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The abundance of macroinvertebrates: An attractive strategy to monitor the water quality of the Daha River of Bihar, India

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Abstract
Water pollution is the main cause for diminishing of local small rivers in India. Excessive water pollution causes an increase in the biological oxygen demand (BOD) and chemical oxygen demand (COD), which affects the life of aquatic flora. Daha River, a 96 Kilometer small river in the north Bihar region of India originates from Sasamusa in Gopalganj district. In this study, we have monitored the water quality of this river by using macroinvertebrates present in the water system as a biological indicator. In the random sampling of water from Daha River provided evidences that the water condition of the Daha River is highly polluted due to sugar industry effluents, agricultural activities, and municipal waste which are the main troubling agents of the physiochemical property of this river, increasing the BOD of water and the increasing number of macroinvertebrates. This study provided scientific evidence to attract the concern of several government organizations to save this river as well as important aquatic flora and fauna present in the water body of this river.

Keywords: macroinvertebrates, biochemical oxygen demand, chemical oxygen demand, Daha River, pollution

1. Introduction
Pollution is an active problem on the Earth which affects the quality of air, water, land and sound that consequently has adverse effects on life. There are several diseases which has been caused due to the effect of different types of pollution such as several diseases like Asthma, Lung Cancer, stroke, ischaemic heart disease etc. are reported due to cause of air pollution [1-3]. Water pollution causes several water born diseases like, Cholera, Typhoid fever, hepatitis, giardiasis etc. [4]. Freshwater is important for survival of animal being. The important sources of freshwater are the rivers and the streams. The archeological evidences showed that the people of ancient period grew along the bank of river. Even in present scenario million of people live near the bank of river and their many activities depend on it [5]. The pollution in river Ganga and the other river is the gift of industrial revolution and our modernization. The water quality is getting degraded day to day due to excessive disposal of sewage and industrial waste which affects the biological oxygen demand resulting in extinction of many aquatic organisms [6]. Benthoic macroinvertebrates are reported to be helpful in the biomonitoring purposes rather than other aquatic organisms [7-9]. There is a direct correlation between biological indicators and the ecological health of an aquatic ecosystem [10]. The clean water also supports the growth of specific macroinvertebrates in a limited numbers with balanced distribution of macroinvertebrates population [11]. There are four major changes in the water bodies that have been reported to affect the community structure of macroinvertebrates [12]. These changes consist of increased inorganic micronutrients, increased organic subtances and increased toxic chemical pollution [13]. There are several macroinvertebrates which are reported to found in the polluted water and is used to predict the water quality [14]. In this study we have analyzed the water quality of Daha River in the Gopalganj distrct of Bihar. In the study we have found the abundance of several species of Annelids like *Pheretima posthuma*, Placobdella species, Helobdella species, Chaetogaster species and Hirudo species. Further we have found different abundant species of Arthropods like Chironomus species, Nymph of dragonfly, Nepa, Micronecta species, Larvae of Mosquitoes and Hyphoporus species. In addition, we have found different abundance species of Molluscs, *Pila globosa*, *Lymnea corrianus*, *Lamellidens marginalis* and *Parreysia caerulea*. The abundance of the above macroinvertebrates reveals the poor water quality i.e highly polluted water and danger zone for aquatic organisms. Further, we have also monitored the BOD and COD of three places of water which were 2 ± 0.8 mg/L and 5.5 ± 0.6 mg/L respectively. The reported BOD and COD are non-permissive limit for survival of aquatic animal. In addition we calculated the Macroinvertebrate Biotic Index (MBI) which was 7.5. This MBI value also indicates the high pollution level of Daha River. This study demands the government, non-government organization to concentrate to save this local rivers and their aquatic organism from the extinction.

2. Material and Method
2.1. Sampling of Water
The water sample containing the macroinvertebrates were collected in one liter sterilized plastic bottles in the month of November 2020 from Daha river at three places, Lakshwar, Badarjimi and Sasamusa in the periphery of 25 kilometer in the Gopalganj Distrct of Bihar and preserved in 5% formalin solution [15].

2.2. Macroscopic Analysis
The collected water samples were concentrated and the samples were scanned under compound microscope.

2.3. Biological Oxygen Demand 5 (BOD5) calculation
The Biological Oxygen Demand was calculated by the standard protocol used for examination of water and wastewater [16-18]. The BOD5 was separately measured from the collected water sample of Daha River from three places in the Gopalganj district of Bihar, India at 20 °C. The experiments were performed four times and the results were presented with standard deviation. The BOD5 was calculated by the using of following formula.

t-day BOD = $[DO_t - DO_0]/P$
Where P = Dilution factor = 300 mL/ (sample volume in mL).

2.4. Chemical Oxygen Demand calculation
The Chemical Oxygen Demand was calculated by the standard protocol [16, 19]. The COD was separately measured from the collected water sample of Daha River from three places in the Gopalganj district of Bihar, India. The experiments were performed four times and the results were presented with standard deviation.

2.5. Macroinvertebrate Biotic Index (MBI)
The MBI value was calculated by the standard protocol [20]. In brief, we calculated the number of macroinvertebrates present in the three above places mentioned to collect the water sample. The MBI value was calculated using the following formula

$$MBI = \sum_{i=1}^{n} (niti)/N$$

Where,
ni = number of individuals of each taxon of Macroinvertebrate i;
ti = tolerance rating value allotted to that Macroinvertebrate taxon i;
N = total number of individuals in the collected sample.

3. Result and Discussion
The species abundance, composition, stability, productivity and physiological condition of aquatic organism depend upon the physical and chemical characteristic of water [21]. It has betfrb5hen reported that the number of several Macroinvertebrate rises due to excessive accumulation of pollutants which serve as biological indicators to monitor the condition of water [22]. Due to excessive accumulation of pollutants it affects the biochemical properties of water [23]. In this study, we checked the condition of Daha River. We measured the BOD5 and COD from the water sample of Daha River. We found that BOD5 and COD of collected water were 2 ± 0.8 mg/L and 5.5 ± 0.6 mg/L respectively. These obtained results were very worrying for the life of the aquatic flora of the Daha River. The reported BOD5 and COD are non-permissive limit for survival of aquatic animal. To check the rapid stream-quality assessment we monitored the Macroinvertebrate Biotic Index (MBI) which was calculated 7.5. This MBI value also indicates the high pollution level of Daha River. To further validate these results, we monitored the abundance of the above macroinvertebrates which are known as biological indicators and population increased due to the increasing level of pollutants in the river. By using microscopy we found that the population of Annelids, Arthopods and Mollusca get increased in the water body of Daha River which was observed in the presence of high level of pollution. In the Annelids, the population of *Pheretima posthuma*, Helobdella species, Hirudo species, Placobdella species, Chaetogaster species were found to be 50 ± 5%, 20% ± 3 and 15 ± 3%, 10 ± 2%, 5% ± 2 respectively (Figure 1). Further, we have monitored the percentage of abundance of Arthropods in the collected water. We found that percentage of population of Nymph of dragonfly, Larvae of Mosquitoes, Nepa, Chironomus species, Micronecta species, Hyphoporus species were 30% ± 4, 25 ± 5%, 17 ± 3%, 15 ± 2%, 8% ± 3 and 5 ± 2%, respectively (Figure 2). In addition we also measured the percentage of different species of Mollusca population present in the water body of Daha River. We Found that the percentage of *Pila globosa*, *Lamellidens marginalis*, *Lymnea corrianus*, *Parreysia caerulea* were 60 ± 5%, 20 ± 3%, 15 ± 5% and 5 ± 2%, respectively (Figure 3). Our study provided an evidence to give the proper attention to minimize the pollution and raise a quick concern to save the Daha river as well as the aquatic organisms present in the river.

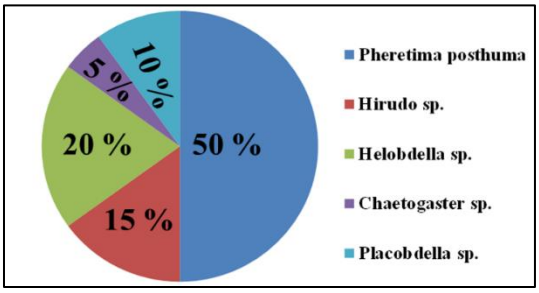

Fig 1: The abundance of different species of Annelids population present in the water body of Daha River.

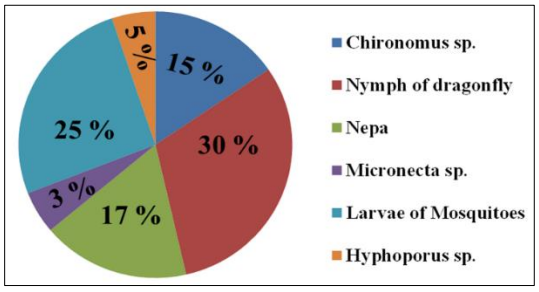

Fig 2: The richness of different species of Arthropods population present in the water body of Daha river.

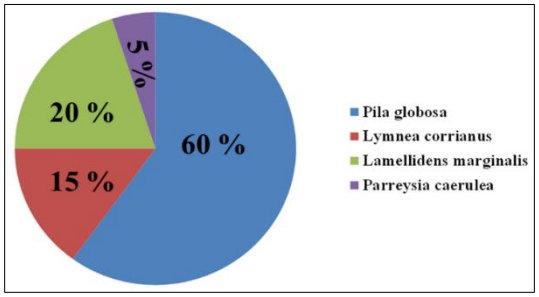

Fig 3: The richness of different species of Mollusca population present in the water body of Daha River.

4. Conclusion

The aquatic flora and fauna needs clean and sustainable aquatic system for their survival [24]. Water pollution not only affects the life of aquatic organisms but it indirectly also affects the life of terrestrial organism through the food chain [25]. The study shown here indicates that the condition of Daha River is not promising for the survival of aquatic organisms due to massive amount of pollutants present in this river. The polluted water may not useful for the dostic purpose and it also poses threat for the local livestock's. Therefore this study demands the local government and non-government organization to help in the cleaning of this Daha River which may help aquatic organism from the extinction.

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