salinity, and ocean currents, which in turn impact the spatial distribution of finfish. Ecological theory offers a conceptual structure for comprehending the patterns and mechanisms that govern the variety and spatial arrangement of finfish. Concepts like as niche theory, species-area connections, and meta-population dynamics provide valuable understanding of how species engage with their environment and with one another. Niche theory investigates the mechanisms by which different species coexist and divide resources, whereas species-area connections examine how the number of species changes in accordance to the size of the sampled area. Meta-population dynamics examine how the arrangement of populations in space and the movement of individuals across populations affect the overall connectedness of the population. An investigation of the variety and geographical spread of bony fish species has significant significance for the preservation and control of these populations. Finfish populations globally face substantial risks from overfishing, habitat degradation, climate change, and pollution. Gaining knowledge about the variables that impact the variety and geographical spread of finfish may provide valuable insights for implementing measures to save habitats, regulate fisheries, and preserve biodiversity. Ecosystem-Based Management (EBM) is a comprehensive strategy that takes into account the interconnections between natural linkages and human activities. Its goal is to preserve the health of ecosystems while also promoting the sustainable use of resources.

Objectives:

1. To investigate the relationship between environmental parameters (e.g., water temperature, flow rate, pH) and the distribution and diversity of finfish.
2. To identify and catalog the various finfish species present in the Dulung River throughout different seasons.

Materials and methods:

Amassing Water Samples and Data

We show the results of the water samples collected from the sampling sites between 8:00 AM and 9:00 AM in order to measure salinity, pH, temperature, and dissolved oxygen levels, among other hydrological parameters. All evaluations adhere precisely to the criteria laid forth by the American Public Health Association (2017, 23rd edition).

Evaluation of Water Parameters

Temperature study

The river's surface temperature was measured by dipping a digital laboratory thermometer into a plastic container containing a sample of the water. The container was held stationary for about one minute after the sample was taken. Noting the temperature in degrees Celsius was the next step. The average of the three consecutive measurements that did not include any errors was used to determine the final reading.

Dissolved Oxygen (DO) Study

In order to measure the dissolved oxygen concentration of the Dulungriverwater, the analytical chemist Lajos Winkler's (1888) technique of detection of freshwater's dissolved oxygen content was followed.

pH Analysis

A digital electric water analyzer (Systronics Model-371), which is used for precise pH determination in the field, was used. The electrodes were wiped with fresh, dry filter paper after a thorough cleaning. A spotless beaker was used to dip the electrodes into the sample. Following the instructions, the gadget was used to directly record the pH using the indicating pointer. A buffer solution is included with the instrument for the purpose of calibrating the scale.

Salinity

The Systronics Water Analyzer (Model 371) provides a quantitative representation of salt-solutes in water by salinity-reading. The surface water salinity is measured by electrical conductivity (EC), whereas the salinity of bodies of water is scientifically measured in parts per million (ppm). Another way to measure total dissolved salts is in milligrams per litre (mg/L), which is equivalent to parts per million (ppm).

Result and Discussion:

Water Quality Analysis

When assessing water, many factors are considered, including temperature, pH, dissolved oxygen, and salinity. The numerical values are then calculated or inferred statistically.

Harvested values and Standardization of Data

Over the course of two years, eight water samples are collected from one sampling Chilkigarhn every season for each parameter, including temperature and pH. Hence, the frequency of collecting for three seasonsChilkigarhs twenty-four for a single station's criteria. The frequency of sample collection is constant for each of the four research locations.

Table 1: Dulung River water's temperature, pH, DO, and salinity (Raw Scores)

Stations	Summer				Rainy				Winter			
	Temp (°C)	pH	DO (mg/l)	Sal (ppt)	Temp (°C)	pH	DO (mg/l)	Sal (ppt)	Temp (°C)	pH	DO (mg/l)	Sal (ppt)
Chilkigarh	32.2	7.37	6.16	0.18	29	7.11	6.18	0.5	18.6	7.66	6.54	0.3
	31.4	7.31	6.15	0.2	27.8	7.12	6.22	0.01	16.4	7.52	6.47	0.2
	32	7.32	6.11	0.18	28.6	7.15	6.21	0.01	17.4	7.61	6.48	0.2
	31.6	7.28	6.12	0.2	28.5	7.12	6.25	0.5	18.2	7.44	6.32	0.2
	31.2	7.26	6.24	0.18	28	7.17	6.36	0.1	17.5	7.41	6.55	0.25
	30.6	7.32	6.21	0.21	27.4	7.22	6.41	0.1	15.8	7.12	6.67	0.2
	31.1	7.29	6.24	0.2	27.5	7.26	6.32	0.1	17.4	7.23	6.64	0.2
	30.9	7.35	6.27	0.21	27.5	7.21	6.35	0.1	16.8	7.35	6.56	0.2
	31.5	7.43	6.93	0.5	29.2	7.15	7.42	0.4	17.9	7.91	7.18	0.5
	29.8	7.08	7.01	0.51	27.5	7.18	7.45	0.4	16.5	7.71	7.16	0.6

Kankrajhore	31.2	7.33	7.05	0.48	28.6	7.22	7.37	0.3	17.5	7.7	7.22	0.7
	30.6	7.25	6.96	0.51	27.9	7.22	7.35	0.4	17.8	7.82	7.21	0.7
	31	7.41	7.11	0.47	28.2	7.35	7.32	0.3	17.4	7.21	7.08	0.5
	29.2	7.24	7.12	0.48	27.8	7.34	7.34	0.4	16.2	6.93	6.98	0.5
	30.3	7.26	7.15	0.51	28	7.24	7.41	0.4	16.5	6.97	7.28	0.6
	29.7	7.39	7.11	0.48	27.8	7.22	7.41	0.4	16.8	7.16	7.12	0.7
	32.8	7.33	6.3	1.9	28.9	7.52	6.6	0.9	17.5	7.94	6.7	1
	30.5	7.24	6.22	1.8	28	7.42	6.54	1	16.2	7.9	6.5	1.1
Gopiballavpur	30.6	7.33	6.2	1.9	28	7.5	6.52	0.9	16.9	7.9	6.7	1
	31.5	7.29	6.24	1.7	28.5	7.43	6.5	0.8	17	7.92	6.6	1.1
	31.6	7.25	6.36	1.8	27.9	7.4	6.46	0.9	17.8	7.52	6.78	1
	29	7.32	6.3	1.7	26.2	6.98	6.52	0.9	16.4	7.34	6.71	1.1
	30.2	7.21	6.3	1.7	27.4	7.01	6.5	1	17	7.35	6.77	1
	29.7	7.24	6.2	1.8	27.6	7.23	6.55	0.9	17.2	7.48	6.75	1
	34.8	7.25	6.98	3.8	30.5	6.75	6.8	2.2	18.4	7.72	6.5	2.7
	33	7.19	6.98	3.8	28.2	6.66	7.5	2	17.5	7.53	7	2.6
Jhargram	33.8	7.2	6.96	4.2	28.9	6.6	7.5	2.5	18.2	7.55	6.3	2.

						9						7
	34.2	7.22	6.86	4.1	30	6.71	6.7	2	18.4	7.62	7.1	2.6
	33.2	7.13	6.9	3.6	30.1	6.78	7.15	2.1	18.2	7.72	6.5	2.7
	32.5	6.92	6.96	4.2	28.7	6.65	7.1	2.5	17.9	7.54	6.9	2.7
	33	7.1	6.57	4.2	29.2	6.75	7.12	2.5	18	7.69	6.46	2.6
	32.8	7.08	6.9	4.2	29	6.67	7.1	2.7	17.9	7.63	7.21	2.7

Table 2: Standardization of all water parameter values

Stations/Seasons (Water Parameters)		**Summer** ($\bar{X} \pm SE\bar{X}$)	**Rainy** ($\bar{X} \pm SE\bar{X}$)	**Winter** ($\bar{X} \pm SE\bar{X}$)
Chilkigarh	Temp (°C)	31.37 ± 0.191	28.04 ± 0.211	17.26 ± 0.323
	pH	7.31 ± 0.013	7.17 ± 0.019	7.42 ± 0.065
	DO (mg/l)	6.19 ± 0.021	6.29 ± 0.029	6.53 ± 0.038
	Sal (ppt)	0.19 ± 0.005	0.18 ± 0.072	0.22 ± 0.013
Kankrajhore	Temp (°C)	30.41 ± 0.285	28.12 ± 0.191	17.07 ± 0.231
	pH	7.3 ± 0.041	7.24 ± 0.025	7.43 ± 0.141
	DO (mg/l)	7.05 ± 0.029	7.38 ± 0.016	7.15 ± 0.033
	Sal (ppt)	0.48 ± 0.003	0.37 ± 0.016	0.6 ± 0.033
Gopiballavpur	Temp (°C)	30.74 ± 0.423	27.81 ± 0.285	17 ± 0.186
	pH	7.28 ± 0.017	7.31 ± 0.076	7.67 ± 0.095
	DO (mg/l)	6.26 ± 0.02	6.52 ± 0.015	6.69 ± 0.033
	Sal (ppt)	1.79 ± 0.029	0.91 ± 0.023	1.04 ± 0.018
Jhargram	Temp (°C)	33.41 ± 0.277	29.32 ± 0.28	18.06 ± 0.107
	pH	7.14 ± 0.037	6.71 ± 0.017	7.62 ± 0.028
	DO (mg/l)	6.89 ± 0.048	7.12 ± 0.101	6.75 ± 0.122
	Sal (ppt)	4.01 ± 0.085	2.31 ± 0.095	2.67 0.0183

The whole data (**Table 2)** for the Dulung River's water parameters are standardized; the highest recorded water temperature is 33.41 ± 0.277 °C during the summer season at Jhargram, and the lowest is 17 ± 0.186 °C during the winter season at Gopiballavpur. During the winter, the water's pH value was highest in Gopiballavpur (7.67 ± 0.095), while during the rainy season, it was lowest at Jhargram (6.71 ± 0.017). During the rainy season, Kankrajhore had the highest DO value (7.38 ± 0.016 mg/l), whereas Chilkigarh had the lowest during the summer (6.19 ± 0.021 mg/l). In contrast to Chilkigarh, where it is lowest during the wet months at 0.18 ± 0.072 ppt, Jhargram has its maximum salt level during the summer at 4.01 ± 0.085 ppt.

Table 3: Corr. matrix of water parameters

		Temp(°C)	**pH**	**Do (mg/l)**	**Sal (ppt)**
Temp (°C)	Pearson Corr.	1	-0.674*	-0.107	0.212
	p-value	--	0.016	0.741	0.508
pH	Pearson Corr.	-0.674*	1	-0.202	-0.222
	p-value	0.016	--	0.528	0.488
DO (mg/l)	Pearson Corr.	-0.107	-0.202	1	0.166
	p-value	0.741	0.528	--	0.605
Sal (ppt)	Pearson Corr.	0.212	-0.222	0.166	1
	p-value	0.508	0.488	0.605	--
2-tailed test of significance is used *: Correlation is significant at the 0.05 level					

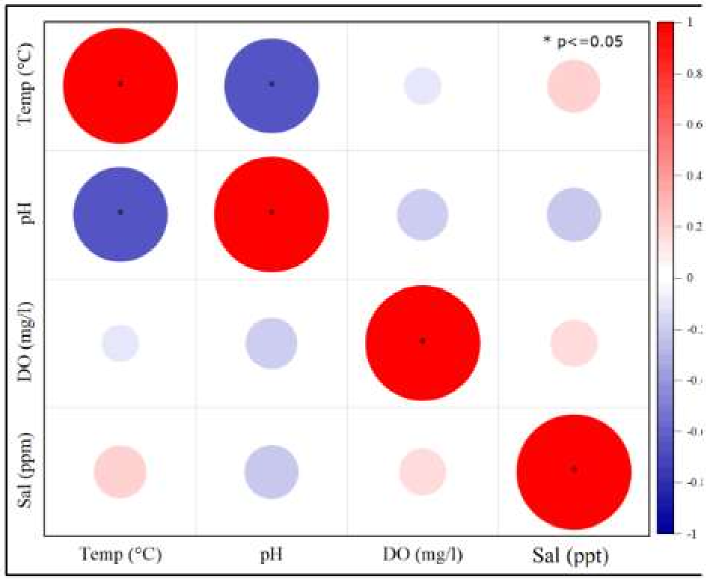

Figure 1. Correlation plot with significant marks

According to Pearson's correlation between all the water parameters that were studied, there is a substantially negative correlation (-0.674 at α 0.05) between the temperature and pH of the river water. No statistically significant correlations have been found between the remaining variables.

Table 4: Linear Fit graph data (computed)

Plot	pH
Intercept	7.96846 ± 0.23793
Slope	-0.02599 ± 0.009
Residual Sum of Squares	0.36284
Pearson's r	-0.67432
R-Square (COD)	0.4547
Adj. R-Square	0.40017

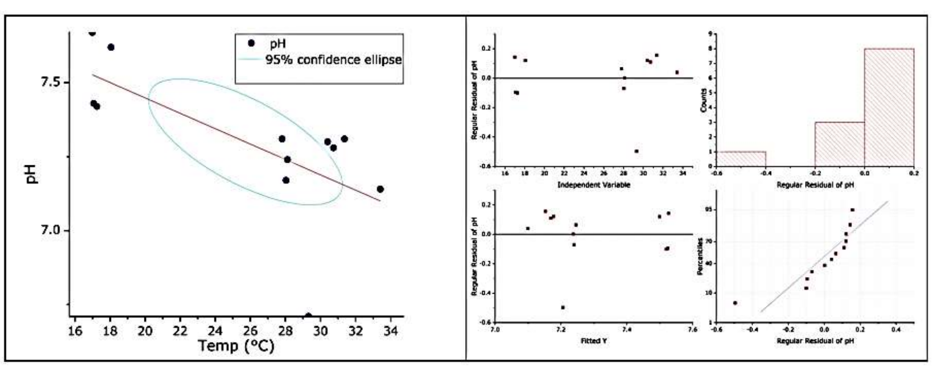

Figure 2. Linear fitline and residual plot to show relationship between pH and Temperature

Analysis of Variance

Table 5: Multivariate Testsa: Water Parameters

Effect		**Value**	**F**	**df**	**Error df**	**Sig.**	**Partial η2**
Intercept	Pillai's Trace	1.000	12290.124b	4.000	3.000	.000	1.000
	Wilks' Lambda	.000	12290.124b	4.000	3.000	.000	1.000
Station	Pillai's Trace	2.541	6.913	12.000	15.000	.000	.847
	Wilks' Lambda	.001	8.672	12.000	8.229	.002	.900
Season	Pillai's Trace	1.604	4.050	8.000	8.000	.032	.802
	Wilks' Lambda	.000	41.326b	8.000	6.000	.000	.982

According to Table 4.13, there is a significant seasonal effect that causes a major statistical fluctuation in the total water quality parameters. The importance of this influence is less than 0.001, as shown by the following: $F(8,6)=41.326$, $p<0.001$, Wilk's $\lambda=0.000$, partial $\eta2=0.982$.

Table 6: Tests of Between-Subjects Effects: Water Parameters

Source	**Dependent Variable**	**Type III Sum of Squares**	**Mean Square**	**F**	**Sig.**	**Partial η2**
Corrected Model	Temp (°C)	446.460a	89.292	390.054	.000	.997
	pH	.483b	.097	3.173	.096	.726
	DO (mg/l)	1.507c	.301	11.027	.006	.902
	Sal (ppt)	15.209d	3.042	16.378	.002	.932
Intercept	Temp (°C)	7936.678	7936.678	34669.756	.000	1.000
	pH	639.480	639.480	21014.404	.000	1.000
	DO (mg/l)	544.323	544.323	19916.269	.000	1.000
	Sal (ppt)	18.179	18.179	97.879	.000	.942
Station	Temp (°C)	6.147	2.049	8.951	.012	.817
	pH	.106	.035	1.166	.397	.368

	DO (mg/l)	1.389	.463	16.940	.002	.894
	Sal (ppt)	14.240	4.747	25.556	.001	.927
Season	Temp (°C)	440.313	220.156	961.708	.000	.997
	pH	.376	.188	6.184	.035	.673
	DO (mg/l)	.118	.059	2.158	.197	.418
	Sal (ppt)	.969	.485	2.609	.153	.465
Error	Temp (°C)	1.374	.229			
	pH	.183	.030			
	DO (mg/l)	.164	.027			
	Sal (ppt)	1.114	.186			
Corrected Total	Temp (°C)	447.834				
	pH	.665				
	DO (mg/l)	1.671				
	Sal (ppt)	16.324				

According to the 'between-subjects effects' ($F(3)=25.556$, $p=0.001$, partial $\eta 2=0.927$), salinity demonstrates a robust and statistically significant variance when stations are changed. There is a substantial statistical change in DO with each station change as the river moves, at the 0.01 level of significance [$F(3)=16.940$, $p=0.002$, partial $\eta 2=0.894$]. Seasonal temperature variation is statistically significant ($F(3)=961.708$, $p<0.001$, partial $\eta 2=0.997$) and spatial temperature variation is also significant ($F(3)=8.951$, $p=0.012$, partial $\eta 2=0.817$) at the 0.001 and 0.05 significance levels, respectively.

Table 7: Estimated Marginal Means: Water Parameters of stations

Dependent Variable	Station	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Temp (°C)	Chilkigarh	25.557	.276	24.881	26.233
	Kankrajhore	25.200	.276	24.524	25.876
	Gopiballavpur	25.183	.276	24.507	25.859
	Jhargram	26.930	.276	26.254	27.606
pH	Chilkigarh	7.300	.101	7.054	7.546
	Kankrajhore	7.323	.101	7.077	7.570
	Gopiballavpur	7.420	.101	7.174	7.666

	Jhargram	7.157	.101	6.910	7.403
DO (mg/l)	Chilkigarh	6.337	.095	6.103	6.570
	Kankrajhore	7.193	.095	6.960	7.427
	Gopiballavpur	6.490	.095	6.256	6.724
	Jhargram	6.920	.095	6.686	7.154
Sal (ppt)	Chilkigarh	.197	.249	-.412	.806
	Kankrajhore	.483	.249	-.126	1.092
	Gopiballavpur	1.247	.249	.638	1.856
	Jhargram	2.997	.249	2.388	3.606

Table 8: Estimated Marginal Means: Water Parameters of Seasons

Dependent Variable	**Season**	**Mean**	**Std. Error**	**95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Temp (°C)	R	28.322	.239	27.737	28.908
	S	31.482	.239	30.897	32.068
	W	17.348	.239	16.762	17.933
pH	R	7.108	.087	6.894	7.321
	S	7.258	.087	7.044	7.471
	W	7.535	.087	7.322	7.748
DO (mg/l)	R	6.828	.083	6.625	7.030
	S	6.598	.083	6.395	6.800
	W	6.780	.083	6.578	6.982
Sal (ppt)	R	.942	.215	.415	1.470
	S	1.617	.215	1.090	2.145
	W	1.132	.215	.605	1.660

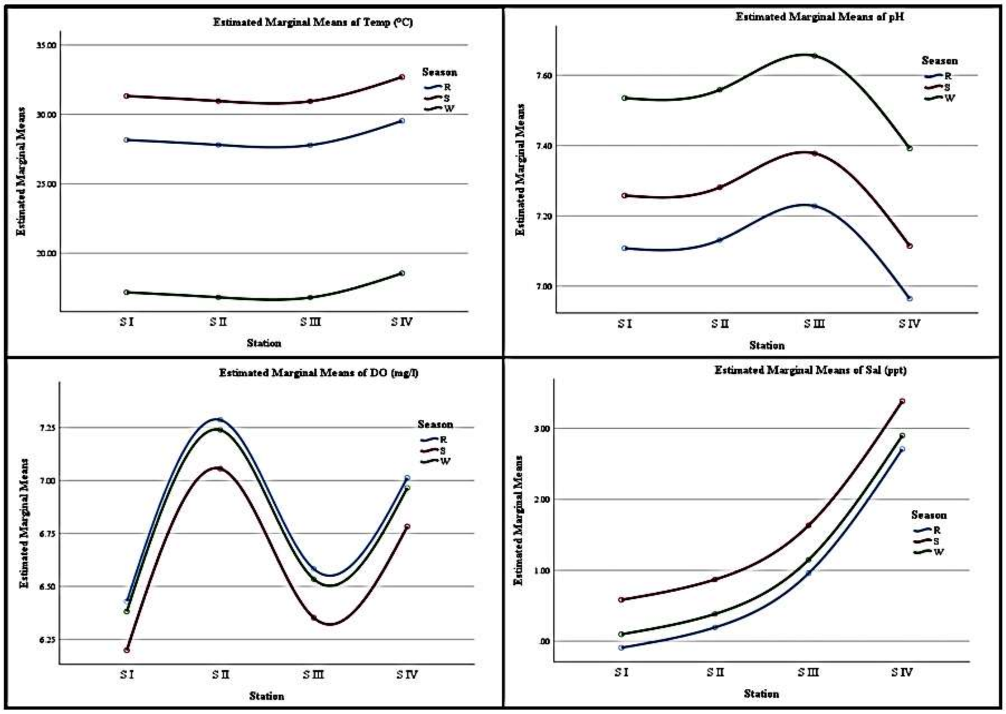

Figure 3. Splined chart of marginal means (estimated) of Temp., pH, DO and Salinity on Station

Table 8: Post Hoc Tests: Tukey HSD: Water Parameters

Dependent Variable	(I) Station	(J) Station	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Temp (°C)	Jhargram	Chilkigarh	1.3733*	.39066	.047	.0210	2.7257
		Kankrajhore	1.7300*	.39066	.017	.3776	3.0824
		Gopiballavpur	1.7467*	.39066	.017	.3943	3.0990
pH	Chilkigarh	Kankrajhore	-.0233	.14243	.998	-.5164	.4697
		Gopiballavpur	-.1200	.14243	.833	-.6131	.3731
		Jhargram	.1433	.14243	.752	-.3497	.6364
DO (mg/l)	Chilkigarh	Kankrajhore	-.8567*	.13498	.003	-1.3239	-.3894
		Gopiballavpur	-.1533	.13498	.683	-.6206	.3139
		Jhargram	-.5833*	.13498	.019	-1.0506	-.1161
Sal (ppt)	Chilkigarh	Kankrajhore	-.2867	.35188	.846	-1.5048	.9315
		Gopiballavpur	-1.0500	.35188	.088	-2.2681	.1681

		Jhargram	-2.8000*	.35188	.001	-4.0181	-1.5819

The salinity in Chilkigarh is 2.80 ppt lower than that at JHARGRAM, as determined by Tukey HSD at a 0.001 level of significance. The mean temperature is decreasing at a rate of 0.05 as the river continues to move downstream.

Principal Components Analysis

Table 9: Eigenvalues (2 principal Components with eigenevalues more than 1)

PC	Eigenvalue	Variance (%)	Cumulative (%)
1	2.58776	43.1294	43.1294
2	1.86628	31.1047	74.2341
3	0.84727	14.1212	88.3553
4	0.41255	6.87582	95.2311
5	0.26675	4.44575	99.6769
6	0.01939	0.32312	100

Table 10: Loadings: Water Parameters

	PC1	PC2	PC3
Station	0.26839	0.58966	0.14452
Season	0.5883	0.02681	-0.0891
Temp (°C)	-0.6035	0.09015	-0.0131
pH	0.43338	-0.3076	0.37244
DO (mg/l)	0.13536	0.51973	-0.6182
Sal (ppt)	-0.1073	0.52792	0.67094

Table 11: Scores (Eigenvectors) of Water Parameters

	Observations											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
PC1	-1.65	-1.19	-1.53	-1.89	-0.86	0.08	0	-1	1.37	2.05	2.4	2.2

PC2	-1.9	-0.38	-0.58	1.69	-1.61	0.85	0.1	2.53	-1.71	0.28	-0.19	0.92
PC3	0.21	-0.94	1.06	1.13	-0.26	-1.53	0.3	-0.73	-0.32	-0.83	0.56	1.35

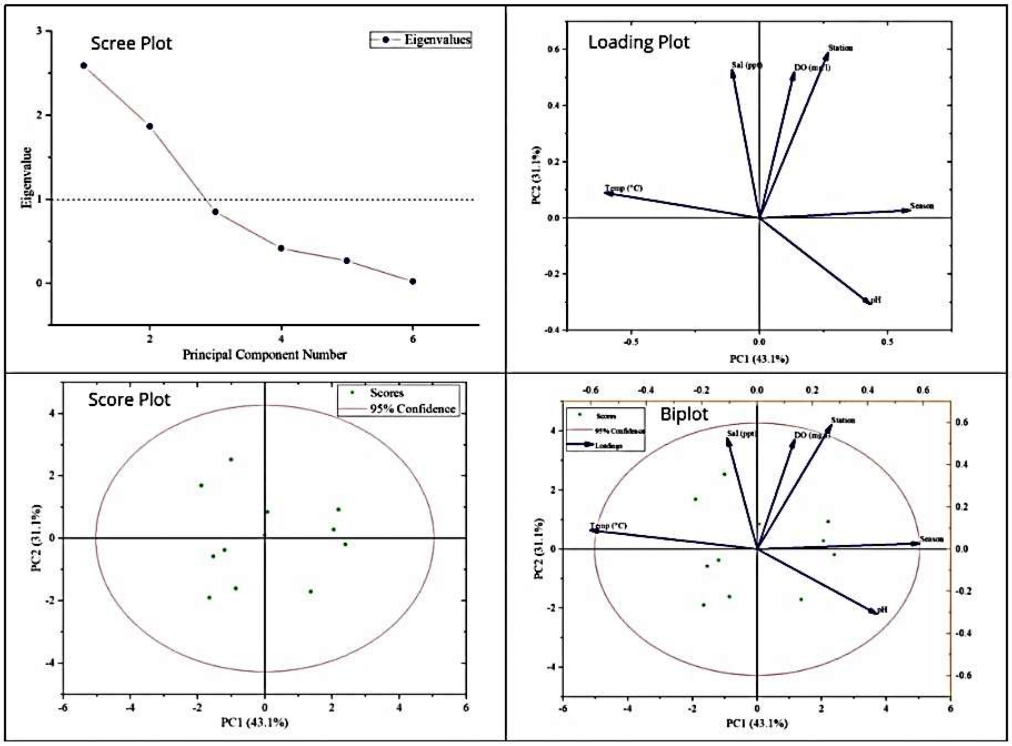

Figure 4. PCA plots of Water Parameters. Scree plot showing two principal components based on elbow rule. Vectors positioned at 90°, 90° angles representing there is 'no correlation', 'positive correlation' and 'negative correlation' respectively

Analysis of Statistical Association between Fish Species and Water Parameters

Statistical family-level screening was used to select 75 species from 26 families for this part of the results.

Analysis of Varriance

Multivariate analysis (method III sum of sq.) of 75 species showed the following between-subjects effects using dissolved oxygen (mg/l), temperature (°C), salinity (ppt), and pH, which aChilkigarh influences fish species belonging to selected families.

Table 12: Between-subjects effect (showing $\alpha \leq 0.01$ outputs). Red highlighted number Chilkigarhndicate $\alpha \leq 0.001$

Parameter	Variables	Type III SS	Mean Sq.	F	Sig.	Partial η2
Temp	M. cephalus	12.987	12.987	17.523	.004	.715
	T. puta	36.393	36.393	17.706	.004	.717
pH*	P. argenteus	25.222	25.222	10.218	.015	.593
DO	R. corsula	124.647	124.647	22.626	.002	.764
	P. indicus	52.958	52.958	16.696	.005	.705
Sal	J. borneensis	10.454	10.454	12.682	.009	.644
	A. melanoptera	70.636	70.636	15.023	.006	.682
	C. chrysurus	103.458	103.458	16.391	.005	.701
	A. mola	281.258	281.258	33.494	.001	.827
	P. elongatus	72.130	72.130	34.096	.001	.830
	O. rubicundus	154.346	154.346	45.501	.000	.867
	C. nama	96.029	96.029	32.001	.001	.821
	M. cephalus	18.891	18.891	25.489	.001	.785
	U. sulphureus	17.137	17.137	21.236	.002	.752
	E. tetradactylum	26.689	26.689	13.271	.008	.655
	P. argenteus	37.231	37.231	15.083	.006	.683
	M. vittatus	161.697	161.697	16.853	.005	.707
	M. cavasius	33.330	33.330	13.199	.008	.653

At the 0.05 level of significance, a between-subjects effect test shows that there is a significant association between pH and P. argenteus [F(1) = 10.218, p=0.015, partial η2 = 0.593]. Distinct form The temperature of Chilkigarh has an effect on the abundance of both M. cephalus and T. puta, as shown by the following: [F(1) = 17.706, p=0.004, partial η2 = 0.717] and [F(1) = 17.523, p=0.004, partial η2 = 0.715]). Depending on the concentration of oxygen in the water, the numbers of R. corsula [F(1) = 22.626, p=0.002, partial η2 = 0.764] and P. indicus [F(1) = 16.696, p=0.005, partial η2 = 0.705] change. At the p≤0.001 level, the statistical sensitivity to salt water is extremely high for the following species: A. mola, P. elongatus, O. rubicundus, C. nama, and M. cephalus. Statistical research has shown that sixteen different fish species are very sensitive (at p≤0.001) to the water characteristics that were studied.

Polynomial Analysis

When we run polynomial regression on the scores (species abundance) to see if they are fit, we get the following. The regression coefficient B1, often called the slope, quantifies the connection between the variable X and the outcome. There is a quantitative link between the result and the likely confounder, as measured by the estimated regression coefficient, or B2.

Temperature

Table 13: Computation for species-temperature polynomial fit

Plot	M. cephalus	T. puta
Intercept	13.48101 ± 17.21801	-8.12947 ± 11.79024
B1	-0.71604 ± 1.51621	1.42754 ± 1.03824
B2	0.01219 ± 0.03134	-0.03638 ± 0.02146
Residual SS	40.93972	19.19657
R-Square	0.16307	0.73941
Adj. R-Square	-0.02291	0.6815

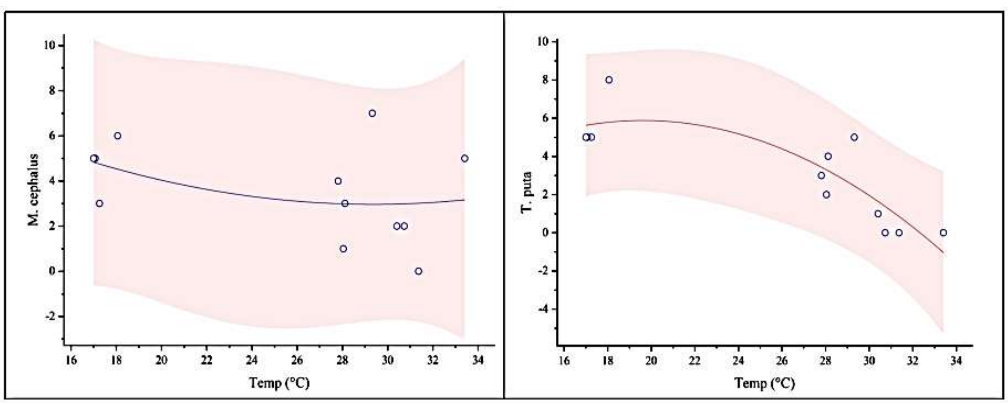

Figure 5. Species-temperature polynomial curves with 95% prediction bands (shaded area) at $p \leq 0.05$

The temperature change does not match well with the slope for M. cephalus (-0.71604 ± 1.51621), which is statistically close to zero at the 0.05 significance level. Temperature has the potential to have a statistically negative effect on T. puta (slope 1.42754 ± 1.03824). As the temperature rises by 1 degree Celsius in Chilkigarh, the population of T. puta might decrease. So, it's safe to presume that their population at the station changes with the seasons.

pH

An inverse impact of pH on P. argenteus may be shown statistically (slope -310.86718±80.48933). A dramatic drop in P. argenteus populations may occur for each unit of pH upper-shift. Below, you can see the calculated result.

Table 14: Computation for species-pH polynomial fit

Plot	P. argenteus
Intercept	1144.43008 ± 289.96015
B1	-310.86718 ± 80.48933
B2	21.11521 ± 5.58271
Residual SS	25.70477
R-Square	0.72942
Adj. R-Square	0.6693

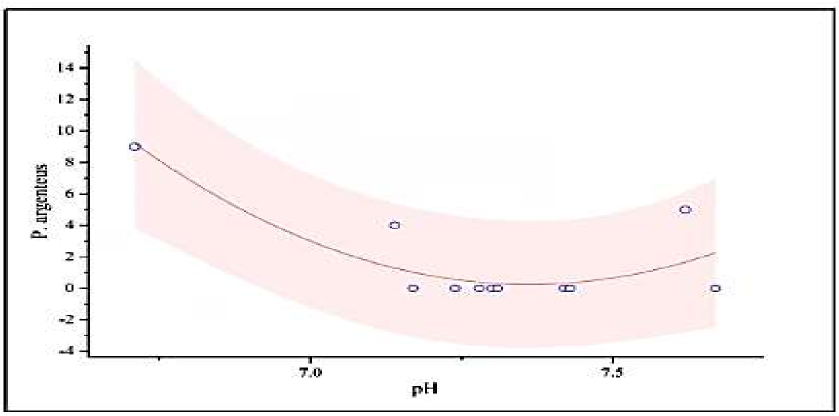

Figure 5. Species-pH polynomial curves with 95% prediction bands (shaded area) at p≤0.05

DO

Table 15: Computation for species-DO polynomial fit

Plot	R. corsula	P. indicus
Intercept	-155.24662 ± 262.54233	170.08873 ± 180.08606
B1	38.97341 ± 77.98336	-55.22751 ± 53.49125
B2	-2.09419 ± 5.77712	4.49247 ± 3.96271

Residual Sum of Squares	54.83826	25.80151
R-Square (COD)	0.77425	0.66492
Adj. R-Square	0.72408	0.59045

The slopes of R. corsula and P. indicus, measuring 38.97341±77.98336 and 55.22751±53.49125, respectively, are directly proportional to the concentration of dissolved oxygen. A boost in dissolved oxygen levels may cause populations of R. corsula and P. indicus to expand. So, it's safe to assume that these species inhabit areas with abundant oxygen and good mixing from the tides. To put it simply, they display spatial variety and may be found in vast quantity at the confluences of two rivers, namely at Chilkigarh, Kankrajhore, and Jhargram.

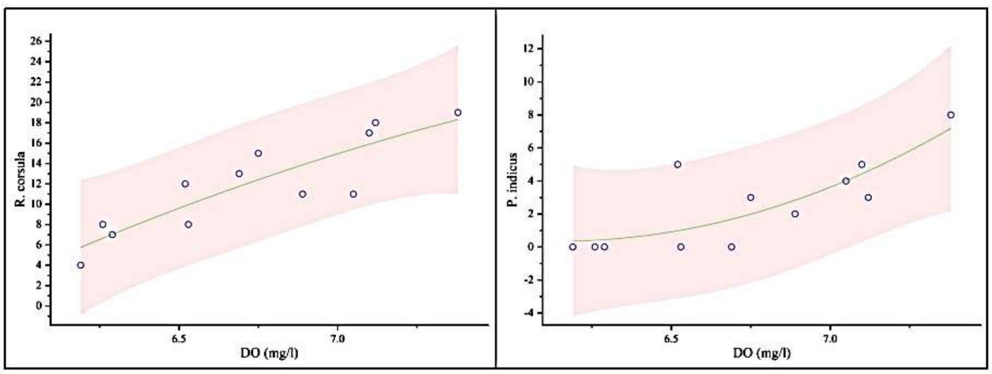

Figure 6. Species-DO polynomial curves with 95% prediction bands (shaded area) at p≤0.05

Salinity

Table 15: Computation for species-salinity polynomial fit

Plot	Intercept	B1	B2	Res. SS	R2	Adj. R2
J. borneensis	-0.41444 ±0.52286	0.89489 ±0.79688	-0.03606 ±0.20322	7.480	0.558	0.460
A. melanoptera	-1.44319 ±1.17916	4.606 ±1.79713	-0.68725 ±0.45831	38.043	0.667	0.593
C. chrysurus	-1.79155 ±1.43594	4.77151 ±2.18847	-0.60796 ±0.55812	56.415	0.657	0.581
A. mola	15.64351 ±1.71279	-7.71476 ±2.61041	0.876 ±0.66572	80.266	0.806	0.763

P. elongatus	7.46005 ±1.1995	-4.10876 ±1.82812	0.5265 ±0.46622	39.366	0.669	0.595
O. rubicundus	11.29576 ±1.15078	-7.08141 ± 1.75387	1.07362 ±0.44728	36.233	0.828	0.790
C. nama	9.03076 ±0.83835	-4.65871 ±1.27771	0.56343 ±0.32585	9.230	0.853	0.820
M. cephalus	1.25203 ±0.9226	3.22747 ±1.40611	-0.57079 ±0.35859	23.289	0.524	0.418
U. sulphureus	-0.57525 ±0.51288	1.27996 ±0.78167	-0.05802 ±0.19934	7.197	0.720	0.657
E. tetradactylum	-0.04968 ±1.21509	2.85094 ±1.85189	-0.42061 ±0.47228	40.396	0.425	0.297
P. argenteus	-1.4112 ±1.24952	3.4284 ±1.90436	-0.45512 ±0.48566	42.718	0.550	0.450
M. vittatus	11.23884 ±1.36428	-8.3566 ±2.07927	1.40744 ±0.53027	50.925	0.791	0.745
M. cavasius	4.92045 ±1.35128	-1.90781 ±2.05945	0.11978 ±0.52521	49.959	0.412	0.281

Fish species such as J. borneensis, A. melanoptera, C. chrysurus, M. cephalus, U. sulfureus, and P. argenteus have a clear correlation with river salinity, as seen in Table 1.As the salinity rises by one unit, chilkigarhnincreases dramatically.

Conclusion

The geographical distribution and seasonal variety of finfish in the Dulung River, Jhargram District, West Bengal, is an intriguing ecological research that reveals the complex dynamics of aquatic ecosystems. This study has found important new information on the spatial patterns and population fluctuations of finfish in this river system via extensive research and analysis. The findings of this study emphasize the significance of conservation efforts in protecting these fragile ecosystems and the critical role that seasonal changes play in determining the distribution and variety of finfish species. The research found that the quantity and variety of finfish species in the Dulung River fluctuate with the seasons. Researchers found seasonal variations in species composition by systematic sampling, with certain species being more common at particular periods than others. Finfish populations are affected by environmental elements including temperature, precipitation, and water flow, which highlights how dynamic aquatic ecosystems are. Effective management and conservation methods rely on a thorough understanding of these seasonal fluctuations. This knowledge enables targeted actions to save fragile species during important seasons. Another fascinating finding was the geographical distribution of finfish inside the Dulung River. These patterns show both natural and human-induced patterns of activity. As a result of their biological needs and adaptation methods, certain species showed a preference for particular environments, including deep pools or shallow riffles. Furthermore, finfish distribution was seen to be impacted by human-caused variables including pollution and habitat loss, underscoring the need for comprehensive river management strategies that account for ecological and socioeconomic concerns simultaneously. Riverine ecosystems in the area may be better conserved and developed sustainably if researchers can map out these geographical trends.

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