Energic value of phytoplankton in relation to water quality of the river Gomati at Jaunpur

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SUMMARY
Monthly variation in algal GPP, NPP, CR, per cent respiration as well as NPP : GPP and NPP : R ratio were studied at four sampling sites of the river Gomati at Jaunpur (U.P.). Maximum value of GPP was found at S1 in May while lowest at S2 in August. Usually at all the sites, NPP were lower than S1. Banning a few exceptions community respiration (CR) was usually less than 50% at all stations except S4 where values invariably exceed more than 50% and reached up to 92% in June. NP : GP ratio showed an increasing trend from S1 to S4. NP : GP ratio was generally more than one except few months and sites. Thus, on the basis of productivity and community respiration, it may be concluded that river is polluted in whole stretch of the city. Therefore, there is an urgent need for an effective management action plan to save the river.

Key words : Energetic value, Phytoplankton, Productivity, Water quality, River Gomati

River, an important component of water resource, is a need for the development of an area. The flow of water plays an important role for determining the habitat conditions, distribution of abiotic and biotic constituents and horizontal movement of water mass of the river ecosystem. Algal flora consists of a diverse assemblage of nearly all major taxonomic groups. Many of the forms have different physiological requirements and show variation to physico-chemical parameters viz., light, temperature and nutrient regimes (Kumar, 1996). The community structure and abundance of planktonic algae are dependent on the physico-chemical nature of the river water is, primarily, synthesis of the primary producer and products are transferred to the consumers through different trophic levels.

Primary productivity has been used as potential index of productivity for many diverse ecosystem of the world (Wetzel, 1966) and gives a quantitative information about the amount of energy available to support the bioactivity of the system. The contribution of productivity studies were made by Gaarder and Gran (1927). The biological information along with physio-chemical information can be of great significance for river water quality monitoring because of flowing conditions which allow the pollutants to wash away leaving behind only the affected biota. Due to change in hydrochemistry of the river water as a result of pollution, the planktonic community is seriously affected (Harikrishna and Aziz, 2000; Kumar et al., 2001; Pandit et al., 2008; Singh et al., 2010). There is a paucity of data on productivity in relation to physico-chemical properties of the river Gomati at Jaunpur. Hence, to fulfill this gap of knowledge and to provide the basic ecological information, the present investigation was undertaken to assess the effect of sewage and effluents on phytoplankton productivity of the river Gomati at Jaunpur (U.P.).

MATERIALS AND METHODS
Four sampling sites viz., Kalichabad ghat (S1), Hanuman ghat (S2); Achaladevi ghat (S3) and Ramghat (S4) to cover the whole distance of the river in city, were selected for the study of algal productivity in the river. Kalichabad ghat (S1) was considered as control site of the river, S2 and S3 were the mixing zone and S4 was selected as down stream of the river. Samples were collected in the second week of each month from the selected sampling sites in stoper bottle and brought to the laboratory for final analysis. The bottles were labelled as...
initial bottle (IB), light bottle (LB) and dark bottle (DB). Dark bottles were wrapped by black carbon paper. Water samples were treated with manganous sulphate (MnSO₄), alkaline + iodine and sulphuric acid to fix the initial concentration of oxygen. Primary productivity and respiration were measured by estimating the changes in dissolved oxygen content by light and dark bottle method (Gaarder and Gran, 1927) and dissolved oxygen was estimated by Winkler’s method (APHA, 1985). Recorded oxygen values were converted into equivalent carbon value and the rate of production and respiration were expressed as MgCl¹ h⁻¹.

RESULTS AND DISCUSSION

Monthly variation in phytoplankton (algal) gross primary productivity (GPP) and net primary productivity (NPP), community respiration (R), percentage respiration as well as NPP/GPP and NPP/R, ratio are given in Fig. 1-4. The GPP ranged between 0.4 ± 0.05gC l⁻¹d⁻¹ in August to 3.75 ± 0.12gC l⁻¹d⁻¹ in May at S₁, 0.20 ± 0.05gC l⁻¹d⁻¹ in August to 2.08 ± 0.10gC l⁻¹d⁻¹ in June at S₂; 0.25 ± 0.05gC l⁻¹d⁻¹ in Aug. to 2.18 ± 0.10gC l⁻¹d⁻¹ in May at S₃; 0.33 ± 0.12gC l⁻¹d⁻¹ in Aug to 2.78 ± 0.05gC l⁻¹d⁻¹ in May S₄. Maximum value of GPP was found at S₁ in May while lowest at S₂ in Aug. (Fig. 1).

NPP of the river varied from 0.15 ± 0.05gC l⁻¹d⁻¹ to 2.95 gC l⁻¹d⁻¹ at different stations (Fig. 1-4). It varied from 0.34 ± 0.02gC l⁻¹d⁻¹ 1.26 ± 0.15 gC l⁻¹d⁻¹ in June at S₃; 0.02 ± 0.01 gC l⁻¹d⁻¹ (June) to 1.65 ± 0.01 gC l⁻¹d⁻¹ in May at S₃; 0.25 ± 0.07 gC l⁻¹d⁻¹ in September to 1.69 ± 0.12 gC l⁻¹d⁻¹ in June at S₄ (Fig. 1-4). Usually at all the sites the NPP were lower than S₄.

The community respiration values ranged between

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0.1 gCl⁻¹.d⁻¹ (Aug.) to 0.9 gCl⁻¹.d⁻¹ (April) at S₁; 0.05 gCl⁻¹.d⁻¹ (Aug.) to 0.82 gCl⁻¹.d⁻¹ (June) at S₂; 0.05 gCl⁻¹.d⁻¹ (Aug.) to 0.53 gCl⁻¹.d⁻¹ (May) at S₃; and 0.02 gCl⁻¹.d⁻¹ (Feb.) to 1.33 gCl⁻¹.d⁻¹ (May) at S₄ (Fig. 1-4). Respiration values have also been expressed as percentage of GPP and ranged between 10.53% to 40% at S₁; 2.50% to 67.85% at S₂; 5.32% to 92% at S₃; 1.66% to 47.84% at S₄. It is noticeable that barring a few exceptions. It is usually less than 50% at all stations except S₄ where values invariably exceed more than 50% and reached up to 92% in June (Fig. 5).

Monthly variation in NP/GP value ranged between 0.610 gCl⁻¹.d⁻¹ in April to 0.85 gCl⁻¹.d⁻¹ (February) at S₁ whereas in S₂, it ranged from 0.605 gCl⁻¹.d⁻¹ (June) to 0.777 gCl⁻¹.d⁻¹ (Oct); 0.579 gCl⁻¹.d⁻¹ (Sept) to 0.850 gCl⁻¹.d⁻¹ (July) at S₃; and 0.521 gCl⁻¹.d⁻¹ (May) to 0.983 gCl⁻¹.d⁻¹ (Feb.) at S₄ (Fig. 6).

NPP and respiration (R) ratio of the river water showed variation from month to month and station to station. Ratio ranged from 0.4 to 10.56 at S₄ in July and June, respectively while 1.80 (Nov.) to 8.50 (Dec.) at S₁; 0.41 (Jan) at S₂; and 0.34 (Jan) to 5.6 (July) at S₄ (Fig. 7).

The primary productivity of an aquatic ecosystem is the rate of radiant energy which is stored by photosynthetic activity of phytoplankton (Odum, 1956). GPP, NPP and community respiration can be affected by pollution from mineral organic nutrients and may undergo seasonal changes due to variation in discharge, temperature and light intensity. Lowest and highest GPP were noticed in rainy and summer season respectively. Lower value of GPP in rainy season might be due to low light intensity and high turbidity and steep fall of phytoplankton population while after monsoon with the increase in phytoplankton concentration the rate of production also increased which is in agreement with observations of Williams and Murdock (1966), Kumar et al. (2001), Pandit et al. (2008) and Singh et al. (2010). Maximum rate of productivity during summer could be possibly due to high temperature and phytoplankton density as reported earlier by Wetzel (1966), Harikrishnan and Azis (2000) and Singh et al. (2010). GPP and NPP values were lower at S2 and S3 than S1 though they were receiving heavy amount of sewage which was full of organic and inorganic nutrients. This might be due to combined effect of physico-chemical characteristics of municipal and domestic sewage which are unsuitable for survival and growth of algae.

The community respiration values were found lower in different sampling sites. It was noticeable that barring a
few exceptions, CR was usually less than 50% at all the stations except S3 where value invariably exceeded over 50% and reached maximum (92%) of GPP in June. This indicated that CO₂ fixation was quite low and rate of respiration was quite high which could create oxygen deficient condition in river water. For healthy aquatic ecosystem, respiration should be 5-10% of GPP (Ketchen et al., 1958). The rate of NPP and GPP approaches unity in a healthy ecosystem. During the present study, it was observed that at all sites the values were less than one while at S4 it was at borderline. It indicated that water quality was slightly improving at S4 which resulted comparatively better growth and survival of algae. The value of NPP/R ratio exceeding was an indicator of pollution (Sharma, 1993). It is evident that despite of optimum temperature, surplus nutrients through sewage, bright sunshine, river productivity was quite low due to potential toxic condition into the river water, the Gomati water is polluted and virtually going to be an aquatic desert.

REFERENCES


