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Anthropogenic factors and their effects on the fish fauna of the Lidder River in Pahalgam, Anantnag district (Jammu and Kashmir)

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Abstract
The pristine Ichthyofauna of the Kashmir Himalaya is declining for a variety of reasons. Impurities in water bodies are currently causing instability, injury, or pain to both the physical systems and living organisms that occupy the environment. This study focuses on the elements that contribute to the declination of fish fauna in the Lidder River, a tributary of the Jhelum River. Fish species are not only resilient to highly polluted waterways, but they also exhibit a devastating spectrum of physical malformations that appear to reflect the extent of water pollution. Over the course of a year, three sites were focused on and analysed to emphasise the research problem. Water quality was shown to be degraded from June to September, which coincided with peak tourist season and agricultural and horticultural activity. Furthermore, the widespread use of fertilisers and pesticides devastates fish habitats, interfering with natural fish growth. Municipal sewage, home sewage, and hotel effluent all contribute to eutrophication and heavy metal bioaccumulation in fish bodies. In addition to the foregoing, the severe methods employed for illegal fishing devastate Lidder's biological status on a wide scale.

Keywords: River Lidder, heavy metals, biodiversity, fish species

Introduction
River Lidder is a prestigious and cold-water river that flows through many villages and towns and originates from the Kolhai glacier. It acts as a drinking water source, is useful for agricultural irrigation, and is home to important aquatic fauna, especially different types of fish. It also serves as the source of employment for the downtrodden section of society, especially the fishermen's community. Both exotic and indigenous fishes such as *Salmo trutta fario, Schizothorax plagiostomus*, *S. labiatus, S. esocinus, Glyptosternum reticulatum, Crossocheilus diplochilus,* and *Triplophysa kashmirensis* are found in river Lidder. In snowtrouts, *S. plagiostomus* is found in large number followed by *S. labiatus* and *S. esocinus* (Bhat *et al*., 2010) [1].

Schizothorax, the dominant group of fishes in Pahalgam Kashmir, has been declining rapidly over the last 3-4 decades due to a variety of factors such as overexploitation, habitat destruction, aside from their specific genetic reasons, and irresponsible, indiscriminate anthropogenic activities. Anthropogenic factors, such as the indiscriminate discharge of industrial effluents and municipal sewage, degrade water quality and lead to the extinction of Ichthyofauna. These factors can alter water quality and affect fish populations. The fish fauna is suffering significantly since habitat is being lost at an alarming rate.

Unfortunately, no comprehensive scientific work, to date, is available about the water quality, sources of pollutants and their impacts on the distribution of fish. The main aim of the present study is to highlight various anthropogenic activities that cause interference with the ecological and biological integrity of aquatic bodies and the impact of anthropogenic actions on the Ichthyo fauna of the Lidder River.

Materials and Methods
The current study is based on regular and repeated surveys conducted between 2019 and 2020. The Lidder River was chosen because it passes through the scenic town of Pahalgam and is a significant tributary of the Jhelum River, which is seriously obstructed by anthropogenic activities.

A preliminary survey of the Lidder River was done to collect information about human impacts on aquatic life. Following the preliminary survey, three sites were chosen for the survey. Each site was chosen based on anthropogenic activities in the catchment region, changes in habitat, the presence or lack of fish species, and the accessibility of the sites. Each location is described briefly below:

Mattan (Site 1)
It is a town and notified area committee in Anantnag district in the Indian territory of Jammu and Kashmir. The Lidder River in this region has less volume of water than the river's upstream regions. This is due to the fact that a bulk of the water is drawn from rivers for drinking and irrigating agricultural lands. This site is densely populated.

Pahalgam (Site 2)
It is a hill station in the north Indian state of Jammu and Kashmir associated with the Amarnath Yatra, an annual pilgrimage to the shrine. Every year, thousands of tourists visit this natural site. Numerous hotels and high tourist pressure on this site are major factors causing pollution in the river**.**

Aru (Site3)
Aru Valley is a popular tourist destination in Jammu and Kashmir, located in the Anantnag district about 12 kilometres from Pahalgam. Tourists are attracted to it because of its lush meadows, pristine lakes, and mountains.

Fig 1: Map showing the catchment areas of river Lidder (Source: Google map)

Sampling and surveys are typically conducted in the morning at 10:00 a.m. and continue into the evening until 4:00 p.m. Every day, one survey location was considered, and the entire survey schedule lasted one week. All samplings were done during sunny days when the stream flow was at a normal level. Periodic surveys, one-on-one interviews, and sampling were done at each site to gather seasonal data. Fish sampling was done prior to and during western disturbances, while other surveys were conducted during the rainy season (July), before the rainy season (April–May), and after the rainy season (September–October). With the aid of fishermen, a few fish samples were captured and sent for identification. Simple nets were used, and no river species were harmed in the process.
In order to describe the study site and highlight the worst impacts of human involvement on the fish population, photography was also used. A series of questionnaires were administered to residents of the selected places in addition to the self-analysis during numerous surveys to collect the primary data about the statement problem.

Results and Discussion
The catchment region of the river Lidder is severely degrading as a result of anthropogenic activity. Upstream of Lidder, which is located around 15 kilometres above the Chandanwari, the water quality was comparatively excellent. The upstream portion, which gets contaminants from agricultural runoff, was least affected by point sources. As streams travelled through several towns like Pahalgam, Akkad, Ashmukam, Sallar, Mattan, etc., where they picked up contaminants from numerous point sources, the water quality of the midstream and downstream parts deteriorated. Due to sedimentation and dilution causes, the water quality at mid-stream locations was severely damaged but improved as it went downstream. Domestic sewage, municipal sewage, and surface runoff in the watershed of downstream villages showed a declining trend of soluble oxygen from upstream to mid-stream near Pahalgam, with a gradual improvement in far downstream areas (Khandi & Srivastava, 2016) [2].
The findings emphasise the temporal variability of many contaminants. Because of surface runoff, non-point source pollutants were most concentrated during the rainy season, whereas point source pollutants were most concentrated when the stream flow was lowest. Seasonal variations in pollution concentrations may be caused by changes in river discharge levels. Throughout the rainy season, the effect of sewage is diluted due to a high discharge level, whereas during the winter and early summer, the effect of effluent is amplified due to an extremely low discharge level. Despite the fact that the number of effluents in the catchment area remains consistent throughout the year, pollutant concentrations are often higher during periods of low stream flow.

Table 1: Origin and usage of different pollutants in the Lidder area

Pollutant	Origin	Domestic usage	Surface runoff	Commercial effluent
Hydrocarbons	Fuel	+++	++	+
Halogens	Plastics	+++	++	+++
Pesticides	Agricultural products	+	++	+++
Soaps and detergents	Domestic sewage and hotel waste	+++	+++	++
Heavy metals	Domestic sewage and Hotel waste	++	++	+
Chlorophenols and chlorobenzenes	Agricultural sprays and fertilizers	+++	+++	+

+++: - very likely, ++: - likely, +: - likely

Data was collected from residents of the Lidder River catchment areas through multiple surveys and fish samplings. Water quality deteriorated from June to August, which coincided with peak tourist traffic and agricultural and horticultural activity (Rashid & Romshoo, 2013) [3]. Domestic sewage, tourism, municipal sewage, hotel discharge, and illegal fishing are the primary factors responsible for the Lidder's degraded ecological state. This also leads to eutrophication and the bioaccumulation of heavy metals in the bodies of fish, and most of the fish species cannot tolerate the low concentration of dissolved oxygen and the high level of COD and heavy metals in stream water. From the secondary sources, we came to know that from 1992 to 2005, there was a change in the conversion of land use from agriculture to orchards in the Lidder region of Pahalgam. Without a doubt, the agricultural area has been reduced as a result of this, but the use of large quantities of fertiliser in the past has caused extensive devastation in the Lidder and its ecology, which has had an impact on the present.

The massive river flows through the gorge at high speed in the upper reaches (Site 3) and with greater depth than downstream (Sites 1 and 2), where the speed and depth are low. Water is diverted downstream of the river through various channels for irrigation, drinking, and other domestic and commercial uses, reducing the river's quantity, flow, and depth. This substantial difference in river characteristics upstream and downstream was found to be responsible for fish distribution and assemblages. In upstream, the number of fish (specimens and species) was less, but the specimens were heavier and older, whereas the trend was reversed in downstream, where only the smaller-sized and more species were present.

Only three Schizothoracines were discovered among the various *Schizothorax* species found in Kashmir Valley. *Schizothorax plagiostomus*, *S. esocinus* and *S. labiatus* were reported in the Lidder River along with *Salmo trutta fario*, *Glyptosternum reticulatum*, *Crossocheilus diplochilus* and *Triplophysa kashmirensis*. The distribution and contribution of these fishes at different sites vary temporally (Table 2). The upper region of the river, where trout were recorded, can be regarded as a trout zone, while downstream, due to the presence of species like *T. kashmirensis*, *C. diplochilus*, *S. labiatus* and *S. esocinus*, can be regarded as carp zone. The presence of smaller-sized fish (fry and fingerlings) in the downstream and midstream has been linked to Schizothoracine feeding and breeding grounds.

Due to its preference for swift, cold water *S. plagiostomus* is most prevalent along the length of the Lidder River, though this fish is present at all depths and velocities (Yousuf, 1996) [4]. Although *S. esocinus* came in second and *S. labiatus* third, the two species were only seen at site 3 during the winter when the current was weak, although they were prevalent further downstream all year long.

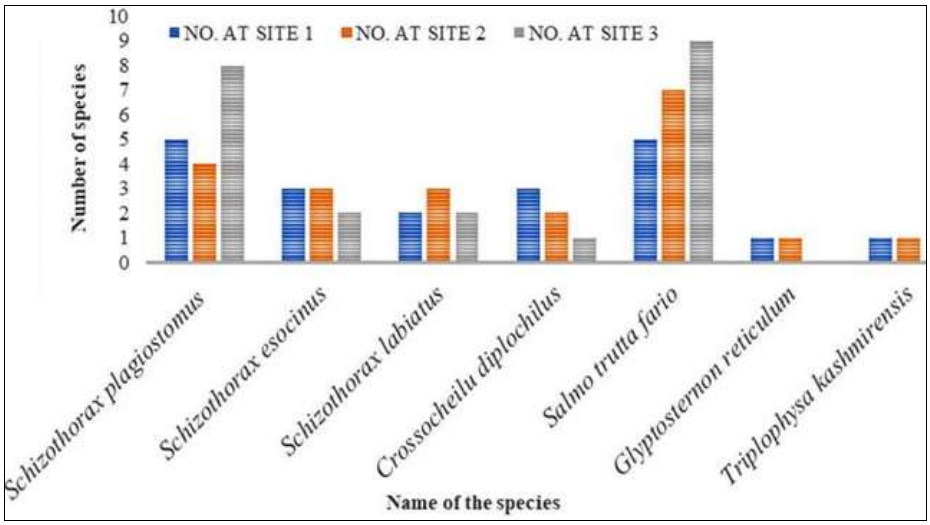

Fig 2: Types and number of fishes found at study sites in river Lidder (Pahalgam)

The upstream fish assemblage was comparatively stable in different seasons under natural conditions but the stream segment does not support the fish life due to anthropogenic activity, which degraded the quality of surface water. As the river traverses through Pahalgam, it receives a large volume of domestic waste (Especially from hotels) and municipal sewage, resulting in the deterioration of water quality, which has seriously decreased the fish population as shown in Figure 1. Many physiological processes can be disrupted in a contaminated river, which always doesn't result in mortality. Contaminated water causes morphological deformities in fish, causing damage to their liver, gills, fins, skin, and kidneys.

Furthermore, human activities disturb fish breeding and spawning locations, either directly or indirectly.

In addition to the facts regarding anthropogenic actions mentioned above, the results show that the fish population is falling at an alarming rate due to the increased greed of the human race. Illegal fishing and poor fishing methods have jeopardised the ecology of the river, affecting the overall ecological balance of nature. Ignorant people using chemical sprays to capture fish in the river for their huge advantage cause a massive loss in the present and future. This procedure kills a large number of fish, as well as some brood stock. This type of fish catching not only kills a few fish or a single brood stock member, but also millions of seeds present in them, effectively reducing the fish population on a vast scale.

To manage the river's fisheries, particularly Schizothoracine fishes, prompt actions must be taken to restrict the input of sewage, agricultural waste, and home effluents.

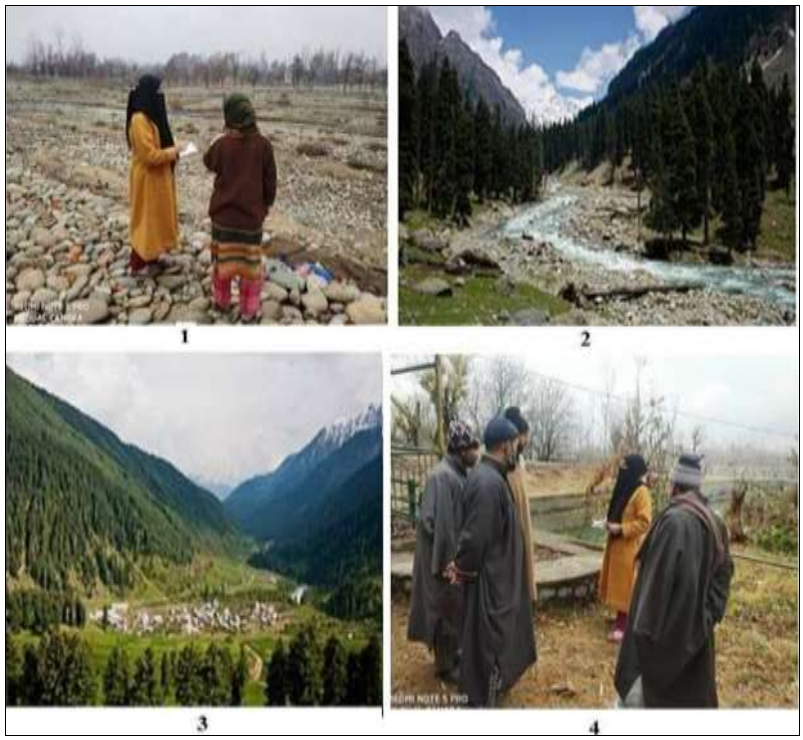

Plate 1-4: 1. Mattan site; 2. Pahalgam site; 3. Aru site; 4. Interviewing people in the catchment of Lidder river

Plate 5-8: 5. Discharge of domestic sewage in Lidder; 6. Guage and water discharge from river; 7. Algal bloom in the river; 8. Plastic and cow dung on the bank of river

Conclusion

An important survey was conducted to find out the effect of anthropogenic activity on the water of Lidder River and their result on the fauna of fish living in that river. The result of the survey shows that the ecology of the river is changing and adversely affecting the distribution of aquatic fauna, especially fish. Urbanization, uncontrolled tourism, and excessive construction of hotels in the catchment of the study area had a negative impact on fish assemblage and diversity. The fish population of the Lidder is reducing day by day at an alarming rate especially the most valuable and delicious endemic species of *Schizothorax*. The people need to highlight the issue that destroys their nature and natural resources and ultimately bring a change in response towards their environment.

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