P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of Agriculture and Biosciences

www.ijagbio.com; editor@ijagbio.com

Research Article

Assessment of Phytoplankton Community of Beresa Reservoir and Its Implication to the Water Quality

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Article History: Received: February 23, 2017 Revised: June 20, 2017 Accepted: July 10, 2017

ABSTRACT

Beresa reservoir has been exposed to industries and anthropogenic activities from local people in past years. In order to assess the water quality status of the reservoir, the phytoplankton community (species composition) and their relative abundance was examined during the study period, from January-June, 2016. Species belonging to different classes were identified including Chlorophytes (green algae), Baccilariophytes (diatoms), Cyanophytes (blue-green) and cryptophytes. Chlorophytes were the most dominant in terms of species richness and abundance and it is constituted about 40% of the total algal population. *Scenedesmus* spp, *straurastum* spp, *Cosmarium* spp and *Closterium* spp were the most abundant spp in the class. Baccilariophytes were represented by *Cyclotella*, *Aulacoserial*, *Melosira* and *Nitzschia*, whereas Cyanophytes were relatively dominated by *Microcystis flos-aquae*. The least of number of species was recorded for Cryptophytes and *Cryptomonas* spp was relatively dominant in the class. The relative dominance of phytoplankton species including *Straurastum* spp, *Cosmarium* spp, and *Closterium* spp indicated moderate enrichment of nutrients in the reservoir. Whereas, the presence of scarce Cyanaophytes likes *Microcystis flos-aquae*, *Oscillatoria agardhii* depicted an increasing trend in nutrient content of the reservoir. The result seemed to indicate that the trophic status of the reservoir to fall in mesotrophic state and at the time of this study the reservoir was not susceptible to generational algal blooms.

Key words: Beresa reservoir, Biomass, Phytoplankton, Water quality

INTRODUCTION

Ethiopia is endowed with many rivers, lakes and wetlands which have been serving as a source of drinking water, power generation, irrigation etc. On the other side, ecosystems of many of these aquatic habitats have been degraded by several anthropogenic impacts (Tenalem Ayalew and Dagnachew Legesse, 2007). In order to suggest well defined management options for our aquatic ecosystems, first their current status and extent of damages should be well studied using appropriate and integrated methods.

Physical (e.g. conductivity) and chemical (nutrients) parameters have been used as water quality indicators for many years in many countries (Vantella *et al.*, 2011). Similar approaches were most commonly used in our country and the role of biological indicators was ignored. Monitoring our aquatic ecosystem using these methods (physical and chemical) has been expensive and demanded well trained expertise so that it was difficult to use such methods for rapid assessment. Water quality is an assemble of physical, chemical and biological characteristics of the given water (Straskraba and Tundisis, 1999). As aquatic organisms continuously live in the environment, they respond to changes, such as an increase in pollutants level, in the habitat over a certain period of time.

Phytoplankton is one of the key biological elements to be used for assessment of ecological status in lakes. Both biomass as well as taxonomic composition should be used to assess ecological status. Phytoplankton communities are very sensitive to environmental changes in their environment and therefore their species composition and biomass can be considered as indicators of water quality (Reynolds, 1997; Reynolds *et al.*, 2002; Brettum and Andersen, 2005). Phytoplankton communities give more information on changes on water quality than mere nutrient concentrations assessment. Hosetti (1987), in his studies on the role of algae in the sewage purification, also revealed that Chlorella,

Cite This Article as: Tariku N and G Tamire, 2017. Assessment of phytoplankton community of Beresa reservoir and its implication to the water quality. Inter J Agri Biosci, 6(3): 149-152. www.ijagbio.com

Microcystis and Scenedesmus may be considered as indicators of organic pollution. Eutrophication of fresh water is regarded as a serious water quality issue which results in the deterioration of the aquatic environment and impacts and water usage. Cyanobacteria have been recognized as a major symptom of eutrophication in fresh water as their blooms are prevalent in waters affected by cultural nutrient enrichment (Reynolds, 1984; Moss, 1998).

The ecosystem of many rivers is under stress globally due and several factors, among which municipal and industrial waste water discharge, water runoff from agricultural areas, and hydro morphological alteration are the most significant factors (Vantella *et al*., 2011). Beresa river and its reservoir is among some of Ethiopian rivers which is providing water to the industries and local people for several purposes although its current status has been rarely monitored and managed using Biological Quality Element (BQE). Therefore, there is a need of develop defined strategies using BQE for the river and the reservoir considering the fact that it is exposed to human interventions.

Now a day, phytoplankton communities of many Ethiopian water bodies have been described by many researchers so as to assess the ecological status and develop well defined strategies to manage the ecosystems. However, the phytoplankton community of Beresa reservoir was not assessed in such studies and has not been included in the development of metrics which hindered the establishment of well-defined strategies to monitor and manage the ecology of the reservoir. Therefore, this study will attempt to assess phytoplankton community of this reservoir (which is currently exposed to anthropogenic impact and flow of industrial wastes in to the river). Hence, this study is intended to assess the current status of the reservoir using BQE, particularly phytoplankton. The assessment will lay base for future monitoring studies on this river since the phytoplankton composition of this reservoir will be described in detail.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Debre Birhan town, near Debre Birhan University. The town is located in North Showa zone in Amhara Regional State which is located 130 km far from Addis Ababa and 659 km far from the capital city of Amhara Regional State, Bahir Dar. It is located 09^0 45' North latitude and 36^0 31' East longitudes and also found on the plateaus of central Ethiopia high land at average elevation of between 2800 and 2845 meter above sea level (fig 1). It receives 695 and 721 ml annual average of rainfall and has average temperature of 6-20^0 c. recently; the probability of Beresa River to become severely impacted by industries as the number of industries is increasing.

Sampling design, method of data collection and laboratory work

Samples were taken using random sampling method from two sites of the reservoir. A phytoplankton net with mesh size of 30µm was used to haul vertically. One litter of sample from different depth of the river was taken and mixed to obtain composite sample from each site. The samples were fixed with Lugol's iodine solution. Then the samples were poured carefully into graduate cylinder and allowed to settle for more than 24 hours before identification and determination of abundance, Kobayashi *et al*., (1998). After settling the sample, sub samples were taken for identification and enumeration from the bottom by decanting gently the sample. Phytoplanktons were identified using keys developed by Whitford and Schumacher (1973) and Komarek and Cenberg (2001). Identification and enumeration of phytoplankton were done using compound microscope.

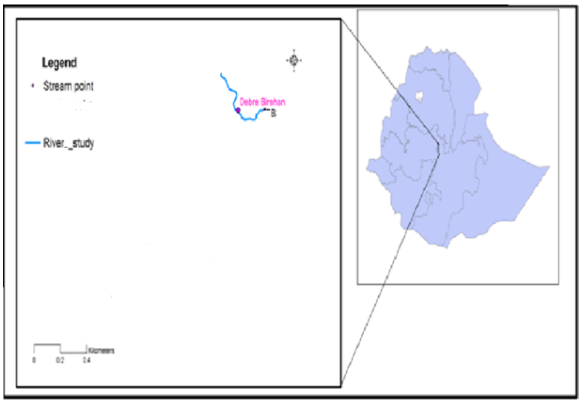

Fig. 1: The study site/area on the map

Data analysis

The relative abundance of phytoplankton was analyzed with simple descriptive statistics (percentage composition etc.) using excel spreadsheet.

RESULTS AND DISCUSSION

Phytoplankton identified in this study mainly comprised of four major classes (Table 1). Thirteen species were identified from these classes. Chlorophytes (green algae) were the most dominant class and it constituted nearly 40% of the total population (Table 2, Fig 2). Six species were identified from this class. Among these species, *Scenedesmus, Straurastum, Cosmarium,* and *Clostrium* spp were more dominant in the class.

Next to Chlorophytes, Baccilariophytes (diatoms) which were represented by *Cyclotella* spp, *Aulacoseira melosira* and *Nitzschia* spp were more dominant than Cyanophytes (blue-green algae) and Cryptophytes and they accounted nearly 30% of the total phytoplankton population sampled (Table 2). Cyanophytes and Cryptophytes were relatively represented by fewer numbers of species and lower abundance each species. They made up only 20% and 10% of the phytoplankton composition respectively. Cyanophytes were dominated by *Microcystis flosaquae, Ocillatoria agardhii and Aphanizomenon* Spp. Especially; Cryptophytes were represented only by a single species, *Cryptomonas* (Table 1).

Phytoplankton diversity of Beresa Reservoir was low compared to other Ethiopian reservoirs. Hadgembes Tesfaye (2007) was able to sample and reported that 36 phytoplankton species were identified from Koka Reservoir. The lower species diversity of phytoplankton in the river Beresa could be due to lower water temperature, lower nutrient status of the lake and the presence of strong grazers in the reservoir. However, all these speculations need additional data to confirm the cause. The other probable reason could be lower sampling effort.

The presence of *Scenedesmus* spp, *Straurastum* spp, *Cosmarium* spp and *Clostrium* spp could probably indicate the reservoir to be moderately rich in nutrients (mesotrophic) (WFD, 2000). The presence of *Nitzschia* diatom with good number could also indicate the moderate enrichment as most species (not always) of *Nitzschia* are indicators of moderate enrichment (Schaumberg *et al*., 2004).

Table 1: The identified phytoplankton species in the study

Class	Species list
Chlorophytes	Scenedesmus spp
	Straurastum spp
	Cosmarium spp
	Clostrium spp
	Spirogyra spp
	Chlorococcus spp
Baccilariophytes	Cyclotella spp
	Aulacoseira melosira
	Nitzschia spp
Cyanophytes	Microcystis flosaquae
	Ocillatoria adardhii
	Aphanizomenon spp
Cryptophytes	Cryptomonas spp

Table 2: Relative abundance (in percentage) of phytoplankton in the reservoir

Class	Abundance (%)
Chlorophytes	40%
Baccilariophytes	30%
Cyanophytes	20%
Cryptophytes	10%

The presences of Cyanophytes like *Ocillatoria agardhii*, *Microcystis*, *Aphanizomenon* were indicators of nutrient rich reservoirs and eutrophic or high tropic level environments (De Bernardi and Guissani, 1995). Although these species were not dominant in this reservoir, their presence could indicate the increasing in enrichment trend in the reservoir. These Cyanobacteria are known for their extensive and highly visible blooms that can form in both fresh water and marine environments when conditions are conducive for them. Especially, higher PH and nutrient favors the formation of bloom of these organisms (De Bernardi and Guisanni, 1995). The blooms can have the appearance of blue-green giant or scum. These blooms can be toxic and frequently lead to the closure of recreational water when spotted. Several studies have reported increased phytoplankton, especially cyanobacteria due to the discharge of nutrients in to water bodies. Therefore, great care should be taken in activities around the reservoir that can add nutrient to prevent bloom of these blue-green algae.

Cryptomonas typically resided near the oxic-anoxic boundary of the water column; however, they actively migrated upward during the day and descended to lower anoxic locations at night apparently responding to diurnal changes in their local habitat (Charles, 2003). Their nocturnal environment had moderate levels of sulfide, elevated secondary nutrients and a community of anoxic phototrophic bacteria, whereas their day time environment had higher light.

The result of this study could have implications for understanding anthropogenic effects on aquatic ecosystems. Specifically, an increasing trend in concentrations of phosphorus and other nutrients due to runoff from human activities could induce the moderate enrichment of the reservoir. In addition morphology of the dominant phytoplankton in the reservoir, especially *Scenedesmus* spp, *Cosmarium* spp, *Ocillatoria agardhii* made them more difficult for grazers (zooplankton) to consume because of their spines and large size. In addition, as *Microcystis* species live in colony, they are difficult to manage for grazers beside their toxicity. Therefore, constitutive defense with increased production in response to increased resource availability could exacerbate algal blooms caused by anthropogenic eutrophication. Ultimately, such defenses could diminish the top-down control by zooplankton to exert on blooms through grazing. Therefore, bottom-up (e.g. managing nutrient enrichment) regulation methods should be considered in Beresa Reservoir to prevent the bloom formation.

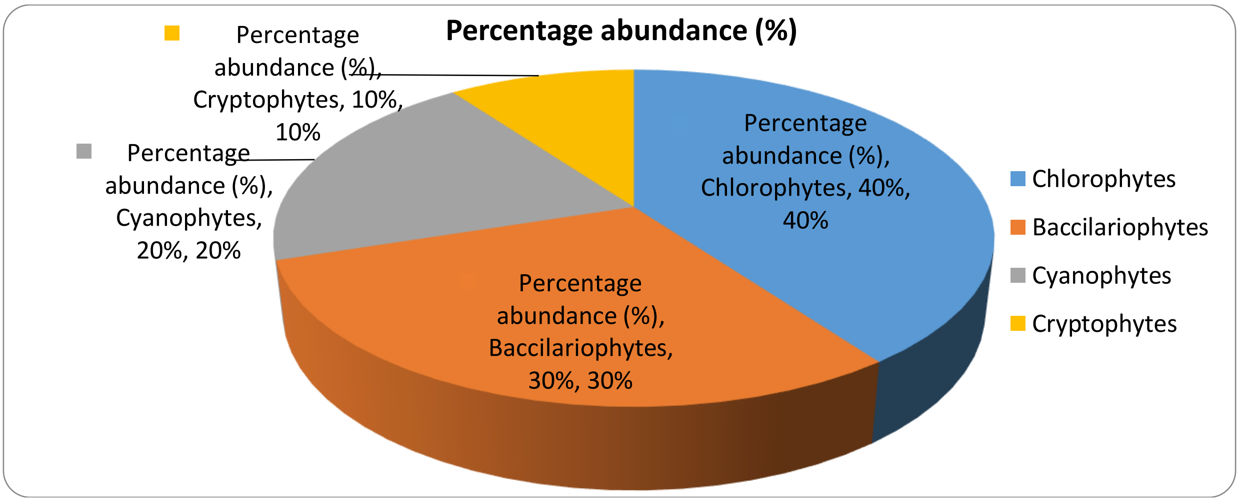

Fig 2: Relative abundance of major phytoplankton in the reservoir.

Conclusions

The assemblage of phytoplankton community in Beresa Reservoir indicated the reservoir's lower richness with regard to species abundance and diversity compared to other Ethiopian Reservoirs. Green algae were predominant in the reservoir whereas blue-green algae and cryptophytes had rare occurrence. However, the general composition of phytoplankton in the reservoir indicated the enrichment trend. It can be concluded from the phytoplankton composition that Beresa Reservoir is under stress due to several factors mainly due to wastes from agricultural areas, local people, industries particularly textile factory and Debre Birhan University. Unless some interventions are taken by the officials of the town and the university, there are clear indications (e.g. presence of blue-green algae) that there is high possibility for the reservoir to turn to eutrophic state.

Recommendations

Based on the results of this study, some particular points which need greater attentions of the concerned governmental, non-governmental and other agencies are recommended as follows.

- Wastes that are being dampened from Textile factory, Debre Birhan University and local people should be stopped or treated before it is released.
- The Reservoir should be protected from excess utilization by local people especially from those people who use detergent as it can enrich the reservoir more.
- Continuous monitoring study should be done by the University to follow the status of the reservoir and suggest appropriate intervention techniques.

Acknowledgments

I would like to express my gratitude to Debre Birhan University, college of natural and computational science, department of biology laboratory technicians for their contribution and willingness in providing the necessary lab materials of the study and follow up in every step of my laboratory work.

Expressing sincere gratitude, reverence and special thanks to Dr Girum Tamire for his general guidance, valuable suggestions and support throughout the perusal and completion of the study.

REFERENCES

Brettum P and T Andersen, 2005. The use of phytoplankton as indicators of water quality. NIVA-report SND 4818-2004.

Charles WK, 2003. In: A text book of applied aquatic biology. J Phycol, 39: 855-861

De Bernardi, R and G Guissani, 1990. Are blue green-algae suitable food for zooplankton? An overview. Hydrobiologia 200/201:29-41.

Gunter G, RH Williams and CC Davis, 1987. Catastrophic mass mortality of animals and coincident phytoplankton bloom on the West coast of Florida. Ecological monographs, 18: 310-316.

Tesfaye H, 2007. Spatio-Temporal Variation of the Biomass and Primary Production of Phytoplankton in Koka Reservoir, MSc. Thesis. Addis Ababa University, 85pp.

Hosetti BB, 1987. Performance of sewage stabilization ponds at different depths. Water, Air, Soil Pollution, 34: 191-198.

Kangalawe RYM and ET Liwenga, 2005. Livelihoods in the wetlnads of Kilmbero valley in Tanzania: opportunities and challenges and integrated water resource management. Earth, 30: 968-95.

Khatri TM, 1987. Seasonal distribution of phytoplankton in Idukki reservoir of Kerala, India. Environ and Ecol, 3: 134-137.

Kobayashi T, A Church, S Hardiman and L Gallgher, 1998. Grazing by a resident macrozooplankton community and non-resident Daphnia carinata King: A preliminary in situ incubation study, Lake and Reservoirs: Res Manag, 3: 193-203.

Komarek J and G Cenburg, 2001. Some of Chroocaccalean and Oscillatoriaean Cyanoprokaryotes from South African Lakes, ponds and pools. Nova Hedwigia, 73: 129-160.

Moss B, 1998. Ecology of fresh waters man and A medium, past and future. 3rd edition, Black well science Ltd.

Palmer CM, 1969. Algae as biological indicators of population. In: A text book of applied aquatic biology, (Hosetti, B.B. ed), Department of applied biology, Kuvempu University, Karnataka.

Reynolds CS, 1984. The ecology of fresh water phyto-plankton. Cambridge University press Great Britain.

Reynolds CS, 1997. Vegetation process in the pelagic. In: A model for ecosystem theory, (Kinne, O.ed), pp 1-371, Ecology Institute, Oldendorfluhe, Germany.

Reynolds CS, V Huszar, C Kruk and L Naselli, 2002. Towards a functional classification of the fresh water phytoplankton. S Plankton Res, 24: 417-428.

Schaumberg J, C Schranz, J Hofmann, D Stelzer and U Schmetdge, 2004. Macrophytes and phytobenthos as indicators of ecological status in German lakes-a contribution to the implementation of the Water Framework Directive. Limnologia, 34: 302-314.

Straskraba M and JG Tundisis, 1999. Reservoir water quality management. Guidelines of lack management. Volume 9, International lack environment committee (ILEC) Shiga, Japan.

Ayenew T and D Legesse, 2007. The changing face of the Ethiopian rift valley lakes and their environs call of the time lakes and reservoirs. Res Manag, 12: 146-165.

Vantella S, P Momir, M Branko, K Vasil, R Milica and M Donka, 2011. Water quality assessment Based on the macro invertebrate fauna-the pcinsa river case study. Water Res Manag, 1: 63-69.

Whitford LA and GJ Schumacher, 1973. A manual of fresh water algae. SPARKS PRESS, Raleigh, NC 323pp.

WFD, 2000. The Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing framework for community action in the field of water policy).