AN EVALUATION OF THE TROPHIC STATUS OF THE SHEN RESERVOIR BY AN ANALYSIS OF PHYTOPLANKTON COMPOSITION AND WATER CHARACTERISTICS

by

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ABSTRACT

In an effort to evaluate the production potential of an artificial impoundment, the phytoplankton of the Shen reservoir was sampled from November 1981 to June 1982 at three stations during three periods of distinct seasonal hydrographic characteristics. The samples were subsampled and quantified. Most of the phytoplankton were identified to the species level. There were in all fifty-three species comprising Chlorophyceae contributing 36.70% with species of Volvox, Pediastrum, Closterium, Staurodesmus and Ankistrodesmus as dominant species in this group. The cyanophyceae contributed 30.00% with species of Microcystis, Nostoc, and Oscillatoria as the dominant species. The bacillariophyceae and dinophyceae contributed 21.70 and 8.30% respectively. The former group had species of Navicula, Nitzhia, Synedra, Tabellaria and Melosira as the dominant individuals.

An analysis of temporal and spatial changes in composition and abundance of the various groups showed that these were influenced by water temperature, sampling period and station.

Based on the trophic status of the most abundant species, the composition of the phytoplankton is indicative of a tropical reservoir with a moderate productivity for fish culture.

INTRODUCTION

Effective utilization of large inland water impoundments is based on adequate knowledge of their pre and post impoundment status. In Nigeria many reservoirs have been constructed either for irrigation or city water supplies but a great majority of them have been inadequately monitored and studied. The Shen reservoir created by damming the Shen river is subject to considerable climatic and temperature fluctuations. The reservoir was first filled in 1978 without a pre impoundment biological study. Subsequently there has been no systematic post impoundment study prior to the present work.

As a correlate of potential productivity of the Shen reservoir, we have examined the occurrence and species composition of the phytoplankton and their distribution in relation to changes in the physico-chemical characteristics of the reservoir. Similar studies have been made in Nigeria by Imevbore (1968) who observed that the dominant phytoplankton in the Eleiyele reservoir in the rainy season was Melosira sp. However, Egborge (1979) noted that following impoundment, 78% of the phytoplankton species originally present in Asijere Lake were displaced by immigrant species. Biswas (1978) observed a positive correlation between phytoplankton abundance and dissolved oxygen in the Volta Lake Ghana.

MATERIALS AND METHOD

Phytoplankton samples were collected with a square mouthed bolting silk plankton net number 21 (70 meshes per linear centimeter diameter) sunk beneath the surface of the reservoir and towed for a distance of five metres for each sampling operation. Samples were either examined live or immediately preserved and stored in a drop of concentrated iodine solution for subsequent examination.

The volume of water sampled by the tow-net was determined by a modification of the relation recommended by Lipsey and Malcon (1981). Numerical estimation of the phytoplankton was made by the drop method of Lipsey and Malcon (1981) in which 5 drops of 0.5 milligrams of well shaken subsamples were examined under the microscope.

The abundance of the various taxa in each sample was determined by the method of Shannon and Weaver (1963).

The reservoir trophic status was evaluated for phytoplankton using the compound index according to Nygaard (1949).

Surface water samples for physico-chemical parameters were collected with the closing type bottle between the hours of 8.00 & 11.00 every forthnight from the three stations.

The dissolved oxygen was estimated by the WINKLER method and values presented both in milligrams per litre and as percentage saturation according to Welch (1960).

The surface water temperature and pH were taken during sampling occassion. Turbidity was monitored by Secchi disc transparency. Alkalinity was determined by titration with 0.02N H_2SO_4. Nitrogen as NO_3 was determined using the phenoldisulphonic acid method. Total phosphorous was determined after the Deniger method.

RESULTS

Four classes of phytoplankton, chlorophyceae, dinophyceae, cyanophyceae and acilariophyceae are present in the Shen reservoir. There are twenty two species of chlorophyceae. The pattern of their occurrence showed variations both in species and total organism number for station and sampling period (Fig. 1). The results show that the dominant species were Volvox, Pediastrum, Chlorella, Closterium, Scenedesmus and Akistrodesmus. An analysis of the pattern of occurrence of the class showed that the highest percentage abundance of 57.95% occurred during the third period (Fig. 2). Based on total phytoplankton organism, the chlorophyceae has a mean of 15.88%.

The dinophyceae accounted for 16.32% of the total phytoplankton. In all, five species were encountered. The dominant members of this group were species of Ceratium, Peridinium and Chlorococcus.

The cyanophyceae were represented by twenty species. Based on total phytoplankton composition, they contributed 33.13% (Fig. 3). Dominant species of the group were Microcystis, Nostoc and Oscillatoria. An analysis of variance indicated that the group was influenced by water volume and temperature.

The bacillariophyceae contributed 32.67% of the total phytoplankton population. They were represented by thirteen species of which the dominant ones were Navicula, Nitzchis, Synedra, Tabellaria and Molosira.

Variations in the water characteristics of the Shen reservoir indicate some degree of change both with sampling period and station (Fig. 5). From this, it will be seen that for a tropical system, the surface water temperature was low (18.50 - 20.60°C) during November to January. However, during April to June, the temperature ranged between 32.0 - 37.5°C. The periods of minimum and maximum surface water temperature corresponded with that of the air temperature fairly closely. The distribution of other physico-chemical features of the lake during the period of study is presented in Fig. 5. From this we note that the turbidity of the reservoir was low from November to January increasing gradually through intermediate values to higher values from April to June. Inspite of the foregoing pattern of turbidity, absolute values indicate that light penetration did not fall below 25.00 centimeter. Hydrogen ion concentration fluctuated between 6.2 and 10.5. The mean pH was 8.35 indicating that the reservoir is generally alkaline. Dissolved oxygen values varied from 5.10 - 6.95 milligrams per litre, while percentage dissolved oxygen saturation values similarly varied from 56.80 - 85.96%. The phosphorous content was very low and showed very little variation with season and sampling period. The nitrate nitrogen values ranged from 55. ug per litre to 85 ug per litre and exhibited marked seasonality in all sampling stations.

DISCUSSION

The phytoplankton density showed significant direct relationship to both water temperature and percentage dissolved oxygen (Fig. 4). The chlorophyceae were the least abundant plankters but show high species diversity. The low occurrence of the group is indicative of the eutrophic status of the reservoir. Though the chlorophyceae showed high species diversity only Pediastrum, Scenedesmus, Closterium and Staurodesmus occured throughout the period of study. An estimate of the evenness value suggests that both seasonal water characteristics and specific features of

the different sampling stations all influenced chlorophyceae abundance (Fig. 1 & 4).

The cyanophyceae and bacillariophyceae were the two most dominant phytoplankton both together contributing 65.78% of the total phytoplankton component. The dominance of these groups would appear to be related to the trophic status of the reservoir. Productive waters exhibit a high nyxophycean index (Nygaard 1949). Positive correlations between phytoplankton production and secondary production indicate that high levels of primary production lead to high levels of secondary production. Although phytoplankton production is basically related to zooplankton production, benthos production seems to be related to the inverse of mixing depth. From a preliminary survey of vertical distribution of temperature, the lake appears to be well mixed due to wind action. Similar observations have been made in the Tiga lake (Abdullahi (1982) . The evidence for good mixing is supported by the non-significance of the analysis of variance test for stations. This feature would favour high production of both phytoplankton, benthos and subsequently fish. For the dinoflagellates, the low species diversity indices suggests that the reservoir was yet unfavourable for their growth. Quantitative analysis of species composition indicate that there is a close relationship between the sequence of dominant species with changes in physico-chmeical parameters and sampling period (Fig. 4).

The analysis of variance estimate shows that there were significant changes in the physico-chemical characteristics of the Shen reservoir during the period of the study. It is further demonstrated that a distinct pattern of variation is in operation in the reservoir such that it exhibits high potential eutrophic status. The turbidity value inspite of the pattern of variation, the minimum values permitted light penetration to depths (minimum depth 25.0 cm) high enough for high phytoplankton photosynthesis and thus primary productivity. The high turbidity recorded between April to June was due to an increase in suspended solids from surface run-off, and river and stream discharge into the lake. The low turbidity values in period I may be due to sedimentation of suspended solids and absence of river run-off. Thomas and Ratcliffe (1973) have recorded similar observations in the Nunguna reservoir Ghana.

Dissolved oxygen values were high enough (minimum 5.00 mg/litre) to maintain active metabolic and physiological activity for fishes of high biomass. It is plausible that the seasonality shown by oxygen has been occassioned by such factors as reservoir volume, phytoplankton development, water temperature, aerating action of wind and mixing brought about by turbulence. The pH was largely alkaline (mean 8.3). The fluctuations were probably due to water volume and river inflow with biogenous material. However, the pH change was generally good for fish production. Carbonate alkalinity was detectable and bad a mean value of (36.95 ppm) during the period of study. Thus the reservoir is slightly alkaline and ideal for many biological processes.

Nitrate - nitrogen and phosphate - phosphorous are most important in determining the productivity of waters being both indispensable for biological growth processes. Phosphate - phosphoruous had a mean concentration of 1.0 ug per litre during the period of the study. The very low concentration of this nutrient during the rains makes the possibility of its replenishment from leaching an unlikely occurrence. Thus the maintenance of the recorded level may be from reservoir sediments during occassions of high pH of the overlying waters. Future fish culture development in this reservoir would thus entail the addition of fertilizers to increase the PO_4-P content and enhance phytoplankton growth. Nitrate-nitrogen levels in the reservoir appears to be elevated following run-off from inflowing rivers during the rains. Nutrient concentration and mixing both have management potentials. The control of production through alterations in nutrient imput has obvious management advantage and has been applied to increase production in fish ponds as well as to decrease production in systems where nutrient imput adversely affects water quality.

Fish production has been shown to depend on the production of plankton, benthos, morphometric, edaphic and climatic factors (Rowson 1960). Although Moyle (1956) stressed the importance of total alkalinity, Northcote and Larkim (1956) emphasized dissolved nutrient. Based on the physico-chemical characteristics of the reservoir, quantitative estimate of phytoplankton composition and species diversity indicates that the Shen reservoir has a high potential for fish production.

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