A Computational Study of Ichthyofaunal Diversity of River Kabul

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Mcclelland initiated the scientific study of the fish species of the River Kabul in 1842, and many researchers have continued this work since then. The primary goal of these studies has been to do a computational study of the fish fauna of the River Kabul and its major tributaries. This study utilized various computational tools along with Python script for the identification and comparison of fish species distribution between Pakistan and Afghanistan. The fish in the river are all members of the superclass Gnathostomata, including the Actinopterygii, subclass Neopterygii, division Teleostei, and superorder Ostaryophysi. Seventy-five fish species have been described from Pakistan and Afghanistan, belonging to four orders, ten families, and thirty-nine genera. Research indicates that Cypriniformes is the largest order and Cyprinidae is the largest family of fish in the River Kabul. Of the thirty-nine genera, twenty-seven are monospecific, and twelve are polyspecific. Notably, 27% of these fish are large and edible, highlighting the river's significant economic potential for the region. It is concluded that the ichthyofauna of this river is diverse and holds great economic value for the local population. However, pollution from industrial zones and anthropogenic settlements poses a significant threat to the aquatic fauna. To preserve the fish and aquatic resources in this river, proper management, law enforcement, and public education are highly recommended.

Keywords: Freshwater Fish, Cypriniforms, Siluriformes, Channiformes, Aquatic Resources.

Introduction:

Currently, fish constitute about half of all vertebrate species. Recent research estimates that there are approximately 35,000 distinct fish species, exhibiting a wide range of morphologies, shapes, and behaviors [1]. Freshwater constitutes only 0.01% of the world's water and roughly 0.8% of the earth's surface, yet this small portion sustains about 100,000 species out of 1.8 million, nearly 6% of all documented species [2]. Freshwater fauna is the most vulnerable, with one-third of total freshwater fish species in decline [3]. Given the advanced nature of biodiversity research and the gaps in our understanding, it is crucial to measure biodiversity by examining fundamental genetic variation. This genetic variation influences ecosystem performance by affecting productivity, survival, and stress resistance.

Fish biodiversity research is essential for evaluating river environments. Consequently, studying aquatic biodiversity is crucial [4]. Aquatic variation has increasingly captured the interest of environmental and social scientists due to its economic significance. According to a meeting of 1,400 scientists from 95 countries at the Millennium Ecosystem Assessment (MEA), biodiversity changes driven by human activities have accelerated more rapidly in the past 50 years than at any other point in history [5]. While aquatic fauna is being lost, its distribution and arrangement continue to be affected by both biotic and abiotic forces.

The River Kabul, known in Greek as Kophes, flows through eastern Afghanistan and northern Pakistan. Its total length is 700 km (435 miles), with 560 km (350 miles) in Afghanistan and 140 km (85 miles) in Pakistan. It originates 45 miles west of Kabul City in the Sanglakh Range, flowing east past Kabul and Jalalabad before joining the Indus River in Pakistan near the Khyber Pass, north of Peshawar. The river begins in the Koh-e-Baba mountains northwest of Kabul City, at Sarchasma, roughly 14,000 feet above sea level, and enters the Kabul Central Valley at Risikor.

In the 20th century, large-scale dam projects on the Kabul River, such as the Warsak and Sarobi dams constructed by the Soviet Union, were initiated by European nations to produce hydroelectric power. The river empties into Pakistan's Khyber Pakhtunkhwa province a little more than 25 kilometers (16 miles) north of the Durand Line border crossing at Torkham. The river flows through Peshawar, Charsadda, Mardan, and Nowshera in Khyber Pakhtunkhwa. It is the only and largest Afghan river to flow into the Indus River.

Figure 1: River Kabul and its tributaries

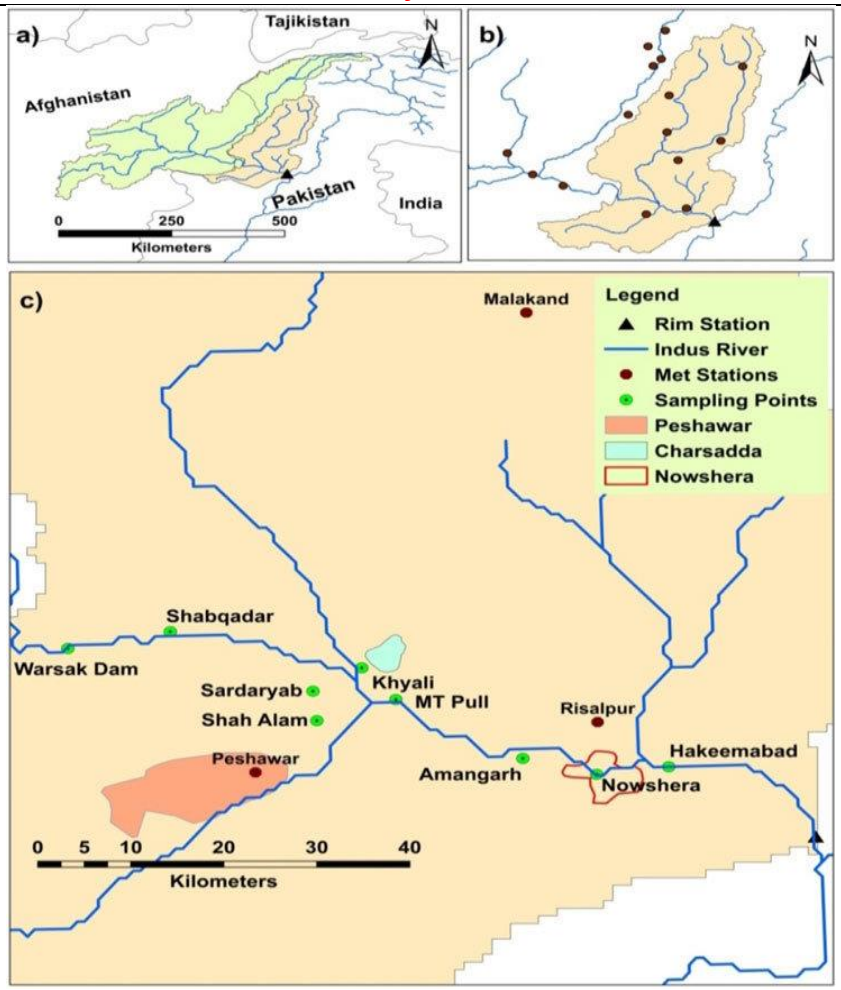

Figure 2: Lower Kabul River basin

There are two main climate zones along the River Kabul. Its higher regions have a continental warm summer climate, with a mean July temperature of around 25°C and a mean January temperature of about 0°C. A significant diversity of fish species is found in these areas. However, pollution from anthropogenic activities and industries has disrupted the habitat. The Kalapani Drain in Mardan, the Hazar Khawani Drain, and the Shahi Katha Drain are notable sources of pollution in the River Kabul. Additionally, three major industrial zones, including Peshawar, Rashakai, and Swabi discharge their waste into the river, further contributing to the pollution.

Statement of Interest:

The primary objective of this paper was to provide a comprehensive overview of the fish diversity in the Kabul River, which spans Afghanistan and Pakistan. The aim is to consolidate information on the entire fish fauna of the Kabul River into a single document, thereby facilitating future research and making it more accessible for scholars studying this river system. According to the results of the current study, the River Kabul maintains a very favorable combination of environmental conditions and is home to a wide variety of fish. Fish and other aquatic life are under stress due to regular floods, pollution, and habitat destruction, it is also found that the river has significant economic potential and an enormous impact on the economy of the local population, not only in terms of irrigation and household use but also due to the abundance of edible and ornamental fish species that, with the right management and use, have the power to alter the fate of the local populace. A research and training facility for molecular

identification, water quality monitoring, and artificial breeding of native edible and attractive fish species is advised because it might improve the economic standing of the local population.

Novelty of Research:

The research focused on the Kabul River, a crucial waterway in Pakistan and Afghanistan. This study represents a pioneering effort to comprehensively document the fish diversity of this significant river. For the first time, the paper consolidates data on nearly all fish species found in the Kabul River, drawing from published literature, unpublished resources, and the authors' personal collections, all compiled into a single report.

Objectives:

- To identify and catalog all fish species inhabiting the Kabul River, classifying them taxonomically within the superclass Gnathostomata, including their orders, families, and genera.
- To determine the diversity of fish species within the river system, focusing on the number of species, orders, families, and genera present.
- To evaluate the economic significance of the fish species, with particular emphasis on the proportion of species that are large and edible.
- To assess the environmental challenges faced by the aquatic fauna, including the impact of pollution from industrial zones and anthropogenic settlements.
- To propose strategies for the conservation and sustainable management of fish and aquatic resources in the Kabul River, emphasizing the importance of effective management practices, law enforcement, and public education.

Methodology:

This review paper consolidates all available data on fish diversity in the Kabul River. The authors conducted field collections during general river surveys and supplemented this with information from published and unpublished research. Published data were drawn from journal articles available in libraries and recent papers accessed online. Unpublished research theses and reports from the Syed Muhammad Ahmad Seminar Library at the Institute of Zoological Sciences, University of Peshawar, were also included to ensure a thorough review. The IUCN status of species was retrieved from its website to identify any threatened or endangered species within the ecosystem. Data analysis was performed using MS Excel, GraphPad Prism, and additional computer-based data analysis tools.

In addition to species identification, the study compared fish species distribution between Pakistan and Afghanistan, highlighting shared and unique species within each region. Furthermore, the study focused on identifying the economically significant fish species in the river, providing an analysis of major edible fish fauna, crucial for local fisheries and food resources. Statistical analyses were performed to quantify species abundance, and the results were presented in tabular form to display the distribution and frequency of fish species.

Python Script for Fish Data Analysis:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
# Step 1: Load the data
fish_data = {
    'S/No': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20],
    'Order': ['Cypriniformes'] * 10 + ['Siluriformes'] * 10,
    'Family': ['Cyprinidae'] * 10 + ['Bagridae', 'Sisoridae', 'Siluridae', 'Heteropneustidae', 'Schilbeidae'] * 2,
    'Genus and Species': [
        'Chela cachius', 'Salmostoma bacaila', 'Salmostoma punjabensis', 'Aspidoparia jaya',
        'Aspidoparia morar', 'Barilius pakistanicus', 'Barilius vagra', 'Danio devario',
        'Rasbora daniconius', 'Amblypharyngodon mola', 'Mystus bleekeri', 'Mystus cavasius',
        'Rita rita', 'Glyptothorax jalalensis', 'Glyptothorax naziri', 'Ompok pabda',
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            'Wallago attu', 'Heteropneustes fossilis', 'Clupisoma naziri', 'Channa punctata'
        ]
    }
    df_fish = pd.DataFrame(fish_data)
    # Step 2: Summarize data - Number of species per family and genus
    family_species_count = df_fish.groupby('Family')['Genus and Species'].count().reset_index()
    family_species_count.columns = ['Family', 'Number of Species']
    genus_species_count = df_fish['Genus and Species'].apply(lambda x: x.split()[0]).value_counts().reset_index()
    genus_species_count.columns = ['Genus', 'Number of Species']
    # Step 3: Visualize the abundance of families
    plt.figure(figsize=(10,6))
    sns.barplot(x='Family', y='Number of Species', data=family_species_count, palette='viridis')
    plt.title('Abundance of Different Families of Fish in River Kabul')
    plt.xticks(rotation=45)
    plt.show()
    # Step 4: Visualize the number of species per genus
    plt.figure(figsize=(10,6))
    sns.barplot(x='Genus', y='Number of Species', data=genus_species_count, palette='magma')
    plt.title('Number of Species per Genus in River Kabul')
    plt.xticks(rotation=45)
    plt.show()
    # Step 5: Compare fish diversity between Pakistan and Afghanistan
    comparison_data = {
        'Fish Name': ['Chela cachius', 'Salmostoma bacaila', 'Aspidoparia jaya', 'Barilius pakistanicus'],
        'Pakistan': ['✓', '✓', 'X', '✓'],
        'Afghanistan': ['X', '✓', '✓', 'X']
    }
    df_comparison = pd.DataFrame(comparison_data)

    # Print comparison table
    print("Fish Species Comparison Between Pakistan and Afghanistan:")
    print(df_comparison)

    # Step 6: Economically significant fish
    economically_significant_fish = [
        'Labeo diplostomus', 'Wallago attu', 'Cirrhinus mrigala', 'Heteropneustes fossilis',
        'Tor putitora', 'Schizothorax esocinus', 'Bagarius bagarius'
    ]
    # Display the list of economically significant fish
    print("Economically Significant Fish in River Kabul:")
    for fish in economically_significant_fish:
        print(f"- {fish}")
```

Data were organized into multiple tables, showcasing fish orders, families, genera, species, and the number of species per genus. Comparison tables between Pakistan and Afghanistan were created to understand the geographical distribution of species, while additional tables provided insights into economically significant and edible fish species.

Biodiversity Indices Calculation

Two biodiversity indices were used to assess the diversity in each river section: the Shannon-Wiener Index and the Simpson Index.

1. **Shannon-Wiener Index (H')**: This index quantifies biodiversity by considering both the richness (number of different species) and the evenness (distribution of individuals among species). The formula is:

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

Where pi is the proportion of individuals of species iii in the total population.

2. **Simpson Index (D)**: This index measures the probability that two individuals randomly selected from a sample will belong to the same species. The formula is:

$$D = \frac{1}{\sum_{i=1}^{s} p_i^2}$$

Where pi^2 is the proportion of individuals of species iii. Simpson's Reciprocal Index is calculated as 1D\frac{1}{D}D1, providing a measure of diversity where higher values indicate greater diversity.

Data Analysis

For each section, the total number of individuals and the proportions of each species were computed. These proportions were then used to calculate the Shannon-Wiener and Simpson indices.

Results:

River Kabul which flows through both Pakistan and Afghanistan, has long been of interest to fishery biologists, with research dating back approximately 200 years. The fish diversity of the Kabul River has been thoroughly studied. This investigation conducted an extensive review of the previously documented fish diversity of the Kabul River. McClelland completed the initial research on the fish flora of the River Kabul in 1842, describing 25 species at that time. [6]described a new species, Nemacheilus prashari, from Nowshera. According to [7], there are 43 species in Afghanistan freshwater. The following species described by Coad are found in the River Kabul in the Afghanistan region: Amblypharyngodon mola, Aspidoparia jaya, *Carassius auratus, Cirrhinus reba, Ctenopharyngodon idella, Danio devario, Esomus danricus, Hypopthylmichthys molitrix, Labeo angra, Labeo dero, Labeo diplostomus, Labeo dycheilus, Labeo gonius, Labeo pangusia, Puntius conchonius, Puntius sarana, Puntius sophore, Salmostoma bacaila, Schizothorax barbatus, Schizothorax chryschlora, Schizothorax edenaina, Schizothorax esocinus, Schizothorax labiatus, Tor putitora, Nemacheilus griffithi (Triplophysa), Nemacheilus sargadenesis (Schistura), Rita rita, Ompok canio, Ompok pabda, Glyptothorax jalalensis, Channa gachua*, and *Channa punctatus.*

The researcher in [8], described 36 species belonging to 24 genera of bony fishes, including six new records previously unreported from the Vale of Peshawar, KP (River Kabul in Pakistan). The identified fish species from the River Kabul and its tributaries are: *Salmostoma bacaila, Salmostoma punjabensis, Chela cachius, Rasbora daniconius, Danio devario, Barilius vagra, Barilius pakistanicus, Osteobrama cotio, Cirrhinus reba, Crossocheilus diplochilus, Garra gotyla, Aspidoparia morar, Amblypharyngodon mola, Tor putitora, Tor zhobensis, Puntius sarana, Puntius sophore, Puntius chola, Puntius ticto, Schizothorax plagiostomus, Cyprinus carpio, Nemacheilus corica, Mystus bleekeri, Mystus seenghala, Wallago attu, Ompok pabda, Clupisoma naziri, Gagata cenia, Glyptothorax naziri, Glyptothorax cavia, Glyptothorax punjabensis, Glyptothorax stocki, Heteropneustes fossilis, Channa marulius, Channa striata*, and *Channa punctata.*

In [9], a total of 25 fish species from the River Kabul and its tributaries were identified. The species identified include: *Salmostoma punjabensis, Barilius vagra, Barilius pakistanicus, Rasbora daniconius, Brachydanio rerio, Cirrhinus reba, Crossocheilus diplochilus, Garra gotyla, Aspidoparia morar, Tor putitora, Tor zhobensis, Puntius chola, Puntius ticto, Cyprinus carpio, Acanthocobitis botia, Nemacheilus corica, Clupisoma naziri, Pseudeutropius atherinoides, Eutropiichthys vacha, Wallago attu, Ompok pabda, Heteropneustes fossilis, Channa punctata, Channa striata,* and *Mastacembelus armatus.*

The researcher in [10], described 52 species from the River Kabul in Pakistan, including *Salmostoma bac, Barilius pakistanicus, Brachydanio rerio, Danio devario, Rasbora daniconius, Chela cachius, Barbodes sarana, Cirrhinus mrigala, Cirrhinus reba, Labeo dero, Nazirator zhobensis, Osteobrama cotio,*

Puntius chola, Puntius punjabensis, Puntius sophore, Cyprinion watsoni, Puntius ticto, Tor putitora, Salmostoma punjabensis, Garra gotyla, Racoma labiata, Schizothorax plagiostomus, Amblypharyngodon mola, Botia birdi, Lepidocephalichthys guntea, Acanthocobitis botia, Aspidoparia morar, Nemacheilus corica, Schistura alepidota, Schistura microlabra, Schistura prashari, Mystus bleekeri, Mystus cavasius, Gagata cenia, Glyptothorax cavia, Glyptothorax naziri, Glyptothorax punjabensis, Glyptothorax stocki, Ompok bimaculatus, Ompok pabda, Crossocheilus diplochilus, Wallago attu, Heteropneustes fossilis, Clupisoma naziri, Eutropiichthys vacha, Pseudeutropius atherinoides, Channa gachua, Channa marulius, Channa punctata, Channa striata, and *Mastacembelus armatus*. He also described the fishes of the River Kabul in Afghanistan, including *Triplophysa brahui, Glyptothorax jalalensis, Schistura alepidota*, and *Schistura paludani*.

The authors of [11] identified the fish flora of the River Kabul in Khyber Pakhtunkhwa's District Nowshera. They recognized a total of 24 fish species, divided into eight families and four order; Cyprinidae, Sisoridae, Siluridae, Bagridae, Channidae, Nemacheilidae, Mastacembelidae, and Schilbeida. However, the orders include Cypriniformes, Siluriformes, Channiformes, and Mastacembeliformes. Fourteen species from the family Cyprinidae made it the most represented family in the study, including *Carassius auratus, Cyprinus carpio, Hypopthylmichthys molitrix, Puntius sophore, Puntius ticto, Crossocheilus diplochilus, Tor macrolepis, Orienus plagiostomus, Barilius pakistanicus, Barilius vagra, Barilius modestus, Garra gotyla, Labeo rohita*, and *Cirrhinus mrigala*. The family Channidae was represented by two species, *Channa punctata* and *Channa gachua*. The family Siluridae was also represented by two species, *Ompok pabda* and *Wallago attu*. Two species, *Mystus bleekeri* and *Sperata sarwari*, characterized the family Bagridae. All other families were represented by a single species each: *Acanthocobitis botia (Nemacheilidae), Glyptothorax punjabensis (Sisoridae), Mastacembelus armatus (Mastacembelidae),* and *Clupisoma naziri (Schilbeidae)*. They initially reported *Sperata sarwari (Bagridae)* from the Kabul River.

[12] described fish diversity in the River Kabul near Michini, KP, Pakistan. They documented 23 freshwater fish species from six orders, nine families, and nineteen genera. Eleven species from the most widespread family, Cyprinidae, include *Rasbora daniconius, Cirrhinus mrigala, Puntius ticto, Labeo diplostomus, Puntius sophore, Tor macrolepis, Crossocheilus diplochilus, Garra gotyla, Barilius vagra, Carassius auratus*, and *Cyprinus carpio*. Four species from the family Sisoridae include *Glyptothorax naziri, Bagarius bagarius, Glyptothorax punjabensis*, and *Glyptothorax stocki*. The family Channidae was represented by two species, *Channa punctata* and *Channa gachua*. The other six families were represented by a single species each: family Cobitidae by Botia birdi, family Siluridae by *Wallago attu,* family Schilbeidae by *Clupisoma naziri*, family Heteropneustidae by *Heteropneustes fossilis*, family Mastacembelidae by *Mastacembelus armatus*, and family Cichlidae by *Oreochromis niloticus*.

The author of [13], studied the fish of the River Kabul downstream at Warsak Dam to ascertain the variety of fish in the area. The study period ranged from March 2014 to July 2014. Fish from four orders, eight families, eighteen genera, and twenty-two species were gathered and described. The richest family in the study, Cyprinidae, was represented by eleven species; Sisoridae by four species; Channidae by two species; Cobitidae, Siluridae, Schilbeidae, Mastacembelidae, and Heteropneustidae by one species each. The species identified in this work were *Barilius vagra, Rasbora daniconius, Puntius sophore, Puntius ticto, Crossocheilus diplocheilus, Tor macrolepis, Carassius auratus, Cyprinus carpio, Labeo diplostomus, Garra gotyla, Cirrhinus mrigala, Botia birdi, Glyptothorax punjabensis. Glyptothorax cavia, Glyptothorax naziri, Bagarius bagarius, Wallago attu, Clupisoma naziri,* and *Channa punctata*.

Data Analysis:

According to their classification, all of the aforementioned species discovered in Pakistan and Afghanistan's River Kabul and its tributaries have been organized in the Table 1.

Table 1: The entire list if the fish species found in river Kabul and its tributaries.

S/No	Order	Family	Sub-family	***Genus and Species***

1	Cypriniformes	Cyprinidae	Cultrinae	*Chela cachius*
2				*Salmostoma bacaila*
3				*Salmostoma punjabensis*
4			Aspidoparinae	*Aspidoparia jaya*
5				*Aspidoparia morar*
6			Rasborinae	*Barilius pakistanicus*
7				*Barilius vagra*
8				*Danio devario*
9				*Rasbora daniconius*
10				*Amblypharyngodon mola*
11				*Esomus danricus*
12			Barbinae	*Cirrhinus reba*
13				*Cyprinion watsoni*
14				*Labeo dero*
15				*Barbodes sarana*
16				*Osteobrama cotio*
17				*Puntius chola*
18				*Puntius punjabensis*
19				*Puntius sophore*
20				*Puntius ticto*
21				*Cirrhinus mrigala*
22				*Puntius conchonicus*
23				*Puntius sarana*
24				*Labeo angra*
25				*Labeo diplostomus*
26				*Labeo dycheilus*
27				*Labeo gonius*
28				*Labeo pangusia*
29			Torinae	*Tor putitora*
30				*Nazirator zhobensis*
31			Garrinae	*Crossocheilus diplochilus*
32				*Garra gotyla*
33			Schizothoracinae	*Racoma labiate*
34				*Schizothorax plagiostomus*
35				*Schizothorax barbatus*
36				*Schizothorax chryschlora*
37				*Schizothorax edenaina*
38				*Schizothorax esocinus*
39				*Schizothorax labiatus*
40			Cyprinidae	*Cyprinus carpio*
41				*Carassius auratus*
42			Luciscinae	*Ctenopharyngodon Idella*

43			Hypopthalmichthyine	*Hypopthylmichthys molitrix*
44		Cobitidae		*Botia birdi*
45				*Lepidocephalichthysguntea*
46		Nemacheilidae		*Acanthocobitis botia*
47				*Nemacheilus corica*
48				*Schistura alepidota*
49				*Schistura microlabra*
50				*Nemacheilus sargadenesis (Schistura)*
51				*Triplophysa brahui*
52				*Schistura paludani*
53				*Nemacheilus griffithi (Triplophysa),*
54	Siluriformes	Bagridae		*Mystus bleekeri*
55				*Mystus cavasius*
56				*Rita rita*
57		Sisoridae		*Glyptothorax jalalensis*
58				*Glyptothorax cavia*
59				*Glyptothorax naziri*
60				*Glyptothorax punjabensis*
61				*Glyptothorax stocki*
62				*Bagarius bagarius*
63				*Gagata cenia*
64		Siluridae		*Ompok bimaculatus*
65				*Ompok pabda*
66				*Wallago attu*
67				*Ompok canio*
68		Heteropneustidae		*Heteropneustes fossilis*
69		Schilbeidae		*Clupisoma naziri*
70				*Pseudeutropius atherinoides*
71	Channiformes	Channidae		*Channa marulius*
72				*Channa punctata*
73				*Channa striata*
74				*Channa gachua*
75	Mastacembeliformes	Mastacembelidae		*Mastacembelus armatus*

Table 2: Analysis of River Kabul's Fish Diversity

Order	Family	Genus	Species
Cypriniformes	3 (30%)	27 (69.23%)	52 (69.33%)
Siluriformes	5 (50%)	10 (25.64%)	18 (24%)
Channiformes	1 (10%)	1 (2.56%)	4 (5.33%)
Mastacembeliformes	1(10%)	1(2.56%)	1 (1.33%)
Total	**10**	**39**	**75**

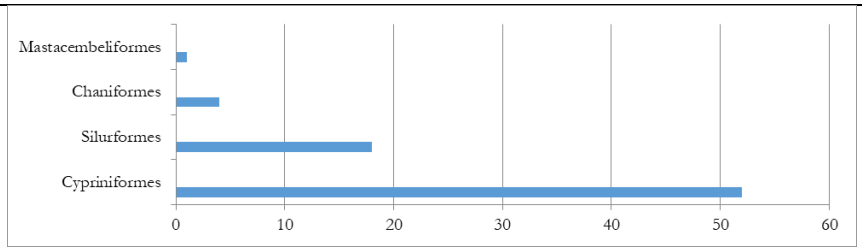

Figure 3: Abundance of different fish orders in River Kabul

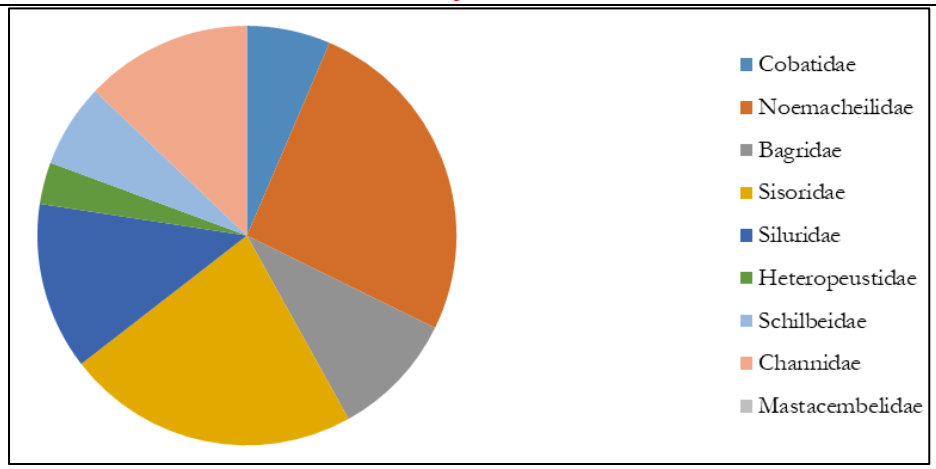

Figure 4: Representation of families of fishes in River Kabul

Table 3: Number of species per Genus

S/No	Genus	No. of species	S/No	Genus	No. of species
1	Chela	01	21.	Ctenopharyngodon	01
2	Salmostoma	02	22.	Hypopthylmichthys	01
3	Aspidoparia	02	23.	Botia	01
4	Barilius	02	24.	Lepidocephalichthys	01
5	Rasbora	01	25.	Acanthocobitis	01
6	Danio	01	26.	Nemacheilus	03
7	Amblypharyngodon	01	27.	Schistura	04
8	Esomus	01	28.	Mystus	02
9	Cirrhinus	02	29.	Rita	01
10	Cyprinion	01	30.	Glyptothorax	05
11	Labeo	06	31.	Gagata	01
12	Barbodes	01	32.	Bagarius	01
13	Osteobrama	01	33.	Ompok	03
14	Puntius	06	34.	Wallago	01
15	Tor	01	35.	Heteropneustes	01
16	Nazirator	01	36.	Clupisoma	01
17	Crossocheilus	01	37.	Channa	04
18	Garra	01	38.	Mastacembelus	01
19	Racoma	01	39.	Pseudeutropius	01
20	Carassius	01			

Table 4: Fish from the River Kabul in Pakistan and Afghanistan are compared.

S/No	*Fish name*	Pakistan	Afghanistan
1.	*Chela cachius*	✓	X
2.	*Salmostoma bacaila*	✓	✓
3.	*Salmostoma punjabensis*	✓	✓
4.	*Aspidoparia jaya*	X	✓
5.	*Aspidoparia morar*	✓	X
6.	*Barilius pakistanicus*	✓	X
7.	*Barilius vagra*	✓	✓
8.	*Danio devario*	✓	✓
9.	*Rasbora daniconius*	✓	X

10.	*Amblypharyngodon mola*	✓	✓
11.	*Esomus danricus*	X	✓
12.	*Cirrhinus reba*	✓	✓
13.	*Cyprinion watsoni*	✓	X
14.	*Labeo dero*	✓	✓
15.	*Puntius sarana (Barbodes)*	✓	X
16.	*Osteobrama cotio*	✓	X
17.	*Puntius chola*	✓	X
18.	*Puntius punjabensis*	✓	X
19.	*Puntius sophore*	✓	✓
20.	*Puntius ticto*	✓	X
21.	*Cirrhinus mrigala*	✓	X
22.	*Puntius conchonicus*	X	✓
23.	*Puntius sarana*	X	✓
24.	*Labeo angra*	X	✓
25.	*Labeo diplostomus*	X	✓
26.	*Labeo dycheilus*	X	✓
27.	*Labeo gonius*	X	✓
28.	*Labeo pangusia*	X	✓
29.	*Tor putitora*	✓	✓
30.	*Nazirator zhobensis*	✓	X
31.	*Crossocheilus diplochilus*	✓	X
32.	*Garra gotyla*	✓	X
33.	*Racoma labiate*	✓	X
34.	*Schizothorax plagiostomus*	✓	X
35.	*Schizothorax barbatus*	X	✓
36.	*Schizothorax chryschlora*	X	✓
37.	*Schizothorax edenaina*	X	✓
38.	*Schizothorax esocinus*	X	✓
39.	*Schizothorax labiatus*	X	✓
40.	*Cyprinus carpio*	X	✓
41.	*Carassius auratus*	X	✓
42.	*Ctenopharyngodon idella*	X	✓
43.	*Hypopthylmichthys molitrix*	X	✓
44.	*Botia birdi*	✓	X
45.	*Lepidocephalichthys guntea*	✓	X
46.	*Acanthocobitis botia*	✓	X
47.	*Nemacheilus corica*	✓	X
48.	*Schistura alepidota*	✓	X
49.	*Schistura microlabra*	✓	X
50.	*Nemacheilussargadenesis (Schistura)*	X	✓

51.	*Triplophysa brahui*	X	✓
52.	*Schistura paludani*	X	✓
53.	*Nemacheilus griffithi (Triplophysa),*	X	✓
54.	*Mystus bleekeri*	✓	X
55.	*Mystus cavasius*	✓	X
56.	*Rita rita*	X	✓
57.	*Glyptothorax jalalensis*	X	✓
58.	*Glyptothorax cavia*	✓	X
59.	*Glyptothorax naziri*	✓	X
60.	*Glyptothorax punjabensis*	✓	X
61.	*Glyptothorax stocki*	✓	X
62.	*Bagarius bagarius*	X	✓
63.	*Gagata cenia*	X	✓
64.	*Ompok bimaculatus*	✓	X
65.	*Ompok pabda*	✓	✓
66.	*Wallago attu*	✓	X
67.	*Ompok canio*	X	✓
68.	*Heteropneustes fossilis*	✓	X
69.	*Clupisoma naziri*	✓	X
70.	*Pseudeutropius atherinoides*	✓	X
71.	*Channa marulius*	✓	X
72.	*Channa punctata*	✓	✓
73.	*Channa striata*	✓	X
74.	*Channa gachua*	✓	✓
75.	*Mastacembelus armatus*	✓	X

Table 5: Economically significant River Kabul's major edible fish fauna

S/No	***Fish Name***
1	*Labeo diplostomus*
2	*Wallago attu*
3	*Cirrhinus mrigala*
4	*Heteropneustes fossilis*
5	*Tor putitora*
6	*Schizothorax esocinus*
7	*Bagarius bagarius*
8	*Racoma labiates*
9	*Cyprinus carpio*
10	*Ctenopharyngodon idella*
11	*Clupisoma naziri*
12	*Clupisoma garua*
13	*Channa species*
14	*Schizothorax species*
15	*Hypopthylmichthys molitrix*
16	*Mastacembelus armatus*

Table 6: Number of edible fish in River Kabul.

S/No	*Fish Name*
1	*Baraline spp.*
2	*Crossocheilus diplochilus*
3	*Garra gotyla*
4	*Carassius auratus*
5	*Glyptothorax punjabensis*
6	*Barilius vagra*
7	*Barilius pakistanicus*
8	*Glyptothorax cavia*
9	*Glyptothorax naziri*
10	*Aspidoparia morar*
11	*Aspidoparia jaya*
12	*Mystus bleekeri*
13	*Xenentodon cancila*

Table 7: Biodiversity Indices for Different Sections of the Kabul River

Section	Shannon-Wiener Index (H')	Simpson Index (D)	Simpson's Reciprocal Index
Section 1	1.083	0.342	2.924
Section 2	1.185	0.346	2.891
Section 3	1.276	0.308	3.247

Table 7 shows the calculated Shannon-Wiener Index (H'), Simpson Index (D), and Simpson's Reciprocal Index for each section of the Kabul River. Section 3 demonstrates the highest biodiversity across all indices, while Section 1 has the lowest Shannon-Wiener Index and Section 2 has the highest Simpson Index.

The study documented a total of 75 species across 39 genera and 10 families belonging to various fish orders in the River Kabul and its tributaries. The Cypriniformes order was the most dominant, comprising 69.33% of the total species, while Siluriformes accounted for 24% and other orders like Channiformes and Mastacembeliformes were represented in smaller proportions. In terms of species richness, the family Cyprinidae was the most diverse, representing over 50% of the species identified in the river system.

A comparative analysis between Pakistan and Afghanistan revealed that certain species, such as *Salmostoma bacaila* and *Schizothorax plagiostomus*, were common to both regions, while others like Chela cachius and Barilius pakistanicus were exclusively found in Pakistan. Conversely, species like Aspidoparia jaya and Schizothorax barbatus were unique to Afghanistan.

In addition, 16 species were identified as economically significant, particularly those contributing to local fisheries and providing food security. Notable species include Labeo diplostomus, Wallago attu, Cirrhinus mrigala, and Tor putitora, which are highly valued for their commercial and nutritional importance.

Discussion:

The Kabul River is a vital watercourse traversing both Afghanistan and Khyber Pakhtunkhwa (Pakistan), which originates in the Sanglakh Range, it travels approximately 700 km to its confluence with the Indus River at Attock. The river experiences a broad spectrum of temperatures, ranging from below freezing to 35°C, with an average temperature of around 25°C. Its geography is equally diverse, spanning high mountains, hilly sections, and plains. From the chilly, high-altitude portions of Afghanistan to the milder, lower-altitude sections of Pakistan, the River Kabul travels through a variety of weather zones. Numerous fish species are supported by the diverse environments that these variances provide. With mean July

temperatures of about 25°C and January temperatures of 0°C, the higher parts experience a continentally warm summer climate. This range of temperatures and habitat types supports species that are acclimated to both warm and cold waters, adding to the river's vast richness of fish.

This diverse topographical and environmental landscape supports a variety of wildlife, including 75 fish species. Of these, 48 species are found in Khyber Pakhtunkhwa (Pakistan) and 27 in Afghanistan. Overall, 95 fish species have been identified in Khyber Pakhtunkhwa [9][8], with 50.52% present in the Kabul River. Comparatively, 179 fish species were recorded in Pakistan by [14] and 195 by [15]. Thus, the Kabul River houses roughly 38.46% of Pakistan's total fish diversity. Since McClelland's initial report in 1842, extensive efforts have been made to document the fish fauna of the Kabul River. This review compares the fish species of the Kabul River between Pakistan and Afghanistan. Fish described from the Kabul River in Afghanistan include *Amblypharyngodon mola, Aspidoparia jaya, Carassius auratus*, and several others.

Certain fish species are found in both regions, such as *Salmostoma bacaila, Barilius vagra*, and *Channa punctata*, due to similar climatic and topographical conditions. The Afghan portion of the river, with its colder environment, contrasts with the warmer waters in Pakistan, accounting for the differences in fish fauna. The study identified 39 genera, four orders, ten families, and 75 species in the river. The order Siluriformes is the largest group, representing 50% of the fish families, while Cypriniformes is the most numerous in species, comprising 69.33% of the total. This distribution aligns with findings across the Indian subcontinent [16] [17][1]. Mastacembeliformes is the least common order, represented by only one species. Cypriniformes and Siluriformes each account for 40% of the river's family diversity, while Channiformes and Mastacembeliformes. each represent 2.56%. The diversity of Siluriformes and Cypriniformes, is due to the presence of carnivorous catfish in cold waters and herbivorous fishes in warm waters.

The study also noted that most genera (69.23%) are monospecific, with Puntius and Labeo having the maximum number of species six each. The classification of *Nemacheilus griffithi* and *Nemacheilus sargadenesis* varies among scientists, with some placing them in the genus Triplophysa and Schistura, respectively. Although *Xenentodon cancila* has not been documented in published literature, unpublished data from the University of Peshawar suggests its presence in the Kabul River. Similarly, Barbodes sarana's identification is debated, with some researchers considering it a synonym of Puntius. Fish are nutritionally and medicinally beneficial, with high digestibility and protein content. Although some species are not commonly consumed due to their small size, they play a crucial role in the river's ecosystem. Additionally, ornamental fish species from genera such as Chela, Salmostoma, and Puntius hold potential for economic development if cultivated for the aquarium trade. The global ornamental fish industry, comprising approximately 4,500 freshwater and 1,450 marine species, represents a significant market with promising opportunities in Pakistan [18] [19].

Floods have a profound impact on aquatic ecosystems, as demonstrated by the extensive damage caused by the 2010 flood of the Kabul River in Khyber Pakhtunkhwa. While the flood likely disrupted the river's fish populations, data indicate that these populations gradually stabilized over time [20]. Pollution also affects fish diversity, with lower diversity observed in polluted areas. Industrial activities may contribute to low water pH, necessitating governmental action to reduce pollution and protect the fish habitat [20]. Overfishing and illegal fishing techniques further stress fish populations. One of the main sources of pollution is waste from industrial areas like Peshawar, Rashakai, and Swabi.Urban Runoff: Urban waste finds its way into rivers through drains such as the Shahi Katha, the Hazar Khawani, and the Kalapani drain in Mardan. Agricultural Runoff: Fertilizers and pesticides from farming operations further add to the pollution of the river. The ecology of the river is greatly impacted by industrial zones' waste management techniques. When industrial effluents are let into rivers untreated or only

partially treated, it can result in Reduced pH and water quality, which have an impact on fish health and biodiversity, which is known as water pollution. Fish find it more difficult to live and procreate when natural habitats are destroyed, a phenomenon known as habitat degradation.

To address these issues, several management and conservation recommendations are proposed: Implementation of strict laws into place and upgrading waste disposal infrastructure in industrial areas. Upholding current environmental regulations to stop overfishing and unlawful discharges. Spreading knowledge about the value of protecting the river's ecosystem among the nearby communities. Establish facilities for the artificial reproduction of native fish species, monitor water quality, and employ molecular techniques for species identification.

Instances of Effective Strategies:

The Ganga Action Plan sought to lower pollution levels by enhancing waste management and launching public awareness initiatives. Projects to restore habitat and enhance water quality and biodiversity were implemented, along with changes to water management. The River Kabul has significant economic potential due to its diverse fish species, many of which are large and edible. This potential can be harnessed through Promoting sustainable fishing practices and developing aquaculture can boost local economies. Developing eco-tourism around the river can provide additional income for local communities. Cultivating ornamental fish species for the aquarium trade can create new economic opportunities.

Approximately 27% of the fish species in the river are large and edible, underscoring their economic significance. The river is vital for irrigation, household use, and fishing, all of which are essential for the livelihoods of local communities. Properly managing these resources and economic opportunities can greatly boost the local economy while preserving the river's biodiversity. By implementing effective strategies, it is possible to enhance the economic well-being of the local population while ensuring the sustainability of the river's ecosystem.

Conclusion:

The scientific exploration of the fish species in the River Kabul, initiated by McClelland in 1842, has revealed a rich and diverse ichthyofauna. With a total of seventy-five fish species described across four orders, ten families, and thirty-nine genera, the River Kabul's aquatic life showcases a significant diversity, primarily dominated by the Cypriniformes order and Cyprinidae family. Notably, 27% of these species are large and edible, underscoring the river's substantial economic potential for the region.

Despite this diversity and economic value, the river faces critical challenges due to pollution from industrial activities and anthropogenic settlements. These threats jeopardize the health of the aquatic ecosystem and the livelihoods dependent on it. To ensure the preservation of the fish species and the sustainability of the river's resources, it is essential to implement effective management strategies, enforce environmental regulations, and engage in public education. Addressing these issues proactively will not only protect the river's biodiversity but also enhance the economic benefits derived from its aquatic life.

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References:

[1] M. V. Nelson, J. S., Grande, T. C., Wilson, "Fishes of the World. John Wiley & Sons", [Online]. Available: https://www.crossref.org/metadatamanager/publications/10.33411%2Fijist/addarticle

[2] D. Dudgeon et al., "Freshwater biodiversity: importance, threats, status and conservation

challenges," Biol. Rev., vol. 81, no. 2, pp. 163–182, May 2006, doi: 10.1017/S1464793105006950.

[3] B. Collen et al., "Global patterns of freshwater species diversity, threat and endemism," Glob. Ecol. Biogeogr., vol. 23, no. 1, pp. 40–51, Jan. 2014, doi: 10.1111/GEB.12096/SUPPINFO.

[4] S. E. Shinde, T. S. Pathan, R. Y. Bhandare, and D. L. Sonawane, "Ichthyofaunal Diversity of Harsool Savangi Dam, District Aurangabad, (M.S.) India," World J. Fish Mar. Sci., vol. 1, no. 3, pp. 141–143, 2009.

[5] MEA, "Millennium Ecosystem Assessment; Ecosystem and Human Well-being: Biodiversity Synthesis," World Resour. Institute, Washington, DC, [Online]. Available: https://www.millenniumassessment.org/documents/document.354.aspx.pdf

[6] S. L. Hora, "Fish of Afghanistan," J.Bombay Nat. Hist. Soc..

[7] C. BW., "Fishes of Afghanistan, an annotated check-list. Publications in Zoology," Natl. Museum Canada, Ottawa 1981; 2614..

[8] J. . M. M. Butt, J. Butt, and M. Mirza, "Fishes of the Vale of Peshawar, North-west Frontier Province, Pakistan," Biol. Lahore, vol. 27, no. 2, pp. 145–163, Jan. 1981, doi: 10.0/FONT/BOOTSTRAP-ICONS.MIN.CSS.

[9] J. A. Butt, "Fishes and Fisheries of North-West Frontier Province, Pakistan," Biol. (Special Suppl., 1986.

[10] "Fish diversity and distribution in Indus River and its drainage system | Request PDF." Accessed: Aug. 31, 2024. [Online]. Available: https://www.researchgate.net/publication/291778987_Fish_diversity_and_distribution_in_Indus_River_and_its_drainage_system

[11] R. Hayat Khattak, F. Aziz, and F. Zaidi, "Ichthyofauna of river Kabul at Nowshera, Khyber Pakhtunkhwa, Pakistan," ~ 57 ~ Int. J. Fauna Biol. Stud., vol. 2, no. 2, pp. 57–61, 2015.

[12] "Ichthyofaunistic study of river Kabul at Michini, Khyber Pakhtunkhwa, Pakistan." Accessed: Aug. 31, 2024. [Online]. Available: https://www.researchgate.net/publication/282344831_Ichthyofaunistic_study_of_river_Kabul_at_Michini_Khyber_Pakhtunkhwa_Pakistan

[13] K. Saeed et al., "Fish fauna of River Kabul Downstraeam Warsak Dam," J. Entomol. Zool. Stud., vol. 5, no. 1, pp. 546–548, 2016, Accessed: Aug. 31, 2024. [Online]. Available: https://www.researchgate.net/publication/373272843

[14] B. M. Mirza MR, "Biodiversity of the freshwater fishes of Pakistan and Azad Kashmir. In: Proceedings of Sem Aquatic Biodiversity of Pakistan. In: Proceedings of Sem Aquatic Biodiversity of Pakistan. 136-144, Pakistan," 1999.

[15] H. Sandhu, "Theory and practice of ecosystem functions and management.," Ecosyst. Funct. Manag. Theory Pract., pp. 3–16, 2017.

[16] "9788185375120 | Natural History of Fishes and Systematic of Freshwater Fishes of India | DattaMunshi, J.S." Accessed: Sep. 03, 2024. [Online]. Available: https://www.nphindia.com/book/9788185375120/natural-history-of-fishes-and-systematic-of-freshwater-fishes-of-india

[17] "Inland fishes of lndia and adjacent countries." Accessed: Aug. 31, 2024. [Online]. Available: https://www.scirp.org/reference/referencespapers?referenceid=1827383

[18] M. Arshad-Ul-Alam and M. A. Azadi, "Fisheries exploitation of the Halda River, Bangladesh," J. Fish., vol. 4, no. 1, pp. 361–370, Apr. 2016, doi: 10.17017/J.FISH.114.

[19] M. Ahmad, A. Hussain Shah, Z. Maqbool, A. Khalid, K. Rasheed Khan, and M. Farooq, "Ichthyofaunal diversity and conservation status in rivers of Khyber Pakhtunkhwa, Pakistan," Proc. Int. Acad. Ecol. Environ. Sci., vol. 2020, no. 4, pp. 131–143, Accessed: Aug. 31, 2024. [Online]. Available: www.iaees.orgArticle

[20] M. Khan, M., Rehman, W. U., Afroz, S., Shamim, Z., Naee, "Ichthyofaunal Diversity of River," Stud. 7, 8., 2020.