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ARTICLE

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PLANKTON DIVERSITY AND ECOLOGY OF RIVER GANGA

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Plankton is used to monitor the riverine ecosystems, as they can indicate the riverine health status. The present investigation was conducted to explore description about the plankton dynamics in a large perennial river, the Ganga. A total of 89 genera of phytoplankton and 43 genera of zooplankton belonging to 10 phyla were recorded during study period. Out of the twenty algal genera listed as pollution indicators by Palmer (1969), eighteen genera were recorded from the river Ganga during the different seasons. The changes of composition pattern of the plankton population are especially dominated by Cyanobacteria and Rotifera in the stretch between Kanpur to Bhagalpur, indicating the stretch is under stress incorporated climate and anthropogenic.

Introduction

The word 'plankton' derives from the Greek word 'planktos' meaning to 'drift' or 'wander' and is used to describe passively drifting tiny plants or animals in aquatic systems[1]. On the basis of size planktons can be classified into four classes, picoplankton (< 2 µm), nanoplankton (2-20 µm), microplankton (20-200 µm) and macroplankton (>200 µm). Planktons are well-known organism for monitoring the health status of aquatic ecosysytem as indicator species[2]. Due to their short life-cycle, they are vibrantly influenced by the multiple environmental factors. It is a natural feed for many of the aquatic organisms including fishes. Plankton is classified in two groups on basis of their origin one is phytoplankton (plant origin) and another is zooplankton (animal origin).

Small microscopic plant organisms float in the aquatic ecosysytem with the current are known as phytoplankton. The size of the plankton varies from 1µm to 2000 µm. The shape of the algae cell varied from single spherical to large multicellular structure. Morphologically it is divided into five types i.e. Blue green algae, Green algae, Desmids, Diatoms, Euglenoid algae. Phytoplankton occupies the base position in the ecological food pyramid because of its autotrophic mode of nutrition. It is considered as the wealth of a healthy aquatic ecosystem, as they are integral part of the aquatic food chain[4,5]. It is also used in determination of the trophic status of the aquatic ecosystem[6]. It is widely accepted as bioindicator of aquatic ecosystem (lotic and lentic).

Microscopic animal in the aquatic ecosysytem floats with the current are known as zooplankton. The size varies from 5 µm to 3500 µm in diameter. On the basis of morphology, it is divied into four goups i.e. Protozoa, Rotiofera, Cladocera, Copepoda. The abundance and distribution pattern of zooplankton narrates the biotic and abiotic characteristics of the aquatic ecosysytem[7]. Among the zooplankton, rotifers are the most fascinating organism in morphological appearance and most preferred food organism influence the microbial food web and an important component of several trophic levels' food web dynamic models[8].

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Zooplanktons are the key links between the phytoplankton and fish in a food chain[1]. Similarly, the zooplankton variation may indicate alteration in the ecological status of the aquatic ecosystem, climatic changes, and pollution. Some other functions of zooplankton are also used in bio manipulation to control eutrophication. Various environmental factors including chemical, physical, morphological, climatic, geographical and land use patterns with most importantly factor such as river hydrological regime affect the plankton in a riverine system[9]. Hydrological regime is one of the key determinants of plankton dynamics[10]. In many of the studies it has been evident that some physicochemical parameter like water temperature, transparency, alkalinity and nitrate have influenced the phytoplankton growth[11].

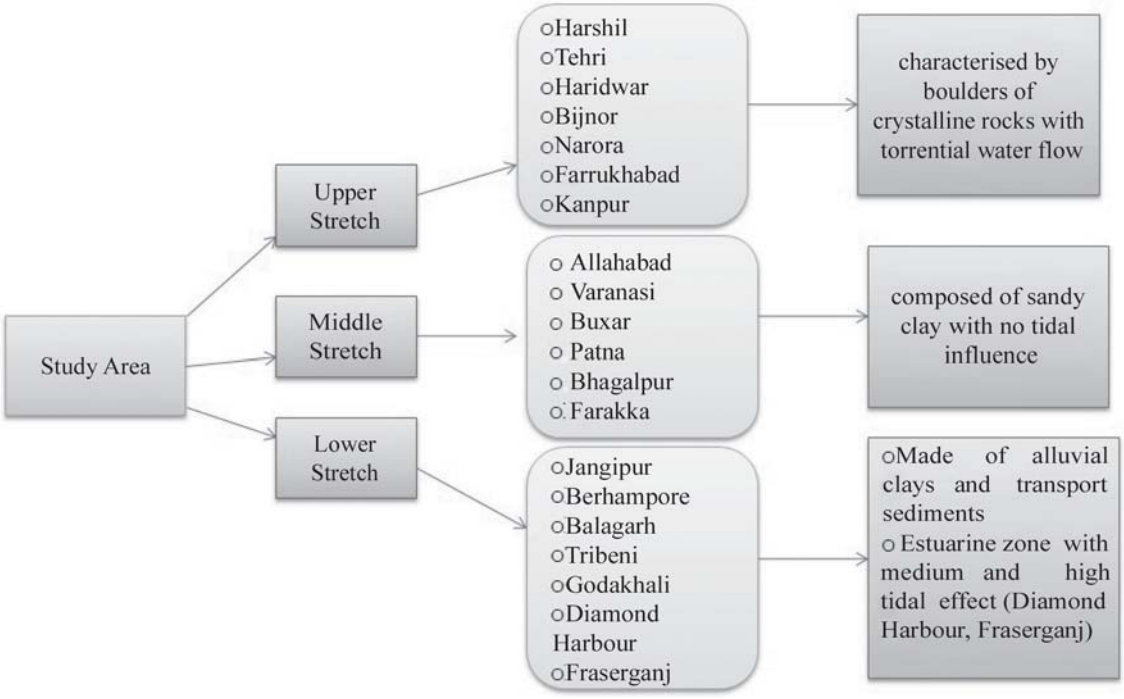

Fig. 1 Sampling sites along Ganga River

Study Site

The mighty River Ganga is believed to be the most sacred and holy River in India. It originates from Himalaya down to the gangetic plain before draining to Bay of Bengal, forming the world's largest delta, the Sundarban. The river Ganga flows to the total approximate length of 2,550 km covering five important states of India (Uttarakhand, Uttar Pradesh, Jharkhand, Bihar and West Bengal). The river traverses through three different eco-regions of India (freshwater, brackish water and estuarine) and thus, sustaining a heterogeneous assemblage of aquatic flora and fauna. We are in this article familiarising the plankton ecology and their dominance patterns changes with river course of studied.

Phytoplankton Diversity of River Ganga

A total of 89 genera of phytoplankton belonging to 6 phyla were recorded across the sampling stations. The major algal groups represented as Bacillariophyceae (25), Mediophyceae (6), Coscinodiscophyceae (3), Chlorophyceae (18), Cyanophyceae (12), Xanthophyceae (4), Zygnematophyceae (8), Trebouxiophyceae (6), and Euglenophyceae (3). The least species diversity was recorded for Synurophyceae, and Noctilucophyceae (one genus for each group). Ulvophyceae is represented by two genera. Out of twelve algal groups, Bacillariophyceae accounted for the maximum in terms of quantitative abundance followed by Cyanophyceae. Out of total genera of diatoms identified, the Pennales showed overall dominance. Some centric diatom such as *Coscinodiscus* sp, *Skeletonema* sp., *Odontella* sp. etc. were noticed in estuarine region from Godakhali to Fraserganj. Under the group Chlorophyceae filamentous multicellular algae such as *Microspora* sp., *Oedogonium* sp., *Pediastrum* sp. etc, were recorded in higher number. Zygnematophyceae was represented by *Mougeotia* sp., *Staurastrum* sp., etc found to have higher abundance during winter and pre-monsoon season. Cyanobacteria represented by the genera *Oscillatoria* sp., *Microcystis* sp., *Lyngbya* sp., etc were

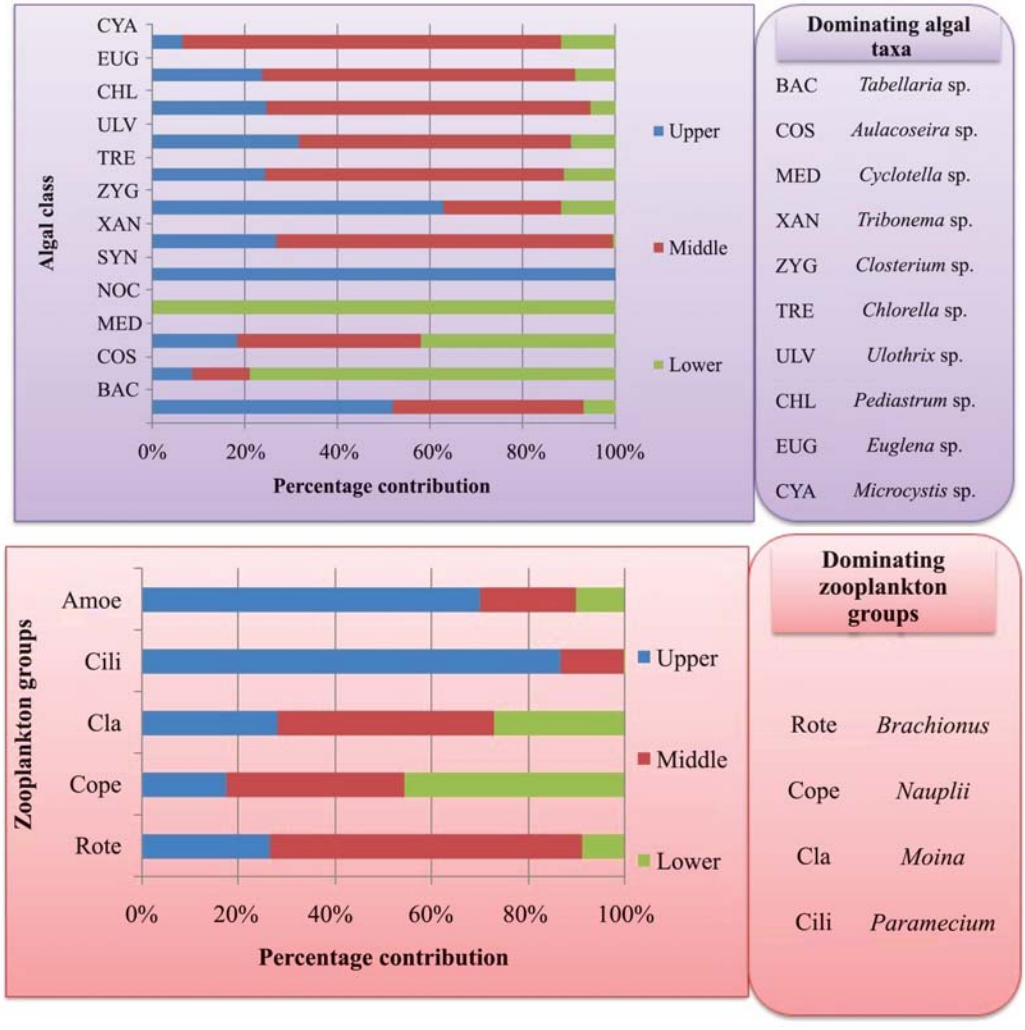

Fig. 2 (A-B) Percentage contribution of different phytoplankton and zooplankton groups (BAC: Bacillariophyceae: COS: Coscinodiscophyceae: NOC: Noctilucophyceae: SYN: Synurophyceae: XAN: Xanthophyceae TRE: Trebouxiophyceae: ULV: Ulvophyceae: CHL: Chlorophyceae: EUG: Euglenophyceae: CYA: Cyanophyceae: MED: Mediophyceae: ZYG: Zygnematophyceae; ROTE: Rotifera; COPE: Copepoda: CLA: Cladocera; CILI: Ciliophora; AMOE: Amoebozoa)

maximum during pre-monsoon season. The higher abundance of Cyanobacteria was recorded during pre-monsoon attributed as result of increasing temperature, pH and alkalinity. Coscinodiscophyceae was maximum during winter and exist only in lower stretch. Maximum density of *Microsystis aeuroginosa* in the middle stretch indicated relatively poor water quality. The seasonal abundance of phytoplankton was maximum during winter (13,304 unit/l) and minimum during post-monsoon (1615 unit/l).

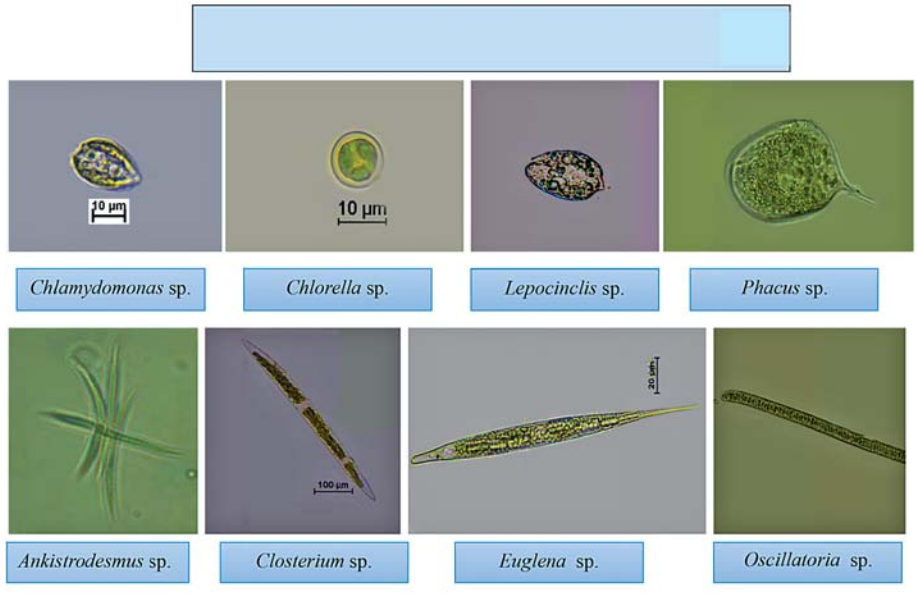

Fig. 3 Pollution indicating Plankton Species

Zooplankton of River Ganga

A total of 43 genera of zooplankton belonging to 11 classes and 4 phyla (Rotifera, Arthropoda, Ciliophora, and Amoebozoa) were recorded. Among zooplankton, Rotifera accounted for 14 genera followed by Cladocera (9 genera), Copepoda (3 genera) Ciliophora (14 genera), Amoebozoa (3 genera). Highest abundance of zooplankton was at middle stretch and minimum at upper stretch. The minimum number of zooplanktons at upper stretch might be due to substratum habitat and higher flow of water. High nutrient content in middle surface had enriched the growth of zooplankton. The mean seasonal abundance of zooplankton was recorded maximum during pre-monsoon (443 ind. l^{-1}) and minimum during monsoon (102 ind. l^{-1}). The remarkable presence of Rotifera in the middle stretch can be explained that the river water in the middle stretch is somewhat impacted by pollution pressure.

Salient Significances of Dominance Species

Phytoplankton

- *Noctiluca,* genus of marine Dinoflagellate in the family Noctilucaceae, is one of the most commonly occurring bioluminescent organisms in coastal regions of the world. It was noticed at Fraserganj station of river Ganga, which may be due to high salinity condition by tidal effect of the sea.
- *Tabellaria* sp. genus of Bacillariophyceae is one of early warning indicator of eutrophication. It grows in alkaline water.
- The planktonic freshwater diatom *Cyclotella* sp. is widely used as an indicator of oligotrophic conditions. The genus is influenced by light, nitrogen, phosphorous.
- In the middle stretch, species *Aulacoseira granulata* was found to have a major contributor to the total phytoplankton as compared to the upper and lower stretch. The turbulent water of river favoured the growth of *Aulacoseira* sp.
- During monsoon (June-July) Cyanophyceae *bloom forming algae such as Microsystis* sp. was observed in Kanpur to Bhagalpur. *Microsystis* sp. is colonial algae freshwater Cynobacteria. The genera *Microcystis* are mostly toxin producing orgamism such mycocystin, which is neurotoxins and hepatotoxins in nature, *Microsystis* sp.is experienced globally, it indicates the stretch is under pollution pressure. High temperature, pH, specific conductivity promotes the growth of Cyanophyceae.
- *Closterium* sp. belongs group desmids Charophytes organism, unicellular, elongated apexing towards both end, cresent-shape organism, mostly found in freshwater. Desmids are found in less nutrient or clear water. These genera are seriously threatened due to its clear habitat preference. This organism is considered as excellent indicator orgamism to monitor an aquatic ecosystem. *Closterium* sp. species was considered as indicators of prevailing environmental conditions. The density increases with increase in water transparency.
- *Chlorella* sp. (Trebouxiophyceae) is found in both freshwater and brackish water. It is influenced by phosphorus.
- Very few studies have shown that *Pediastrum* sp. of chlorophyceae is used as paleoclimatic or paleoenvironmental indicator.
- *Euglena* sp. of the group Euglenophyceae are highly pollution tolerant species and, therefore, reliable indicators of eutrophication.

Zooplankton

- *Brachionus* are important zooplankton components in freshwater and brackish water ecosystems in the river system. The general found in wide range of habitat from oligotrophic to eutrophic aquatic ecosystem. *Brachinus* species is an excellent first food organism for newly hatched youg fish. Many researchers had used this genus as indicating species of riverine heath.
- Most species of *Moina* inhabit freshwater bodies. These species are also used as indicating species of aquatic ecosystem health.

Ecological Dominance Index

- Out of the twenty algal genera listed as pollution indicators by Palmer (1969), eighten genera were recorded from the river Ganga during the different seasons.The pollution indicating species are *Ankistrodesmus* sp., *Chlamydomonas* sp., *Chlorella* sp., *Closterium* sp., *Cyclotella* sp., *Euglena* sp., *Gomphonema* sp., *Lepocinclis* sp., *Melosira* sp., *Micractinium* sp.,*Navicula* sp.,

Nitzschia sp., *Oscillatoria* sp., *Phacus* sp., *Phormidium* sp., *Scenedesmus* sp., *Synedra* sp.

- *Closterium* sp., *Staurastrum* sp. and *Cosmarium* sp. (desmids) indicate good quality of water and the absence of desmids in an aquatic ecosystem may indicate pollution (Hosmani et al. 2002).
- Shannon diversity index of phytoplankton and zooplankton was revealing that the aquatic system was moderately rich in plankton.
- It has been observed that middle stretch has higher diversity of plankton than upper and lower stretch.

Pollution Indicating Species

Out of the twenty algal genera listed as pollution indicators by Palmer (1969), all twenty genera were recorded from the river Ganga during the different seasons.Group Cyanophyceae triggers rapid growth and produces harmful toxins, chemicals that emphasize the negative impact on the aquatic water body. Among Cyanophyceae, *Microcystis aeruginosa* is found to be most prevalent genus in freshwater, which is generated in high density and produce toxic bloom. The toxin, which is produced from *Microcystis* sp. is a cyclic peptide and microcystin which has an adverse impact on the aquatic ecosystem. During the monsoon (June-July) *Microsystis* sp. bloom was formed to Bhagalpur indicating the stretch is under pollution pressure. Besides *Microcystis* sp., other pollution indicating genera were *Anabaena* sp., *Oscillatoria* sp., *Phormidium* sp.,etc. Diatoms are being used as ecological indicators for several decades. *Aulacoseira granulata* was one of the diatoms whose density and morphologycan be used as pollution indicators because of its sustainability in very stressful environmental conditions. It was also found that the blooming condition of the diatoms like *A. granulata* signifies the deteriorated environmental condition of the riverine system which hinders the growth and survival of the native aquatic organisms[11]. Other pollution indicator diatoms are *Cyclotella* sp., *Gomphonema* sp., *Navicula* sp., *Nitzschia* sp., and *Synedra* sp. Under the group Chlorophyceae some genera like *Ankistrodesmus* sp., *Chlamydomonas* sp., *Pandorina* sp., *Scenedesmus* sp., *Chlorella* sp., *Micractinium* sp. were recorded pollution indicating genera. *Closterium* sp., *Staurastrum* sp., and *Cosmarium* sp. (desmids) indicate good quality of water and the absence of desmids in an aquatic ecosystem may indicate pollution[13]. *Euglena* sp. and *Phacus* sp. were represented as pollution indicating species under the group Euglenophyceae.

Conclusion

The article has given brief description about the planton dynamics of River Ganga, its application and application of these algae as ecosystem health status and monitoring. The description of beneficial and harmful lagae was also states. Some pollution indicating species which were observed during study are also explained. The changes of composition pattern of the plankton population are especially dominated by Cyanobacteria and Rotifera in the stretch between Kanpur to Bhagalpur, indicating the stretch is under stress influenced by multiple stressors including climate and anthropogenic. ❐

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