DOI: https://doi.org/10.52756/ijerr.2022.v29.004 *Int. J. Exp. Res. Rev.*, Vol. 29: 40-47 (2022)

Original Article | Peer Reviewed | Open Access

International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online)
www.iaph.in

Idol immersion in Ichhamati river and its impact on water quality parameters

Sejuti Roy[1]*, Niladri Sekhar Das[1], Shubhajit Saha[2] and Dipshikha Ghosh[1]

[1]Department of Zoology, Dinabandhu Mahavidyalaya, Bongaon, West Bengal, India;

[2]Department of Zoology, Sundarban Hazi Desarat College, Pathankhali, South 24 Parganas, West Bengal, India

E-mail/Orcid Id:

NSD, bioniladri@gmail.com; *SS*, s.saha.bgc.wbsu@gmail.com, https://orcid.org/0000-0001-5041-658X
DG, dipsikhaghosh@yahoo.com

Article History:

Received: 20th Oct., 2022
Accepted: 10th Dec., 2022
Published: 30th Dec., 2022

Keywords:
Idol immersion, phytoplankton, zooplankton, water quality parameters, pollution

Abstract: A preliminary study was undertaken in Ichhamati river, Bongaon, N-24 Parganas, West Bengal to evaluate the impact of idol immersion after Durga puja on water quality parameters. Different important physico-chemical parameters were considered for this study as temperature, dissolved oxygen (DO), Biological Oxygen Demand (BOD), pH, nitrate, phosphate, silicate and phytoplankton, as well as zooplankton community structure. Dissolved oxygen (DO) showed an inverse relation with pH showing the maximum (5.68) and minimum (2.3) values during and after immersion, respectively. During the immersion time, the turbidity and nutrient readings were much higher, indicating a high pollution level. During the whole study period, There was no perceptible difference in temperature. During immersion, the plankton population displayed maximum abundance and little variety, characterised primarily by one or two species that thrived in dirty water. Overall diversity was found to be highest prior to immersion and steadily deteriorated after immersion. The study clearly demonstrates the negative effects of religious activity on the river, and the essential actions should be properly followed in accordance with government requirements.

Introduction

Ichhamati is a transboundary river that flows through India and Bangladesh and forms their shared border (Ahmed, 2012). Due to siltation, the river has a restricted water flow during the dry season and overflows during the rainy season. Experts are addressing the situation, while the governments of both India and Bangladesh are discussing possible solutions (Basu, 2007). At the same time, human religious rituals such as idol immersion after Durga puja pose extra hazards to the river.

India is a multiethnic nation with many different religious and cultural holidays. An idol is a sculpture or other material object representing a deity to whom religious worship is directed, or any person or thing regarded with admiration, adoration, or devotion, as well as a religious figure. A representation of a god used as an object of worship is known as an idol (Ahmed, 2012). Plaster of Paris, clay, fabrics, tiny iron rods, bamboo, and a variety of paints, including varnish, water colours, and other materials are used to construct these idols (Idol., 2014).

Plaster of Paris (POP), which is less expensive and lighter, has become the preferred medium for creating these idols. POP comprises phosphorus, gypsum, sulphur, and magnesium, among other compounds. Plastic and thermocols are used to embellish these statues. The thermocol and plastic utilised in the idol's construction are non-biodegradable and so hazardous (Dhote et al., 2014). The heavy elements found in the chemical paints used to decorate these idols, including lead, copper, iron, cadmium, manganese, zinc, chromium, mercury and arsenic, affect the quality of the water (Table 1).

Heavy metal bioaccumulation transports harmful materials from the producer to the consumer, posing health risks to the latter (Kaur et al., 2013, Reddy et al., 2012). When these poisonous compounds are randomly mixed with water, they cause significant qualitative and quantitative alterations in the inorganic and organic

*Corresponding Author: snahabiswas@gmail.com

properties of the water body. According to Reddy and Kumar (2001), thousands of multicoloured statues made of plaster of Paris and painted with chemical colours degraded the overall quality of river water.

Bongaon is a small town where the Ichhamati River has already been restricted due to weeds and extensive siltation. The immersion of a large number of idols after Durga puja, combined with additional things like as flower garlands, coconut shells, coloured paper pieces, and so on, degrades the river water quality and increases the number of slits. Eutrophication is brought on by floating components that an idol releases into a river after it has decomposed (Leland, 1991). Because no documentation exists of the influence of these religious rituals on the water quality parameters of Ichhamati in Bongaon, the current study explores the extent of pollution caused by idol immersion in this river and its impact on planktonic species.

Table 1. Different idol materials and their contribution to aquatic health.

Serial no.	Materials provided through immersion	Affected aquatic body
1	Plaster of Paris (PP)	Sludge is created, metals are added, and dissolved solids increase.
2	Clothing, polish, paint, jewellery, cosmetics, etc. are examples of decoration materials.	Contains metalloids, various organic and inorganic substances, oil and grease, suspended materials, and trace metals (Zinc, lead, iron, chromium, arsenic, mercury, etc.).
3	Flowers, Garlands, oily substance	Increased levels of oil and grease, different organic and inorganic materials, and floating suspended particles.
4	Beauty goods, bamboo sticks	Small parts remained in the water or settled at the river bottom, residing in the river flow, while larger pieces were recovered and recycled.
5	Plastic items/polythene pouches	Contaminate the water with dangerous, settleable, suspended, and suspended pollutants that strangle aquatic life.
6	Meals, food products, etc.	Contributes organics and oil, and grease to water bodies.

Materials and methods

Study site

The Ichamati River is a trans-boundary river that divides Bangladesh and India as it flows through both nations. The Ichamati River has split into three parts: (1) The longer section begins from the Mathabhanga River, a tributary of the Padma, and after flowing for 208 kilometers (129 miles), it joins the Kalindi River close to Hasnabad in North 24 Parganas and Debhata in Satkhira District. (2) Historically, the most important river to the west of Dhaka and (3) Ichamati of Dinajpur. The study site is located in Bongaon, North 24 Parganas ($23^0$4’12’’N, $88^0$49’12’’E), West Bengal. Figure 1 shows the location of the present study site along the way to Ichhamati.

Sample collection and preservation

Collection of Phytoplankton and zooplankton sample

Plankton samples were collected using a phytoplankton net with a mesh size of 20 metres. The nets trawled the surface water for about 20 minutes, and the samples that were recovered were promptly preserved in 4% buffered formalin and taken to the lab for additional analysis. A binocular microscope was used to evaluate a 1 ml aliquot sample in a Sedgwick-Rafter counting cells for both quantitative and qualitative evaluations. Phytoplankton was identified using common taxonomic monographs, such as Desikachary (1987) for diatoms, Subramanian (1968 and 1971) for dinoflagellates, and Fristch (1935) for green and blue-green algae (cyanobacteria). Small zooplanktons (protozoa, rotifers, and naupli) were counted in a 1 to 5 mL clear acrylic plastic counting cell fitted with a glass coverslip under a compound microscope at a magnification of 100x. A counting chamber holding 5 to 10mL was utilised for larger, mature microcrustaceans. Because of its size, a Sedgwick-Rafter cell is insufficient.

Water samples

Collection of water samples

Surface water samples were also taken at the same time as plankton samples for assessments of pH, turbidity, temperature, salinity, dissolved oxygen (DO), biological oxygen demand (BOD), nutrients (nitrate, phosphate, and silicate), and salinity. Water samples were collected in plastic bottles that had already been cleaned,

DOI: https://doi.org/10.52756/ijerr.2022.v29.004

conserved right away at 4^0C, and sent to the laboratory for additional testing. BOD bottles (125 ml) were used to collect water samples for the dissolve oxygen analysis, and the dissolved oxygen was instantly fixed using Winkler's reagents.

(A) (B)

Figure 1. (A) Ichhamati river, Bongaon and (B) Map showing the location of the study site.

Temperature

A centigrade thermometer with a 0°C precision was dropped into 1 litre of sea water on board to measure the water's temperature. The temperature was recorded after five minutes when the mercury level remained stable. In Celsius, temperature values are expressed.

pH

Using three replicate samples from each station under study, the pH of the water samples was measured using a Deluxe Digital pH Meter (Model No. 101 E).

Table 2. Water quality parameters in three different phases of idol immersion

	Temperature	pH	DO	BOD	Turbidity	Nitrate	Silicate	Phosphate
Pre immersion	31	7.5	5.2	8	42.7	0.08	14.4	0.09
Immersion	31	7.1	5.68	8.3	45.5	0.1	9.8	0.47
Post immersion	26	8.1	2.3	9	41.9	0.05	14.91	0.07

Dissolved Oxygen (DO)

The Winkler titrimetric method was used to determine the dissolved oxygen concentration. The Winkler's I and Winkler II solutions were applied to the water samples after carefully drawing into 125 ml of BOD without the interference of air bubbles. The bottles were thoroughly shaken. After the collections were finished, this was completed in the file and taken to the lab for additional analysis. Adding 1 ml of concentrated H_2SO_4 helped dissolve the brownish-white Manganous hydroxide precipitates by releasing iodine equivalent to the original dissolved oxygen. A 250 ml conical flask was used to transfer the brown colour solution and titrate it against a standard sodium thiosulfate solution of 0.01 N (W/V). As the indicator, 2% starch solution (W/V) was utilised. The transformation of the blue colour that resulted from the reaction of iodine and starch to colourless was considered the end result. The dissolved oxygen content in each sample was determined using the formula below based on how much thiosulphate was consumed throughout the titration. The oxygen levels are displayed as ml/l.

Biological Oxygen Demand (BOD)

The biological oxygen demand, which is a measurement of the degradable organic material present in a water sample, is the quantity of oxygen needed by microscopic organisms in order to stabilise biologically degradable organic matter under aerobic conditions. The difference in oxygen content between the sample and after three days of incubation at 20°C serves as the basis for this measurement. The 3-day test process involves completely filling an airtight bottle with a sample and incubating it for 3 days at the recommended temperature. Before and after the incubation, the amount of dissolved oxygen was measured. The BOD was then computed by deducting the initial and final DO. Since the initial DO was obtained quickly after the dilution, the BOD calculation considers all oxygen uptakes that took place after this measurement.

BOD (ml/l) = Dissolved oxygen content of the first bottle (mg/l) – Dissolved oxygen content of the second bottle after five days (mg/l).

Measurement of nutrients

The Strickland and Parsons method measured all nutrients (Nitrate, Silicate and Phosphate). In order to analyse the link between all the variables, correlations were generated using logarithmically translated data and Pearson's correlation coefficient. The Index of Dominance for phytoplankton and the calculation for zooplankton was made using the formula, Yi= (Ni/N)*fi, where Yi = Index of dominance, Ni= No. of individual species, N= Total no. of all species and fi= Frequency of individual species.

Results and Discussion

Limnological parameters

The water quality parameters showed considerable variation in different phases of idol immersion (Table 2). Surface water temperature varied from 26°C to 31.5°C. In general, the temperature is regulated by solar radiation intensity, evaporation, freshwater intake, cooling, and mixing with the ebb and flow from adjacent neritic seas (Prabhu et al., 2008). The pH was lowest during the

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immersion phase (7.1) and reached a high value after the immersion period (8.1). Idols are built of non-biodegradable thermocol and paints containing heavy metals, which cause the water to be slightly acidic in nature (Piyankarage et al., 2004). Normal anthropogenic activities, such as swimming and washing clothing in river water with alkaline detergent, increased the pH of the water after the event.

Dissolved Oxygen

The maximum (5.68) and minimum (2.3) values of dissolved oxygen (D.O.) were observed during and after immersion, respectively. Under certain situations, a high pH may limit algal photosynthesis, not increase DO (Jin, 1992). The more pollution put into bodies of water, the less oxygen is accessible. This leads us to believe that the cause could be a decline in algal life due to increased pH levels caused by pollution. We hypothesise that increasing pH levels reduce dissolved oxygen levels, preventing aquatic life from keeping dissolved oxygen levels high (Bailee et al., 2015).

Turbidity

When an enormous amount of idol, flowers, and other materials were added to the water and rendered the water unstable, the turbidity value was determined to be at its highest (45.5) during the immersion of the idol. Lower values were discovered both before and after the incidents in comparison. High turbidity may also be caused by massive erosion linked to sediment imbalances brought on by human intervention (Nicholus et al., 2014).

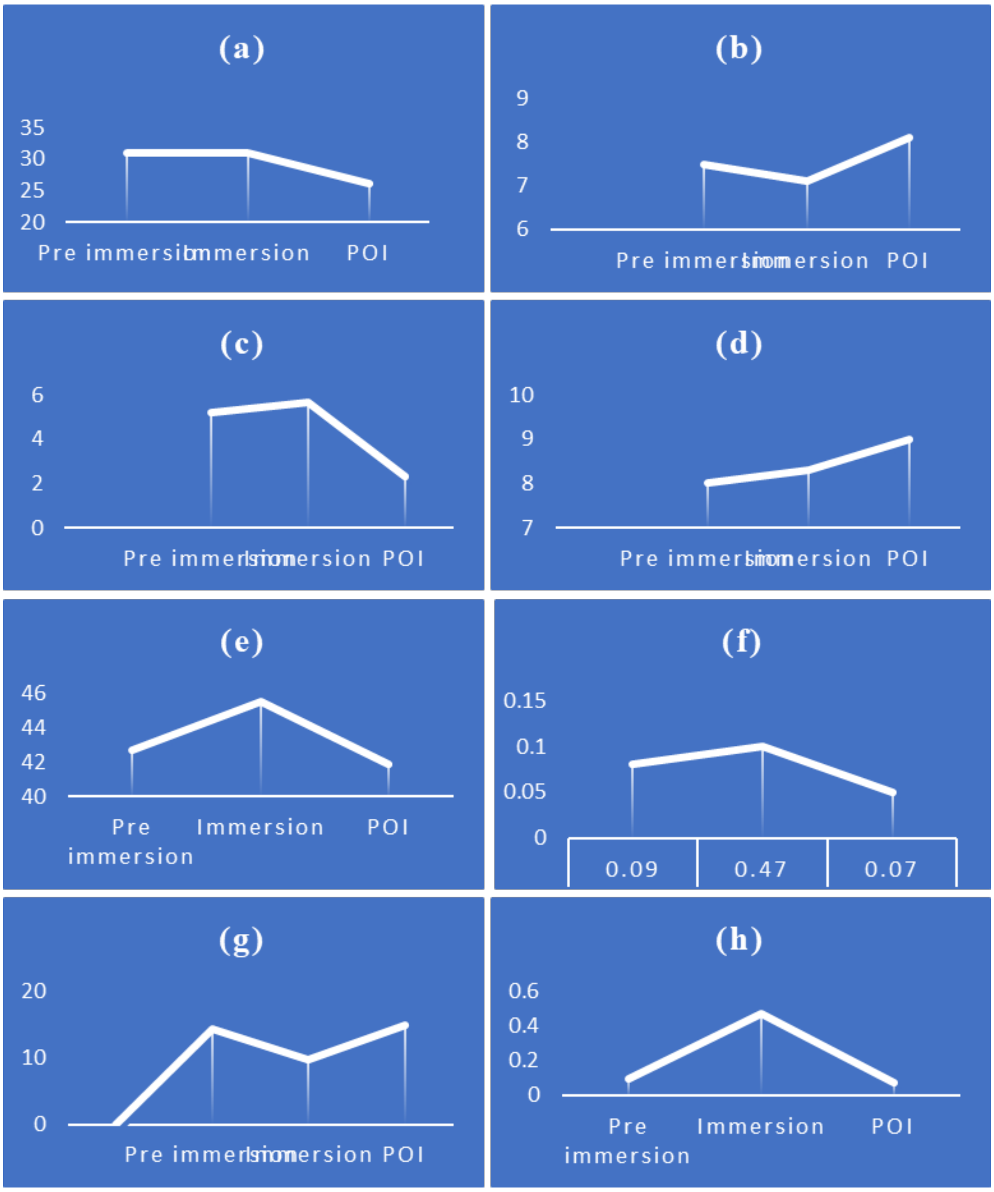

Figure 2. Variations of hydrological parameters (a) temperature, (b) pH, (c) DO, (d) BOD, (e) turbidity, (f) nitrate, (g) silicate, (h) phosphate in different phases.

Nutrients

Nitrate (NO_3^-)

During immersion, there was little fluctuation in the total nitrate content throughout the investigation. The

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concentration ranged from 0.05-0.1. However, nitrate concentration was highest during immersion and comparatively low pre and post-event.

Phoshate (PO_4^-)

During immersion, the range of inorganic phosphate was much higher, ranging from 0.07 to 0.47 g atm/l. Phosphorus concentration is primarily influenced by phytoplankton consumption and replenishment by microbial decomposition of organic debris, independent of physical and chemical processes (Satpathy et al., 2007). Following the immersion of Jagadhatri idols, Bhattacharya et al. (2014) discovered a similar outcome in the Ganges.

Silicate (SiO_4^-)

Silicate concentration surged during the post-immersion phase due to the non-shifting of immersed idols and the dissolution of non-degradable elements, which were the main sources of this reactive silicate.

Phytoplankton community structure

The phytoplankton community's quantitative and qualitative traits both shown vast variations that suggest they may survive under hydrographic settings that are constantly changing (Rajkumar et al., 2009, Vengadesh Perumal et al., 2009, Saravanakumar et al., 2008).

During this study, a total of 22 species were identified, including *Coscinodiscus* sp. The density was more or less constant during the pre-immersion (PI), immersion (I),

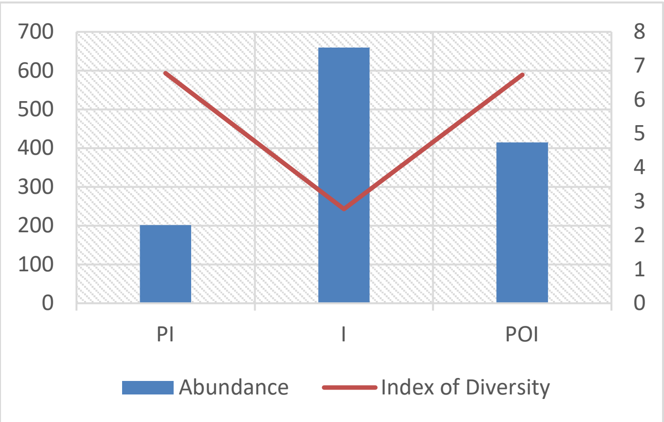

Figure 3. Phytoplankton abundance and index of diversity in different phases of idol immersion

and post-immersion (POI) phases, and there was a positive connection with temperature. However, several species, such as *Spyrogya* sp. and *Vaucharia* sp., appeared just during the immersion phase, displayed a steep increase in density curve, and then vanished. Spirogyra is a typical eutrophic water organism that forms slimy filamentous green masses.

Spirogyra grows submerged in water during the spring, but when there is sufficient sunlight and warmth, they produce a lot of oxygen, which sticks as bubbles between the tangled filaments. This could be the cause of the higher concentration of DO during immersion. Most spirogyras are found in ponds, lakes, slow-moving streams, and rivers with freshwater with neutral or slightly acidic pH (Bellinger et al., 2015). It frequently flourishes in ponds that form during rainy weather and then dry out.

Increased frequency and quantity of inorganic fertiliser inputs cause changes in phytoplankton community composition (Piehlera, 2004). Maximum phytoplankton abundance was obtained during the events (659 no/ 10 ml) and minimum before the events (201 no/ 10 ml) for the high nutrient load. Statistical investigation demonstrated that *Spirogyra* has a substantial positive connection with phosphate and silicate (p value= 0.927).

Although phytoplankton produces energy from carbon and water, they still require both organic (vitamins) and inorganic (phosphorus, nitrogen, silicon, iron, etc.) nutrients to survive. The most physiologically available form of phosphorous for the majority of phytoplankton is phosphate. Last but not least, silicon is usually present in higher concentrations than nitrogen and phosphorous and is used in the cell structure of silicoflagellates and diatoms (Dawes, 1998). Because each taxon has different needs, the phytoplankton composition changes as a result of nutrient fluxes (Tilman, 1977; Kilham and Kilham, 1984). Nitrogen enrichment has an impact on the composition of the phytoplankton population, according to enclosure experiments (Goldman and Stanley, 1974; Sanders et al., 1987).

The Index of Diversity represents the variation in species diversity across the three stages of idol immersion. In this scenario, the diversity curve was inversely related to the abundance, i.e., it was lowest during immersion (Figure 3). This could be owing to the excessive turbidity of the water caused by the massive deposition of flowers and other puja items alongside the idols.

Dominance indices are weighted toward the abundance of the commonest species. In this study, *Spyrogyra* sp. (0.28) showed the highest dominance among the phytoplanktons in all three phases, followed by *Oedogonium* sp. (0.17), *Skeletonema* sp. (0.15) and *Coscinodiscus* sp. (0.14) (Figure 4).

Zooplankton Community Structure

During this investigation, 13 species were documented

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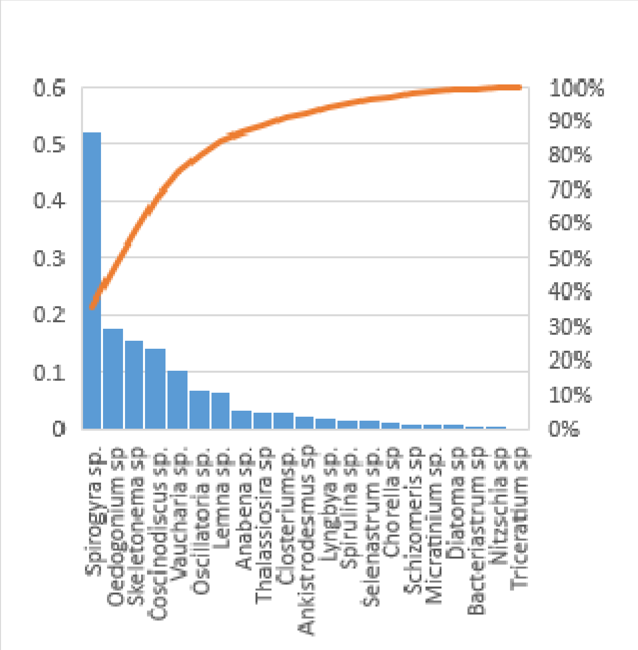

Figure 4. Index of dominance for Phytoplankton

under the family Calanoids, with Calanoids being the most dominant, followed by *Bosmina* sp., *Daphnia* sp., and *Brachionus* sp. Another species, *Moina sp.*, vanished totally during immersion, while two others, *Diffugia* sp. *and Keratella* sp., were discovered only afterwards. *Moina* sp. is linked to *Daphnia* sp., which is much larger. This genus can thrive in waters with low oxygen levels, high salinity, and other pollutants, such as salt pans, and is usually eutrophicated (Xiong et al., 2019). The highest total abundance was discovered during immersion, followed by immersion and the pre-immersion interval (Figure 5). *Keratella* sp. was impacted by the water input regime, temperature, nutrient concentrations, and phytoplankton composition. This species was found in the post-immersion period when the temperature was quite low. Individual and egg-bearing female densities are low in the summer and fall and high in the late winter and spring.

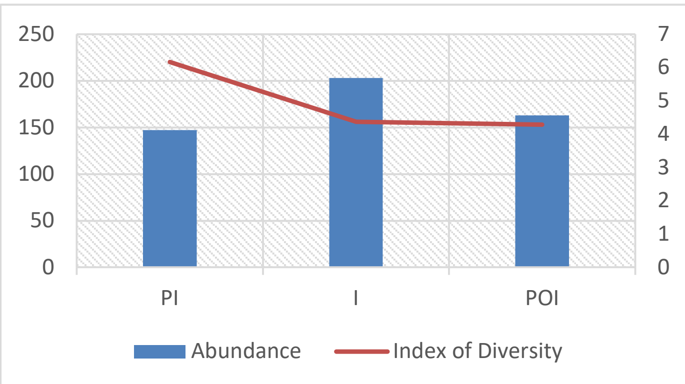

Figure 5. Zooplankton abundance and index of diversity in different phases of idol immersion

The pattern of zooplankton distribution indicated significantly lower values before the events and a rising trend towards the events. In contrast, the diversity index was highest before and decreased during and after immersion, respectively. Among Zooplankton, the highest index of dominance was showed by Calanoids (1.07) followed by *Bosmina* sp. (0.39) and *Daphnia* sp. (0.48) (Figure 6).

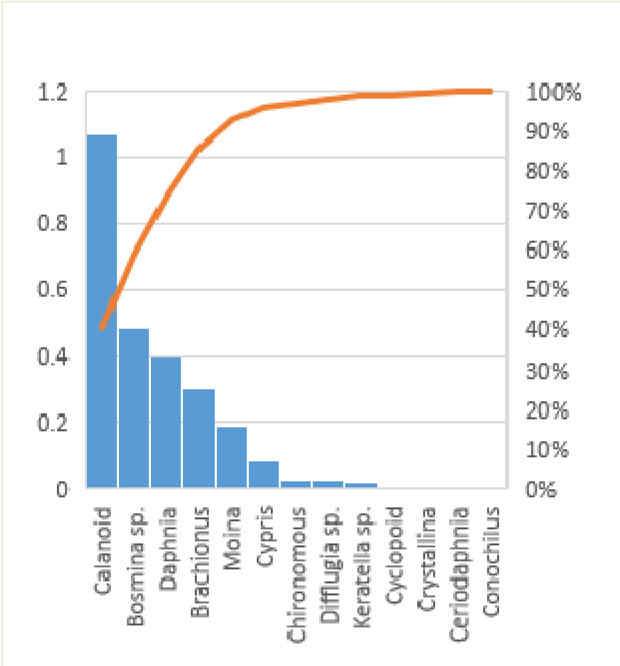

Figure 6. Index of dominance for Zooplankton

Conclusion

Though religious celebrations such as idol immersion are places of widespread public faith and emotion, pollution is also a serious worry these days. Various studies are constantly highlighting the worsening of water health due to these festivities. The government has enacted and implemented many rules and regulations to manage pollution. People everywhere should be aware of and rigorously adhere to these norms. The Act should be amended to make people more conscious and to celebrate the ceremonies in a more environmentally friendly manner. Punishment should also be implemented for rule breakers.

Acknowledgement

The authors are thankful to the department of Zoology, Dinabandhu Mahavidyalaya, Bongaon, for providing the laboratory facilities for conducting the research. We also thank Ankita Biswas, Tathagata Chakravarty, Subha Maitra, Rajdeep Paul and Sneha Singha (students of the 6th semester, Zoology Hons.) for assisting in sample collection and analysis.

Conflict of interest

The authors declare that there is no conflict of interest.

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How to cite this Article:

Sejuti Roy, Niladri Sekhar Das, Shubhajit Saha and Dipshikha Ghosh (2022). Idol immersion in Ichhamati river and its impact on water quality parameters. *International Journal of Experimental Research and Review*, *29*, 40-47.

DOI：https://doi.org/10.52756/ijerr.2022.v29.004