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Species Composition, Ecological Parameters and Seasonal Changes of Planktonic Ciliates Population in Bukan Dam Reservoir

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Abstract: Problem statement: Since there is no evidence to identify present species in the Bukan dam reservoir, therefore, this study was conducted to provide background for fisheries purposes. **Approach:** The abundance and species composition of ciliates were analyzed in the Bukan Dam reservoir (west Azerbaijan, Iran) from January to December 2007. Surface water samples were collected at monthly intervals at two different points, open water (Station 1, 3) and in the shallowest area of the reservoir (Station 2, 4) and examined for planktonic protozoa composition and density. Chlorophyll a was analyzed and a few ecological parameters such as dissolved oxygen, pH, turbidity and temperature were measured. **Results:** Totally 50 ciliates species were found in Bukan dam reservoir. Concerning the protozoa density, a high-density period was detected from January to April with a mean number of 2.86×10^3 cells.L^{-1} protozoa at Stations 1, 3 and 4.16×10^3 cells.L^{-1} protozoa at shallowest areas at stations 2, 4 thanks to disappear of phytoplankton in the winter. The summer development of protozoa was possible thanks to the development of bacteria and moderate metazooplankton densities due to the appearance of non-edible algae. The density of ciliates was low during the rest of the year. The mean number of organisms at the high-density period was approximately 4-fold more than that obtained during the low-density one. The ciliates occurring at the highest densities were *Coleps tessellates*, *Paradileptus elephantinus*, *Zosterograptus labiatus*, *Cyclidium citrullus*. **Conclusion/Recommendations:** It was concluded that ciliates density have important role for saprobic condition of Bukan reservoir. Therefore, it can be recommended to determine more effective parameters for density of ciliates and management policies must be programmed in order to improve ecological condition for this reservoir.

Key words: Plankton, ciliates, Bukan reservoir, West Azerbaijan, Iran

INTRODUCTION

Bukan dam reservoir is located in south part of west Azerbaijan, with the total length of 17 km. It has been formed by the building of the dam, 48 m high in 1969. The total volume of the reservoir is 650×10^6 m^3 and useful volume is 486×10^6 m^3 and total area is 45×10^6 m^2. The complex hydrobiological examinations with monthly sampling have been taken to study the pelagic ciliates on this reservoir, because the ecological role of planktonic cilliates as trophic links between bacteria and pelagic zooplankton has been increasingly appreciated during recent years (Foissner *et al*., 1999). Protozoa are known to play an important role by consuming bacteria and thus reducing their numbers in environments rich in organic matter (Javornicry and Perokesova, 1963). They also consume phytoplankton (Brook, 1952) and are consumed by Cladocera, Copepoda and Rotifera (Rerk *et al*., 1977) in addition to being highly efficient in releasing phosphorus (Porter *et al*., 1979). Study of the zooplankton cycle in a marine environment, showed that protozoa act as a link in the food chain of the sea between small planktonic organisms to the large metazooplanktonic herbivores (Smetacek, 1981). Ciliates graze on autotrophic and heterotrophic pico and nanoplankton and functioning as prey for larger zooplankton, contribute to the remineralization and cycling of nutrients (Blomqvist *et al*., 2001; Ventela *et al*., 2002). They play a pivotal role in the indication of pollution degree in lakes (Sonntag *et al*.,

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2002). The present investigation was undertaken to study the abundance and frequency of planktonic cilliates and some ecological parameters in deep and shallow environment of Bukan dam reservoir.

MATERIALS AND METHODS

Three samples were taken in the middle water column by means of a 5 L sampler (Bernatowicz, 1953), 200 mL of this sample was fixed immediately with 8.6 mL of a saturated $HgCl_2$ solution and stained with 0.04% bromophenol blue (Pace and Orcutt, 1981). Three subsamples were counted in a chamber and examined with a microscope (×100). Protozoa were identified according to the work by Jahn *et al*. (1949); Pennak (1953) and Lynn (2008). Taxonomic identifications were based mostly on Foissner *et al*. (1999). Additionally the following physical and chemical factors were studied: visibility, pH, O_2, conductivity and biogens (TN, PO_4, $N\text{-}NH_4$, $N\text{-}NO_3$). Visibility, pH, O_2 and conductivity was determined *in situ* using the Secchi disc and electrode Jenway 3405 and remaining factors were analysed in the laboratory, according to Hermanowicz *et al*. (1976).

RESULTS

The seasonal variations of water transparency, dissolved oxygen and chlorophyll a are shown in Fig. 1. Chlorophyll a fluctuation showed two distinct phases: A period from May to Jun during which showed values higher than those observed at a period from July to October during which the opposite occurred. The maximum chlorophyll a value observed at the reservoir water was 10.39 $\mu g.L^{-1}$ being obtained in May.

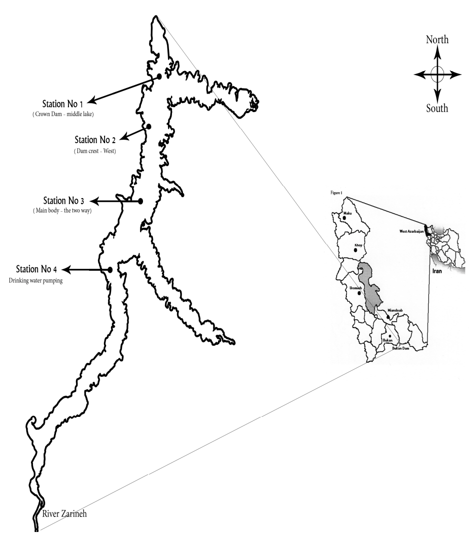

Fig. 1: Location of sampling and collection of data

Temperature and pH profiles at reservoir are shown in Fig. 2 and 3. The highest temperatures were recorded from July to September, with a maximum value of 27.5°C. The minimum values were observed in February, with values of 4.8. PH was between 7.3 and 8.55 during the study period at the reservoir.

The chemical properties of water including hardness, conductivity, PO_4, TN and BOD, N-NO3, N-NH4 were different among months and their particular values are presented in Table 1. These parameters confirmed mesotrophic status of the reservoir and were similar to that observed in other mesotrophic lakes (Carlson, 1977; Wetzel, 1983).

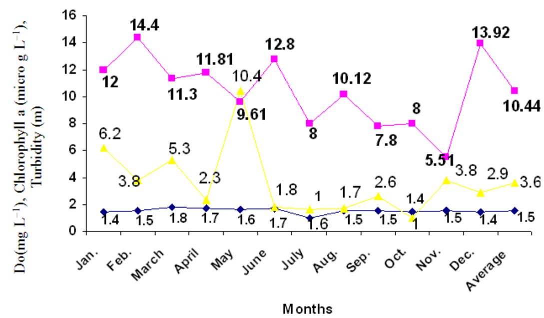

Fig. 2: Monthly variations of turbidity, dissolved oxygen and chlorophyll a

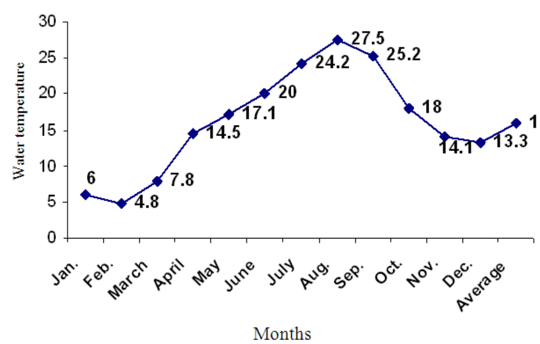

Fig. 3: Water temperature profile at Bukan reservoir-2007

Table 1: Chemical properties of water on Bukan reservoir-2007

	Hardness	Ec	PO_4	TN	BOD	$N\text{-}No_3$	$N\text{-}NH_4$
Jan.	150.40	61.40	0.14	1.09	6.42	1.60	0.20
Feb.	159.20	229.80	0.16	1.58	2.92	1.13	0.10
March	145.71	281.57	0.06	1.24	2.65	1.42	0.15
April	156.80	219.00	0.32	1.62	1.54	1.67	0.06
May	147.00	212.25	0.22	1.14	2.51	1.38	0.03
June	158.33	150.10	0.34	1.19	1.41	1.00	0.16
July	145.67	48.12	0.37	1.70	4.77	1.00	0.23
Aug.	141.75	46.65	0.04	1.39	2.19	1.00	0.12
Sept.	161.50	53.79	0.34	1.10	6.59	1.60	0.18
Oct.	173.00	73.09	0.09	1.22	5.69	1.00	0.15
Nov.	140.40	230.40	0.11	1.07	7.37	1.40	0.26
Dec.	172.80	53.64	0.15	1.73	4.87	1.14	0.15

Table 2: Ciliates taxa in open water and shallowest areas the Bukan reservoir

Ciliates species groups

Kinetofragminophora	Oligohymenophora	Polyhymenophora
Prostomatida	**Hymnostomatida**	**Heterotrichida**
Eoleps hirtus Nitzch.	*Tetrahymena pyriformis* Schewiakoff.	*Metopus es* Mull.
Holophrya atra Svec.	*Glaucoma chattoni* Corliss.	*Stentor polymorphus* Ehrb.
H. hexatricha Savi.	*Paramecium aurelia* Ehrb.	*S. roeseli* Ehrb.
Prorodon brachyodon Kahl.	*P*. caudatum Ehrb.	*Condylostoma rugosum* Kahl.
P. viridis Ehrb-Kahl.	*P. bursaria* Focke.	**Oligotrichida**
P. ovum Kahl.	*Frontonia acuminate* Kahl.	*Halteria grandinella* Mull.
P. teres Ehrb.	*F. leucas* Fabr.-*Dom.*	*Strombidium viride* Stein.
Coleps tesselatus Kahl.	*F. elliptica* Beard.	*S. mirabile* Penard.
Haptorida	*Urosentrum turbo* Mull.	*S. fallax* Zach.
Enchelys pupa Mull.-Ehrb.	*Stokesia vernalis* Wenrich.	*Strombilidium gyrans* (Stok.)
Didinium nasutum Mull.	**Scuticociliatida**	*S. velox* Faur.-Fr.
Paradileptus elephantinus (Svec.)	*Pleuronema coronatum* Kent.	*Tintinnidium pusillum* Entz.
P. conicus Wenrich.	*Cyclidium glaucoma* Mull.	*Tintinnopsis cylindrata* Kofoid.-Campbell.
Lacrymaria olor Mull	*C. citrullus* Cohn.	**Hypotrichida**
Pleurostomatida	*Vorticella nebulifera* Mull.	*Oxytricha minor* Kahl.
Litonotus lamella Ehrb.	*V. campanula* Ehrb.	*O. pellionella* Mull.
Nassulida	-	*Stylonychia mytilus* (Mull.)
Nassula citrea Kahl.	-	*Euplotes patella* Mull.
Zosterograptus labiatus Kahl.	-	*E. eurystomus* Wrz.
Trithigmostoma cucullalus Mull.		
T.steini (Blochm.)	-	*Aspidisca costata* Duj.

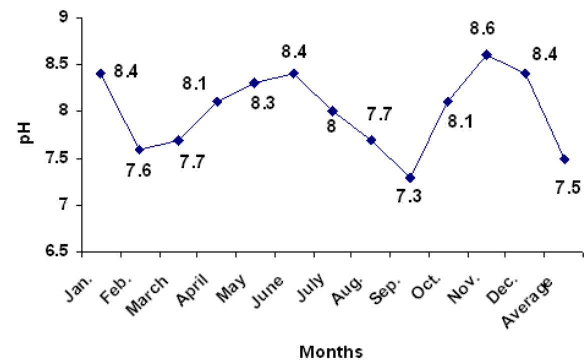

Fig. 4: pH profile at Bukan reservoir-2007

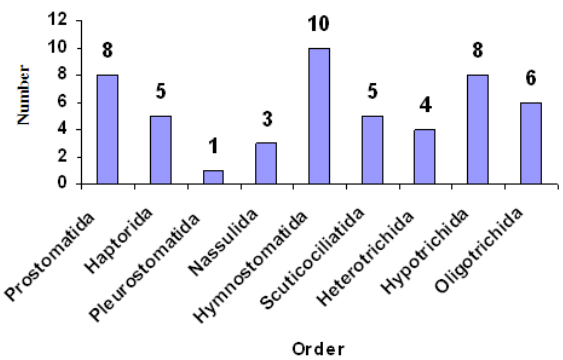

Fig. 5: Species number of Ciliates Classes at Bukan dam reservoir-2007

The composition and abundance (mean values) of the major ciliates taxa in open water and shallowest areas of Bukan reservoir are presented in Table 2 and Fig. 4.

A total number of 50 ciliates species were found in plankton samples. The most abundant species was belonged to Hymnostomatida (10 species) and the least species was belonged to Pleurostomatida (1 species). The seasonal distribution of Ciliates populations in the Bukan reservoir is presented graphically in Fig. 5 and 6. Three different periods can be observed with respect to the density of protozoa detected, i.e., a high-density period from January to April and from July to August and a low-density period from September to December.

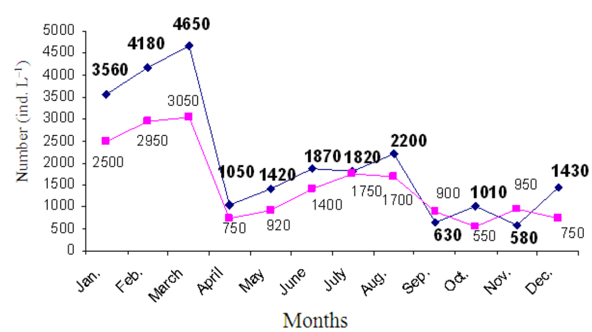

Fig. 6: Seasonal distribution of Ciliates population in the Bukan reservoir-2007

The mean number of organisms detected during the low-density period at autumn was about 1000 protozoa L^{-1} at the shallowest areas and 700 protozoa L^{-1} at open water. During the high-density period, the mean number at the shallowest areas was about 4000 protozoa L^{-1} while at the open water it was 2800 protozoa L^{-1}. Thus, during the high density period the mean number of organisms was approximately 4 fold that obtained during the low density period. The densities of ciliates showed clearly marked seasonal changes in Bukan reservoir. They fluctuated from 1 ind. mL^{-1} in April to 5 ind. mL^{-1} in March. During this period Prostomatida (*Coleps tesselatus*), Haptorida (*Paradileptus elephantinus*), Nassulida (*Zosterograptus labiatus*), Scuticociliatida (*Cyclidium citrullus*), Heterotrichida (*Metopus* sp.) and Oligotrichida (*Strombilidium gyrans*) constituted 60% of the total number of the ciliates.

DISCUSSION

Among the physico-chemical variables investigated at the Bukan Reservoir, temperature showed a pattern commonly observed in shallow and turbulent aquatic ecosystems. pH varied little around 7.5 and 8.5; the concentration of dissolved oxygen was between 5.75 and 14 mg L^{-1}, corresponding to 65-152% saturation, with the environment being well oxygenated throughout the study period. Chlorophyll a concentration, measured from Jan to Dec. 2007, was relatively low with a maximum of 10.39 µg L^{-1}. The highest densities of planktonic protozoa in the Bukan reservoir were observed from January to April. The densities of ciliates showed clearly marked seasonal changes in the reservoir. Also the peaks in the winter and the summer were probably determined by abiotic water factors. They were observed also in other eutrophic (Takamura *et al*., 2000) and hypertrophic lakes (Ventela *et al*., 2002). Protozoan abundance tended to increase with increasing lake productivity (Beaver and Crisman, 1990). The present study clearly showed that ciliates abundance correlated with reservoirs productivity, too. The concentration of appropriate food (bacteria, nanoflagellates and algae) are probably the major regulator of abundance, biomass and diversity of planktonic ciliates (Wisckowski *et al*., 2001). Very high densities of ciliates in late winter in Bukan reservoir might have been caused by the phytoplankton density. It seems that with the death of these organisms there is greater decomposition and consequently, a larger number of bacteria and amount of detritus available for the protozoa, which in turn increase in density. Similar situation relating a large abundance of protozoa after the death of the phytoplankton and simultaneous bacterial growth has been previously observed in Lake Dalnee-USSR (Sorokin and Paveljeva, 1972). The small bacterivorous ciliates, mainly Scuticociliatida are typical of mesotrophic lakes individuals in each sample (Beaver and Crisman, 1990). Also omnivorous *Coleps tesselatus* and *Vorticella* sp. dominated in pelagial of lakes in pH>7 and their importance increases with eutrophication (James *et al*., 1995). The highest densities occurrence of *Coleps tessellates*, *Paradileptus elephantinus*, *Zosterograptus labiatus*, *Cyclidium citrullus* in the late winter showed increasing of eutrophication in the reservoir that was happened with increased water entrance at this season. Totally, we may conclude that the Bukan dam reservoir was mesotrophic at the study period.

CONCLUSION

Totally, considering the physicochemical factors and population composition of ciliatae, we may conclude that the Bukan dam reservoir was mesotrophic at the study period.

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