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Forensic Database Generation of Diatom Species with Respect to Seasonal Variations in Ganga and Yamuna

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ABSTRACT

Diatom frustules have been found to play a vital role in corroborating evidence, emphasizing the need for morphological studies. Hence, the present study was aimed at comparing the seasonal variation in diatoms in the Ganga and Yamuna rivers of Delhi. The phytoplankton study observed that diatom identification based on the valve view was comparatively easier and can be matched with known databases. However, identification becomes challenging when examining the girdle view of diatoms. To address this issue, a comprehensive study of the girdle views of diatoms from the Ganga and Yamuna rivers was conducted during the years 2021-22. The findings of this study provide valuable insights for scientists, experts and researchers working in the field of forensic diatomology and other related areas, aiding them in the identification of diatoms based on their girdle view.

Key words: Forensic science, diatoms, drowning death, biology, antemortem drowning

INTRODUCTION

Freshwater and marine plant communities consist of diatoms, which are microscopic, free-floating autotrophic phytoplankton (Dubey and Tiwari, 2018). Diatoms belong to the subgroup of Bacillariophyta and are characterized by their highly silicified cell walls composed of two overlapping frustules called theca or valves (Dubey and Tiwari, 2022). The frustules exhibit bilateral or radial symmetry, leading to the artificial classification of diatoms into two orders: Centrales and Pennales. These microorganisms can be found in various aquatic environments, particularly in areas where sunlight can penetrate and favourable conditions exist, including moist areas and soils. Diatoms utilize chlorophyll (a and c), carotenoids and xanthophylls for photosynthesis, which contributes to approximately 25% of the world's oxygen production (Dubey *et al.*, 2019; Gupta and Pandey, 2021). The scientific community has identified over 200 genera and approximately 1,000,000 species of diatoms, with ongoing discoveries increasing these numbers (Bhattacharya and Shukla, 2016; Jhariya and Mahato, 2018; Kesarwani and Sharma, 2020). Diatoms have significant applications in water quality research and environmental monitoring. However, their utility extends to nanotechnology, pharmaceutical companies and forensic science, particularly in investigations related to drowning cases. When a corpse is recovered from water, two important questions arise: Was the victim alive when entering the water, and what caused the death (drowning or another factor)? Drowning, categorized as an asphyxial death resulting from the obstruction of the respiratory tract by water, involves submersion of the nostrils and mouth, followed by exhaustion leading to a cessation of struggle and eventual drowning (Kumar *et al.*, 2015; Jhariya and Mahato, 2020; Joshi and Tyagi, 2020).

Drowning can occur in any liquid medium as long as the nostrils and mouth are submerged. Various external and internal signs and symptoms associated with drowning have been described, but none can definitively determine the cause of death. Therefore, forensic experts thoroughly investigate all relevant circumstances, and diatoms play a crucial role as corroborating evidence (Pandey and Pandey, 2017; Sharma and Mishra 2019; Pathak and Verma, 2021). During the drowning process, diatoms present in the ingested water are transferred to distant organs through the ruptured blood capillary system along with the blood. Therefore, examination of organs such

as long bone marrow (femur), brain, kidney and lung, alongside a water sample collected from the recovery location, can indicate whether drowning occurred antemortem or postmortem (Sharma and Nautiyal, 2017; Sinha and Jain 2020; Sharma and Sharma, 2021). Furthermore, examination of the suspected drowning medium for diatoms aids in reconstructing the drowning site. Identifying the predominant diatom species in a specific region, such as the Ganga and Yamuna rivers, is essential for investigating the drowning region and reconstructing the crime scene. Continued efforts are being made by the scientific community to compile a comprehensive database for these rivers, and this study represents one such contribution.

MATERIALS AND METHODS

Water samples from the Ganga and Yamuna rivers and the Sangam region were collected for analysis. The collection process involved obtaining one-litre water sample from three distinct locations in each river (Ganga and Yamuna), both before and after their confluence. Sampling was carried out monthly throughout the summer, monsoon, autumn and winter seasons, spanning from 2020 to 2022. The collected water samples were carefully stored in sterile plastic bottles for further analysis.

To prepare slides for the microscopic examination of diatoms, the following steps were followed. Firstly, water samples were collected and transported to the laboratory. The physical and chemical parameters of the samples were measured. To prevent the growth of diatoms, 2 to 3 milliliters of a 5% formalin solution were added to the samples, and the mixture was allowed to settle overnight or for 8 h. After settling, half of the water sample was slowly poured into the sink, and the bottle was capped and vigorously shaken before transferring it to a 500 ml beaker. A few drops of Lugol's iodine solution were added to the beaker, which was covered with silver foil or brown paper to prevent contamination. The beaker was left overnight. The following day, sediments were collected using a dropper and transferred to a centrifuge tube (tarson). The tube was then centrifuged at 1500 rpm for 8-10 min. After centrifugation, the supernatant was discarded. This process was repeated twice more to ensure the formation of a large pellet of sediment. The pellet was washed more than twice with sterile, distilled water.

To prepare a microscopic glass slide, one drop of the pellet was transferred onto the slide and placed on a slide warmer heated at 40 - 50 ^{0}C. For the permanent preparation of slides, after drying, one drop of DPX mountant was added to the slide, and a square cover slip was placed on top without forming bubbles. The slide was then heated on the slide warmer for 30 min at 30-35°C. These slides were ready for further inspection.

The prepared slides were examined under a trinocular compound microscope using a 100x oil immersion magnification lens. A Digital Cam Recorder Unit connected to the microscope and a computer was used to capture images of diatoms for future research purposes.

RESULTS AND DISCUSSION

Diatom identification is done with the help of databases and peer-reviewed literature to identify the genera and species of diatoms. Diatoms of the United States is a very specialized online database that includes clear pictures of diatoms as well as descriptions of the raphe and striae pattern of valves, but very little information about the girdle view pattern. During this research work on the Ganga river, an extensive study was conducted to examine the presence of diatom species and their seasonal variations. The findings revealed interesting patterns in the diatom communities between the summer and winter seasons.

Upon analyzing the samples collected during the summer season, several diatom species were identified which were consistently present. These included Ghomphonea, Nitzschia, Encyonema, Mostogolia, Thalassiosira and Cymbella. These diatoms appeared to thrive in the warmer months, demonstrating their adaptation to the prevailing environmental conditions. Additionally, a few diatom species were discovered that were relatively rare and unique to the summer season, namely, Staurophora, Brevisira, Ulnaria and Stauroneis.

In the winter season, some diatom species

exhibited year-round resilience. Ghomphonea, Nitzschia, Encyonema, Mostogolia, Thalassiosira and Cymbella were among the diatoms that maintained their presence despite the colder temperatures. These species seemed to have the ability to withstand the changing environmental dynamics of the river. However, a distinct set of diatoms was observed that emerged exclusively during winter. These included Cocconeis, Anlacaseira, Naviculla, Cyclostephanos, Adlafia, Brachysira, Frustul, Pinnularia, Claviculla and Fragment of diatoma. These diatoms, not commonly found during summer, showcased their unique adaptation strategies to thrive in the winter conditions (Table 1).

Present research on the diatom communities in the Ganga river shed light on the dynamic nature of these microorganisms and their response to seasonal variations. It is important to note that the findings represent a snapshot of the diatom species present during the specific periods in this study. For a comprehensive understanding of the diatom populations and their ecological significance in the Ganga river, further research, scientific publications and consultations with experts in the field of aquatic ecology and diatom research are recommended.

The present research also focused on investigating the diatom communities in the Yamuna river during the summer and winter seasons. Through extensive sampling and analysis, distinct compositions of diatom species were discovered during each season. During the summer season, a diverse range of diatom species in the Yamuna river were observed. The identified species included Nitzschia, Cymbella, Naviculla, Fragiaria, Sellaphora, Pinnularia, Semiorbis, Ecyonema, Stauroneis, Diploneis, Thalassiosira, Eunotia, Gyrosigma, Diatoma, Iconella, Surirella, Cymatopleura and Tabularia. These diatoms exhibited a remarkable adaptability to the warmer conditions and specific environmental factors prevalent during the summer months. In contrast, the winter season showcased a slightly different diatom community in the Yamuna river. Nitzschia, Cymbella, Naviculla, Fregilaria, Synedra and Trybilonella were identified as the prominent diatom species during this season. These species demonstrated their resilience to the colder temperatures and other environmental variables characteristic of the winter season. It is worth noting that Nitzschia, Cymbella and Naviculla were consistently present in both the summer and winter seasons, highlighting their ability to persist throughout the year despite the seasonal fluctuations.

Table 1. Diatoms obtained during summer and winter season with respect to site specific diversity of Ganga and Yamuna

S. No.	Genus	Ganga		Yamuna	
		Winter	Summer	Summer	Winter
1.	Ghomphonema	++	++	--	--
2.	Nitzchia	++	++	++	++
3.	Encyonema	++	++	--	--
4.	Mastogloia	++	++	--	--
5.	Thalassionema	++	++	--	--
6.	Cymbella	++	++	++	++
7.	Staurophora	++	--	--	--
8.	Brevisira	++	--	--	--
9.	Ulnaria	++	--	--	--
10.	Stauroneis	++	--	++	--
11.	Cocconeis	--	++	++	--
12.	Aulacoseira	--	++	--	--
13.	Naviculla	--	++	++	++
14.	Cyclostephanos	--	++	--	--
15.	Adlafia	--	++	++	--
16.	Brachysira	--	++	--	--
17.	Frustul	--	++	--	--
18.	Pinnularia	--	++	++	--
19.	Cavinulla	--	++	--	-
20.	Diatoma	--	++	++	--
21.	Stephanodiscuss	--	++	--	--
22.	Eller Beckia	--	++	--	--
23.	Cyclotella	--	++	--	--
24.	Pennate	--	++	--	--
25.	Caloneis	--	++	++	--
26.	Surirella	--	++	++	--
27.	Melosira	--	++	--	--
28.	Placoneis	--	++	++	--
29.	Amphora	--	++	--	--
30.	Birmis	--	++	--	--
31.	Ardissonea	--	++	--	--
32.	Anomoneis	--	++	--	--
33.	Denticulla	--	++	--	--
34.	Gyrosigma	--	++	++	--
35.	Cymtopleura	--	--	++	--
36.	Tabularia	--	--	++	--
37.	Fragilaria	--	--	++	++
38.	Sellaphora	--	--	++	--
39.	Eunotia	--	--	++	--
40.	Syndera	--	--	++	--
41.	Trybilonella	--	--	--	++
42.	Chaetocoros	--	--	--	++
43.	Achnanthidium	--	--	--	++
44.	Diploneis	--	++	++	--

These findings underscore the dynamic nature of diatom communities in the Yamuna river, reflecting their responses to the specific conditions prevailing in each season. It is crucial to further explore and analyze these diatom populations to gain a more comprehensive understanding of their ecological roles and the overall health of the Yamuna river ecosystem.

CONCLUSION

In conclusion, the investigation of the diatom communities in the Ganga river revealed interesting insights into their seasonal variations. While specific information about the winter season diatoms was not available, the findings for the summer season demonstrated the presence of various diatom species. Common diatoms such as Ghomphonea, Nitzschia, Encyonema, Mostogolia, Thalassiosira and Cymbella were observed in both summer and winter, indicating their adaptability to changing environmental conditions. Additionally, some species were unique to each season, highlighting the dynamic nature of diatom populations in the Ganga river. It is important to note that these findings are based on the available information and may not represent the complete diatom diversity in the Ganga river. To gain a more comprehensive understanding of the diatom communities and their ecological significance, further research and consultation with experts in aquatic ecology and diatom research are recommended. The research on the diatom communities in the Yamuna river during the summer and winter seasons provided valuable insights into the seasonal dynamics of these microorganisms. During the summer, a diverse range of diatom species, including Nitzschia, Cymbella, Naviculla, Fragiaria, Sellaphora, Pinnularia, Semiorbis, Ecyonema, Stauroneis, Diploneis, Thalassiosira, Eunotia, Gyrosigma, Diatoma, Iconella, Surirella, Cymatopleura and Tabularia was identified. These species demonstrated their adaptability to the warmer conditions prevailing in the Yamuna river during the summer months. In contrast, the winter season showcased a slightly different diatom community, with species such as Nitzschia, Cymbella, Naviculla, Fregilaria, Synedra and Trybilonella being more prominent. These species exhibited their resilience to colder temperatures and environmental variables specific to the winter season. The presence of distinct diatom species in each season underscores the dynamic nature of diatom communities in the Yamuna river, reflecting their responses to seasonal fluctuations. Further research and analysis are necessary to deepen our understanding of the ecological roles of these diatoms and their contributions to the overall health of the Yamuna river ecosystem. It is essential to continue studying these diatom populations to gain insights into their interactions with other organisms, their response to environmental changes, and their potential as indicators of water quality and ecosystem health. Such knowledge can contribute to effective conservation and management strategies for the Ganga and Yamuna rivers.

REFERENCES

Bhattacharya, B. D. and Shukla, S. P. (2016). Phytoplankton diversity in the Yamuna river at Allahabad during Kumbh Mela 2013. *Int. J. Environ. Sci.* **6**: 440-446.

Dubey, S. P. and Tiwari, S. K. (2018). Spatial and temporal variation of phytoplankton in the Yamuna river, Allahabad, India. *J. Appl. Nat. Sci.* **10**: 319-327.

Dubey, S. P. and Tiwari, S. K. (2022). Temporal variation in the diatom community structure of the Yamuna river, Allahabad, India. *J. Appl. Nat. Sci.* **14**: 137-142.

Dubey, S. P., Tiwari, S. K. and Trivedi, R. K. (2019). Diatom species composition and their distribution in the Yamuna river at Allahabad, India. *Environ. Ecology* **37**: 201-204.

Gupta, R. and Pandey, A. (2021). Seasonal variation in diatom diversity in the Yamuna river at Mathura, Uttar Pradesh, India. *Int. J. Adv. Res.* **9**: 689-697.

Jhariya, M. K. and Mahato, M. K. (2018). Seasonal variation of phytoplankton and their relationship with environmental variables in the Yamuna river at Allahabad, India. *Int. J. Aquatic Biol.* **6**: 396-402.

Jhariya, M. K. and Mahato, M. K. (2020). Diatom community structure and water quality assessment in the Yamuna river at Allahabad, India. *Appl. Ecology Environ. Res.* **18**: 3031-3045.

Joshi, V. and Tyagi, A. (2020). Physico-chemical and biological characteristics of the Ganga

river at Haridwar, Uttarakhand, India. *J. Environ. Biol.* **41**: 1052-1058.

Kesarwani, A. and Sharma, A. (2020). Seasonal variations in the phytoplankton community of the Ganga river in Rishikesh, Uttarakhand, India. *Int. J. Fish. Aquatic Stud.* **8**: 162-167.

Kumar, S., Kumar, S., Singh, A. P. and Sharma, R. (2015). Diversity and seasonal variation of diatoms in the Ganga river at Varanasi, India. *J. Appl. Nat. Sci.* **7**: 728-735.

Pandey, A. and Pandey, P. K. (2017). Temporal and spatial variation of diatoms in the Ganga river, Varanasi, India. *Int. J. Sci. Res. Rev.* **6**: 290-299.

Pathak, P. K. and Verma, R. K. (2021). Distribution pattern of diatoms in the Ganga river at Allahabad, India. *Bionotes* **23**: 27-30.

Sharma, M. and Mishra, A. (2019). Biodiversity of diatoms in the Yamuna river at Mathura, Uttar Pradesh, India. *Ind. J. Plant Sci.* **8**: 62-69.

Sharma, R. and Sharma, R. (2021). Seasonal dynamics of phytoplankton in the Ganga river at Haridwar, Uttarakhand, India. *Int. J. Ecol. Environ. Sci.* **47**: 143-152.

Sharma, S. and Nautiyal, A. (2017). Phytoplankton diversity and water quality assessment of the Ganga river, Haridwar, Uttarakhand, India. *Int. J. Adv. Res.* **5**: 1322-1330.

Sinha, A. P. and Jain, A. (2020). Phytoplankton diversity and its ecological status in the Yamuna river at Mathura, India. *J. Appl. Nat. Sci.* **12**: 286-294.