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Assessment of the Effects of Water Pollution on Aquatic Insect Fauna in Bareilly and Budaun Districts, Uttar Pradesh

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Abstract:
The problem of water pollution is common for the Rohilkhand division of the state of Uttar Pradesh; more specifically, water pollution is common in districts such as Bareilly and Budaun where the Ramganga river passes through. This research aims to examine the effect that water pollution has on aquatic insects that play an important role as bioindicator of freshwater ecosystem health. Aquatic insect sampling has been conducted at different sites characterized by different levels of pollution. The study analyzes such physico-chemical characteristics of water as the amount of DO (dissolved oxygen), BOD (biochemical oxygen demand), pH level, TDS (total dissolved solids), and heavy metal concentration in water. The study shows a significant decline in the number of insects from the EPT group (Ephemeroptera, Plecoptera, and Trichoptera). Insects from groups that tolerate pollution such as Diptera and Hemiptera become dominant in contaminated water. An increase in water pollution is associated with industrial discharge, sewage input, and agricultural runoff.
Consequently, insects have lower growth rate and less efficient feeding. The survival rate decreases and causes a sharp decrease in insects' productivity. Furthermore, toxic compounds cause damage to biodiversity in aquatic ecosystems.

Keywords: Water Pollution, insects Growth, Rohilkhand Region, Aquatic Toxicology, Dissolved Oxygen.

INTRODUCTION

The aquatic insects constitute a vital part of freshwater ecosystem communities and have been used extensively as indicators of water quality. In the Rohilkhand area of Uttar Pradesh, specifically in Bareilly and Budaun districts, there are aquatic sites along Ramganga River that are home to many different groups of insects. But the rising pollution levels caused by increasing anthropogenic activities like urbanization and agriculture pollution.
An examination of insect groups at the family level gives better knowledge of ecological conditions because some families are more sensitive to pollution than others.Among these groups, the Dipteran order constitutes a large proportion of insects, such as Chironomidae and Culicidae. Both are tolerant of pollution and occur in stagnant or polluted water. But the families Baetidae and Hydropsychidae, which occur in clear oxygen-filled waters, are sensitive to pollution and thus rare in polluted sites.
Some moderate-tolerant families such as Gerridae, Nepidae, and Libellulidae can be found in slightly polluted areas, as well as clear waters. Other beetle families such as Dytiscidae and Hydrophilidae are also common in slow-moving or pond waters.

MATERIALS & METHODS

The experiment was carried out in select areas of the Rohilkhand to examine the effect of water pollution on insect growth and survival. A structured methodology was followed to ensure accuracy of data.

1. Step 1 - Water Sampling

Water samples were collected from select freshwater sources in the Bareilly district of Uttar Pradesh in India, which includes sections of the Ramganga River and its tributaries. The sampling points were classified as upstream (least contaminated), mid-stream (medium contamination level), and down stream (high contamination level).

Time Frame of Sampling:

Water sampling took place in select periods in 2018, namely, Pre-monsoon (March-May), monsoon (July- September), and Post-Monsoon (October – December) periods.

Water sample Collection:

- Three replicates of surface water samples were collected from each selected point using 1L polyethylene bottles that had been cleaned previously.
- The polyethylene bottles were rinsed thrice with water from each location before collecting the sample.
- The water sample was collected at a depth of around 30 cm below the water surface.

In-Situ Measurements:

The following were the critical parameters that were measured on-site using hand-held measuring devices:

- pH – digital pH meter
- Temperature – thermometer
- Dissolved Oxygen (DO) – DO meter

Electrical Conductivity (EC)/Total Dissolved Solids (TDS) – conductivity meter.

Water samples were obtained from three chosen sites representing freshwater bodies in Budaun district, Uttar Pradesh, India. The sampling was done at three sites with varying degrees of pollution:

- Site 1 – Upstream/ less polluted: site located either near forest or villages with little human intervention.
- Site 2 – Midstream/Moderately polluted: site close to small cities or agricultural waste.
- Site 3 – Downstream/Highly polluted: Site close to big cities or industrial areas.

Sampling Period:

Water sampling was performed thrice in 2020, which was pre-monsoon, monsoon, and post-monsoon periods as follows:

Collection of Water Samples:

Three surface water samples from each sampling point at each sampling event were collected in pre-rinsed 1-L polyethylene bottles.

- The bottle was rinsed with site water thrice prior to the actual sample collection.
- Water samples were collected about 30 cm below the water surface.

In-Situ Determinations:

Determined on-site through portable instruments:

- pH - digital pH meter
- temperature – thermometer
- dissolved oxygen (DO) – DO meter
- conductivity/total dissolved solids (TDS) – conductivity meter

GEOGRAPHICAL FOCUS

STUDY AREA: - The current study was undertaken on the selected freshwater bodies of Bareilly and Budaun districts located in the Rohilkhand region of Uttar Pradesh, India. The region has a subtropical climate with well-defined summer, monsoon, and winter seasons. Aquatic habitats comprise of ponds, lakes, canals, wetlands, and rivers of the Ramganga River basin.

Freshwater bodies studied in the Bareilly district included sections of the Ramganga River along the city of Bareilly, Nakatiya River, Pilibhit bypass drainage channel, and village ponds near Fatehganj and

Bhojipura villages. Urban drainages and canal system receiving domestic and municipal sewage were also included in the study.

Wetlands, irrigated channels, and small streams located near Ujhani, Dataganj, Bilsi, Sahaswan villages, and connected with the cultivated agricultural fields were among those freshwater bodies that have been selected in the Budaun district.

The Bareilly district has witnessed the increased trend in terms of urbanization and industries with associated discharge, whereas the Budaun district is an agricultural district having excessive use of fertilizer and pesticides in farming. Both the districts are subject to the pollution from municipal, domestic, and agricultural effluents.

Hydrographic Features

Both districts have well-established freshwater systems that are highly dependent on monsoon rainfall, agricultural irrigation, and drainage systems. The freshwater systems are known to host diverse aquatic insect communities and play an important part in keeping the ecological balance of the regions intact.

Ramganga River

This is the main river of the Bareilly district that passes into Budaun and other adjoining regions of the Rohilkhand area. Some of the important stretches of this river located close to Bareilly town, Fatehganj, Bhojipura, and further downstream towards Ujhani suffer heavy contamination due to human waste disposal, urban runoff, and industrial effluents. Yet, the river serves as an important aquatic habitat for insects despite habitat degradation brought about by the pollutants.

Canals and Tributaries

The presence of canals and their tributaries originating from Madhya Ganga Canal System have been found in the districts under consideration. The major canals and tributaries like Dataganj, Bilsi, Faridpur, Sahaswan, etc., in the region provide water for irrigation and habitats for aquatic insects. The water bodies thus get polluted due to agricultural runoff and agrochemicals.

Ponds and Seasonal Water Bodies

Apart from the canals, the area is rich in village ponds, marshes, wetlands, and seasonal water bodies. The ponds near Kunwarpur, Wazirganj, and Ujhani villages, etc., are often used for irrigating, domestic activities, rearing animals, and growing fish. The monsoonal season brings many pools, wetlands, and ponds in the region where many species of larvae of aquatic insects like Diptera and Odonata live and develop.

Sampling Sites (Map Description)

For the current study, certain sites have been chosen for the purpose of studying the impact of water pollution on aquatic insect fauna. The sites selected had different levels of anthropogenic impact and pollution load.

District Bareilly

• Location A (Upstream/ Low Pollution):

A location situated close to rural and forest parts of the Ramganga River with little or no human activity.

• Location B (Midstream/Moderate Pollution):

A location situated at the periphery of Bareilly city, where the river along with other associated water bodies is partially affected by urban runoff and domestic waste.

• Location C (Downstream/High Pollution):

A location situated downstream of Bareilly city, near discharge locations, showing high degree of pollution due to industrial discharge and sewerage discharge.

District Budaun

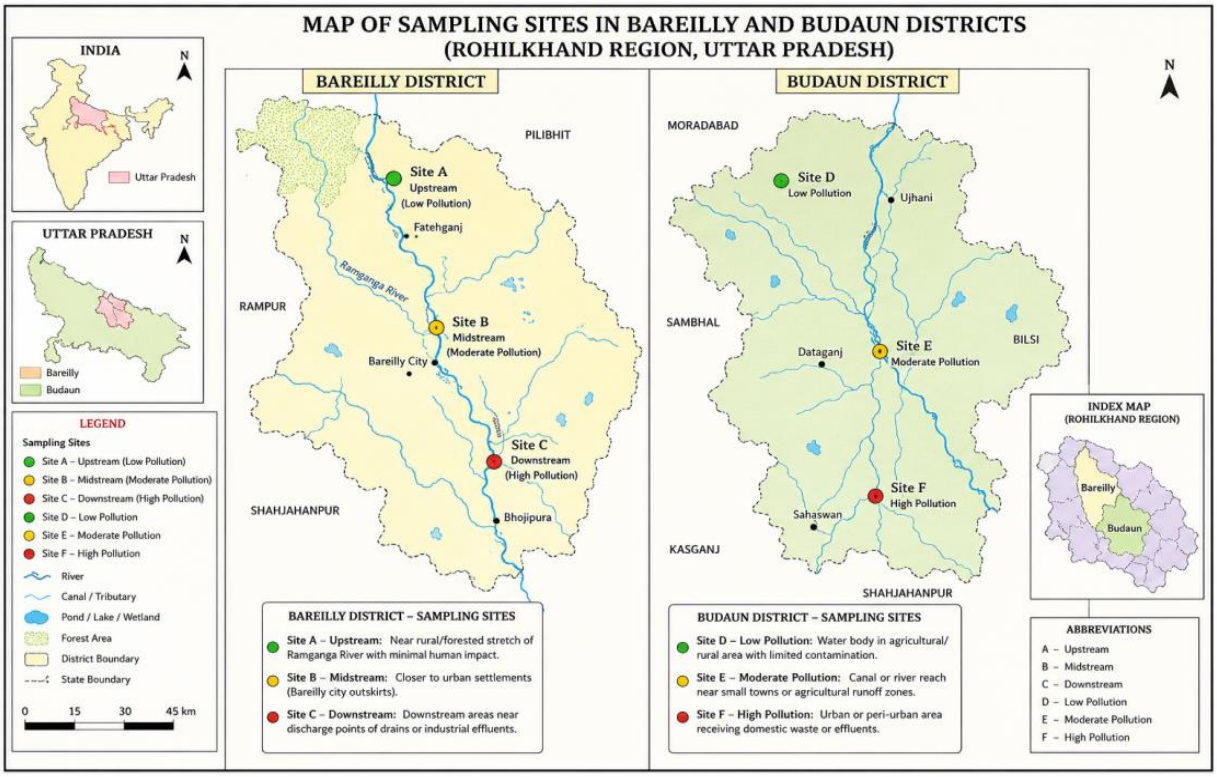
• Location D (Low Pollution):

Freshwater ecosystems that are not contaminated, such as water bodies in rural and agricultural areas.

• Location E (Moderate Pollution):

Ecosystems of rivers/canals in proximity to small towns and agricultural farms that show fertilizer runoff and domestic waste.

• Location F (High Pollution):
Water bodies in peri-urban or urban areas that receive untreated domestic waste and solid waste and other anthropogenic effluents.
These classified locations enabled the analysis of the impact of pollution on aquatic insect diversity.



RESULT AND DISCUSSION

1. Structure of Aquatic Insects' Communities

During the survey conducted in 2018 to identify the aquatic insect fauna in Bareilly and Budaun districts, it was observed that there existed an appreciable variation in terms of community structure along the pollution gradient, from upstream to midstream and then downstream.

Table: Interpretation of Response of Aquatic Insects (2018) Orders of Aquatic Insects in Bareilly and Budaun Districts (Rohilkhand Region, 2018)

Order	Representative Families	Typical Habitat	Pollution Sensitivity	Observed Abundance – Bareilly	Observed Abundance – Budaun	Remarks
Ephemeroptera (Mayflies)	Baetidae, Heptageniidae	Clean, fast-flowing streams and river stretches with rocky substrate	High (Sensitive)	Moderate in upstream Ramganga; very low in midstream and downstream polluted sites	Very low; restricted to less disturbed rural streams	Decline clearly indicates deterioration of water quality due to organic pollution
Trichoptera (Caddisflies)	Hydropsychidae, Philopotamidae	Well-oxygenated flowing waters, under stones and vegetation	High (Sensitive)	Low in polluted drains; moderate in cleaner river sections	Rare; found only in least polluted sites	Presence indicates good water quality; absence in polluted areas confirms stress conditions
Diptera (True flies)	Chironomidae, Tipulidae	Stagnant pools, slow-moving drains, polluted waters	Low (Tolerant)	Very high abundance in drains and sewage-affected areas	Very high in agricultural runoff and stagnant waters	Dominant group in polluted habitats; indicates high organic load
Coleoptera (Beetles)	Dytiscidae, Gyrinidae	Ponds, slow-moving waters, vegetated margins	Moderate	Moderate in ponds and slightly polluted waters	Moderate in ponds and canals	Presence reflects moderate pollution tolerance and habitat diversity
Hemiptera (Water bugs)	Corixidae, Notonectidae	Surface of stagnant or slow-moving water bodies	Moderate	Low to moderate in ponds and canals	Low to moderate in agricultural ponds	Occur in semi-polluted conditions; tolerate mild contamination

2. Scientific Explanation on Effects of Parameters of Water Quality on Diversity (2018 Data)

Physico-chemical parameters revealed significant correlation between quality parameters of water and biodiversity of aquatic insects.

- Dissolved Oxygen (DO)- DO levels were in the range of 7.2–8.4 mg/L (upstream) to 4.8–6.1 mg/L (midstream) and further reduced to 2.9–3.8 mg/L (downstream and polluted).

This signifies that oxygen depletion in the water body is because of sewage and organic wastes, resulting in insect diversity loss.

- Biochemical Oxygen Demand (BOD)-BOD showed opposite trends in the water body, being in the range of 1.8–2.5 mg/L (upstream) to 3.6–5.2 mg/L (midstream) and 6.8–9.4 mg/L (downstream).
- The high level of BOD shows heavy organic pollutants in the water body owing to domestic sewage, agricultural and industrial waste.
- Total Dissolved Solids (TDS)- TDS levels gradually increase from 180–260 mg/L (upstream) to 320–480 mg/L (midstream) and 520–780 mg/L (downstream).
- It means that there is heavy accumulation of fertilizer, pesticides, and dissolved material in the water body.
- PH Variation- PH level varies from 6.8–7.4 (upstream) to 7.2–7

3. Ecological Response Pattern

It is observed from the ecological study that there exists a typical pollution gradient response among the group of aquatic insects:

- Upstream (Low Pollution): High DO, BOD/TDS ratio is low, presence of Ephemeroptera and Trichoptera, high biodiversity.
- Midstream (Moderate Pollution): Mixed community structure, reduction in sensitive insects, more tolerant insects.
- Downstream (High Pollution): Low DO, high BOD/TDS, dominance of Chironomidae (Diptera), low diversity.

4. Scientific Explanation for Relationship Between Insects & Water

From both physical and chemical analysis, we find that:

- Low DO + High BOD + High TDS + Alkaline pH → Dominance of tolerant insects (Diptera)
- High DO + Low BOD + Low TDS + Neutral pH → Presence of sensitive insects (Ephemeroptera and Trichoptera).

5. Scientific Conclusion from Results

The data in 2018 clearly reveal the fact that aquatic insects' diversity at Bareilly and Budaun sites is greatly dependent on the conditions of water quality. The low number of sensitive species and higher dominance of tolerant species of Diptera show organic pollution pressure.

Thus, the findings of this study confirm the fact that aquatic insects serve as great bio-indicators for freshwater ecosystems' state.

CONCLUSION

The present study (2018) clearly indicates that water pollution is a major cause of damage to the insect life in the rivers of Bareilly and Budaun Districts of Rohilkhand, Uttar Pradesh. This was clearly observed in terms of the physico-chemical analysis of water qualities like DO (dissolved oxygen), BOD (biochemical oxygen demand), TDS (total dissolved solids), and pH which clearly shows a clear pollution gradient from upstream to downstream. It is evident from this research that there is a change in the population of aquatic insects in polluted waters with respect to those which are less polluted. Specifically, sensitive aquatic insect groups such as Ephemeroptera, Plecoptera, and Trichoptera (EPT group) were found in well-oxygenated water bodies and vice versa. It is also observed that pollution-tolerant aquatic insects, especially Diptera (Chironomidae), dominated highly polluted and organic-rich waters.

This clearly proves that increasing anthropogenic activities like dumping of untreated sewage water and agrochemicals in freshwaters is one of the main reasons behind degradation in their ecosystems in this region. Furthermore, it is also evident from this research work that aquatic insects are very effective and reliable bioindicators of water quality in rivers.
In conclusion, urgent attention is required towards pollution control measures, proper sewage treatment, sustainable agricultural practices, and conservation of aquatic habitats to protect freshwater biodiversity and maintain ecological balance in Bareilly and Budaun districts.

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