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STRUCTURE AND DISTRIBUTION OF PHYTOPLANKTON FROM TASAUL LAKE

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ABSTRACT

The community structure and ecological function of lentic ecosystems are critically dependent on phytoplankton. Lake water sampling was carried out to identify the structure and abundance of phytoplanktonic communities. Species composition, biomass and diversity were studied from May 2005 to May 2006. Cyanobacteria were the dominant group throughout the year contributing with as much as 49% of the total biomass in the summer months, being surpassed only in December, when Chlorophyta was the dominant group with 34% of the total biomass recorded. Cyanobacteria's dominance could be a major risk to human and ecosystem health.

KEY-WORDS: phytoplankton, shallow lake, eutrophication

AIMS AND BACKGROUND

Lakes are aesthetically, ecologically, and recreationally important parts of our environment. Lakes have ecological importance because of their roles in the hydrologic cycle, maintenance of biodiversity, and temperature regulation. Lakes regulate stream flow, recharge ground water, and moderate droughts. Additionally, lakes provide a variety of habitats critical to plants and animals. Lakes may also serve to moderate temperatures in surrounding lands (Naimen et al., 1995). For these reasons, the continued existence and quality of lakes are an important consideration when faced with an increase in anthropogenic activities that threaten to degrade them. The growth and development of human population, associated with changes concerning land use, continues to be one of the main factors that influence the evolution of aquatic ecosystems, generating substantial modifications of water quality and severe habitat degradation. For lentic systems this situation is exemplified by an acceleration of the eutrophication phenomena. One of the most severe problems related with eutrophication of urban freshwater ecosystems is the occurrence of increasingly frequent blooms of cyanobacteria. Extensive growth of prokaryotic and eukaryotic microalgae can create considerable problems, including water quality deterioration and health hazards. Cyanobacterial blooms can cause a variety of water quality problems, including dissolved oxygen depletion and subsequent fish kills, aesthetic nuisances like increased odors, algal scum, fish tainting, decreased aesthetic quality (Oberholster, 2006).

The practical problems related with water supply, fisheries, recreation, are manifold and intricate and deserve a more profound research, covering all aspects and understanding the sequence of properties changes of the studied system.

This study investigates the taxonomic composition of phytoplankton assemblages in order to increase our insight into phytoplankton species richness and biovolume in Tasaul Lake. Phytoplankton are unicellular, microscopic plants, homogeneously mixed throughout the water column. Because of their rapid turn-over times (in the order of days), phytoplankton are sensitive indicators of environmental stresses. They respond rapidly to physical, chemical and biological factors, making them valuable in monitoring programs.

MATERIAL AND METHODS

Study site description

Tasaul Lake (44°21’00”N, 28°36’48”E) is a coastal lake formed at the mouth of river Casimcea, where its flow was blocked by a bar of sediments (sandbar). Tasaul is a shallow lake, with a maximum depth of 3.75 m, seriously affected by industrial and agricultural development. Phenomena like eutrophication and over-exploitation had an impact on the stability of the ecosystem, with special concerns on the biological diversity.

Sampling strategy

In order to outline the structure of phytoplanktonic communities we established a number of eight sampling stations, placed strategically near what we considered to be the main source points of nutrient and pollutants loads (Fig. 1).

Quantitative samples for phytoplankton were collected from the euphotic zone using a fixed volume device, the Nansen bottle (1 liter capacity). During the period of study, 56 water samples were collected and submitted to analysis. Biological samples were preserved with 4% formaldehyde solution.

Microscopic analysis

An inverted Zeiss microscope with an objective system for magnification up to 400X was used for species identification and cell counting. The sample is mixed by gently inverting the sample bottle. The predetermined sample volume is loaded into a counting chamber. The chamber is topped with a round glass top plate. Enumeration and identification are done by scanning parallel strips. The area counted is recorded as it is needed for cells per liter calculation. Biomass is determined based on morpho-metric measurements of phytoplankton units.

Fig. 1. Tasaul Lake sampling stations: 1) Domestic sewage from limitrophe human settlements 2) Industrial sewage 3) Sediments from adjacent rock quarry 4) Duck farm discharges 5), 6), 7) Tributary rivers loads 8) Agriculture runoffs

RESULTS AND DISCUSSION

Phytoplanktonic assemblages consist of individuals which can reflect the modifications within the abiotic components. The ecological survey of the phytoplanktonic communities allows an evaluation of the water quality and also an estimation of the trophic statute of the studied ecosystem. In the period of study, from May 2005 to May 2006, 84 phytoplanktonic species were identified, belonging to 6 major taxonomic groups as follows: Bacillariophyta 18 species, Dinoflagellata 6 species, Chlorophyta 41 species, Cyanobacteria 11 species, Euglenophyta 7 species and Cryptophyta 1 species (Fig. 2).

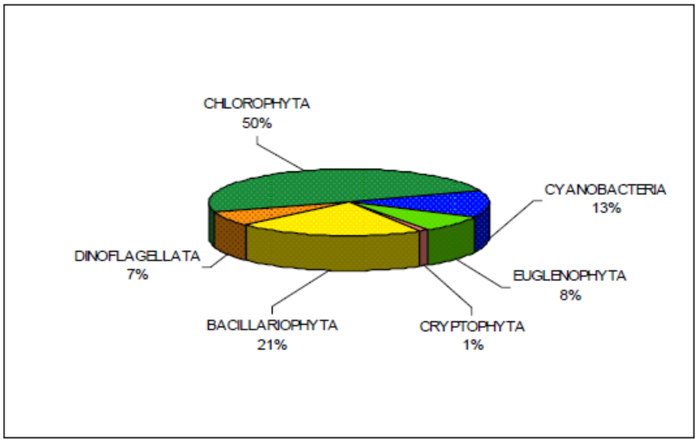

Fig. 2. Overall species share for each taxonomic group identified for Tasaul Lake in the studied period (May 2005 - May 2006)

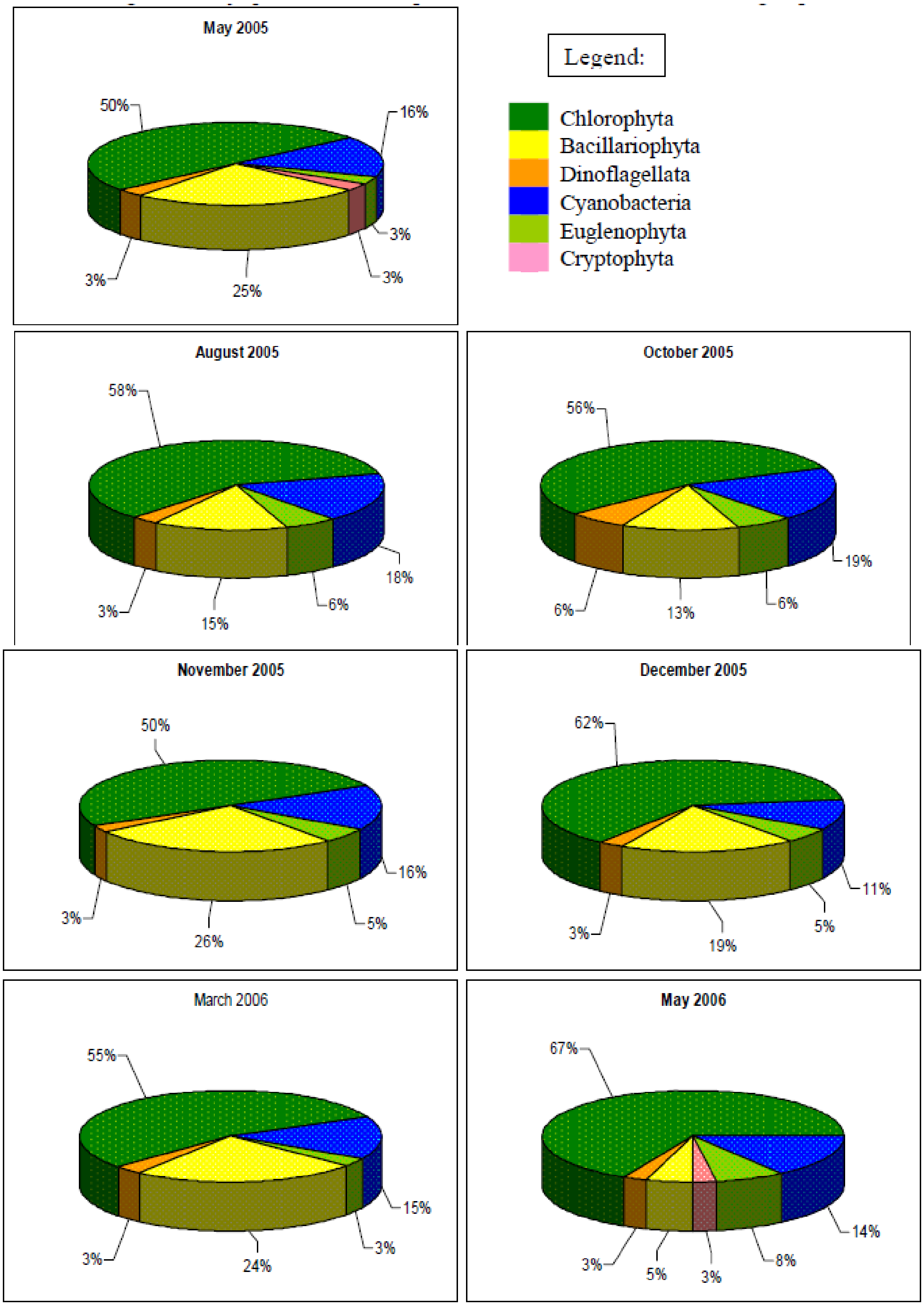

Fig. 3. Monthly species richness repartition for the identified taxonomic groups

Generally, the proportion of species for each taxonomic group identified remains the same throughout the year (Fig. 3 above), with the net dominance of Chlorophyta group, which can overtake up to 67% of the total number of species identified (e.g.: May 2006). Cyanobacteria group is best distinguished in the summer months, for which we registered very high water temperatures (e.g.: up to 26°C in August 2005) and high densities for this group. The weakest represented group of phytoplanktonic species is Cryptophyta, with a single species, pointed out only in samples from May 2006.

Our knowledge of the taxonomy and distribution of Tasaul Lake phytoplankton is scarce. The information gathered throughout the period of study materialized in a checklist comprising the presence of phytoplanktonic species (Table 1), but there is still a need for further study.

Table 1. List of species identified in Tasaul Lake in the period of study
***) BS = brackish water species FS = freshwater species**

Taxon	Ecologic Group *)	2005					2006	
		May	Aug	Oct	Nov	Dec	Mar	May
BACILLARIOPHYTA								
Thallassiosira nordenskioeldii. v. aestivalis	BS	+			+	+	+	+
Thallassiosira parva	BS		+		+	+		
Stephanodiscus sp.	FS						+	
Cyclotella sp.	BS	+		+	+	+		
Diatoma vulgare	FS		+					
Diatoma elongatum	FS						+	
Fragilaria capucina	FS	+	+					
Fragilaria crotonensis	FS	+	+		+	+	+	+
Synedra ulna	FS	+						
Tropidonesis lepidoptera	BS	+						
Coconeis sp.	BS					+		
Nitzschia acicularis	FS			+	+			
Nitzschia sigmoidea	FS	+						
Nitzschia closterium	BS			+	+			
Nitzschia tenuirostris	BS			+	+			
Navicula sp.	BS				+		+	
Gyrosigma acuminatum	FS						+	
Amphiprora sp.	BS				+	+	+	
DINOFLAGELLATA								
Peridinium minimum	BS	+						
Prorocentrum minimum	BS			+				
Prorocentrum micans	BS			+				
Peridinium aciculiferum	FS						+	
Peridinium latum	BS							+
Peridinee vegetative stages	BS	+	+	+	+	+	+	

CHLOROPHYTA								
Pediastrum boryanum	FS	+	+	+	+	+	+	+
Pediastrum tetras	FS		+	+				
Ankistrodesmus falcatus v.acicularis	FS	+	+	+	+	+	+	+
Ankistrodesmus arcuatus	FS	+	+	+	+	+	+	+
Ankistrodesmus mintissimus	FS				+	+	+	+
Ankistrodesmus convolutus	FS		+	+	+	+	+	+
Crucigenia tetrapedia	FS					+		
Actinastrum hantzschii	FS	+			+	+	+	+
Chodatella ciliata	FS		+		+	+	+	+
Lagerheimia genevensis	FS						+	
Chodatella citriformis	FS	+	+	+				
Chodatella quadriseta	FS					+		
Tetrastrum glabrum	FS	+	+		+	+	+	+
Tetrastrum staurogeniforme	FS		+	+				+
Scenedesmus quadricauda	FS		+	+	+	+		+
Scenedesmus armatus	FS	+	+	+	+	+	+	+
Scenedesmus acuminatus	FS	+		+	+	+	+	+
Scenedesmus ecornis	FS	+						
Scenedesmus alternans	FS							+
Scenedesmus intermedius	FS		+	+	+	+	+	+
Staurastrum tetracerum	FS	+						
Staurastrum cingulum	FS					+		
Tetraedron minimum	FS	+		+	+		+	+
Cosmarium bicardia	FS		+	+				+
Staurastrum cingulum	FS		+					+
Quadrichloris carterioides	FS							+
Oocystis Borgei	FS	+	+	+	+	+	+	+
Oocystis lacustris	FS			+			+	+
Oocystis sp.	FS	+			+			
Tetraedron minimum	FS		+			+		
Micractinium pussilum	FS				+		+	+
Hyaloraphidium contortum v.tenuissimum	FS		+	+				
Chlorella sp.	FS					+		
Micractinium pussilum	FS					+		
Golenkinia radiata	FS				+	+		+
Schroederia setigera	FS		+	+	+	+	+	+
Elakatothrix elachista	FS			+				
Kirchneriella lunaris	FS		+					
Kirchneriella contorta	FS	+						+
Closterium acutum	FS	+	+			+		+
Coelastrum sphaericum	FS					+	+	+

CYANOBACTERIA								
Microcystis pulverea	FS	+	+	+	+	+	+	+
Microcystis aeruginosa	FS	+	+	+	+	+	+	+
Anabaena spiroides	FS				+			
Anabaena sp.	FS				+			
Gomphospaheria lacustris	FS			+		+	+	+
Chroococcus minutus	FS			+				
Aphanothece sp.	FS	+	+					
Merismopedia punctata	FS						+	
Merismopedia tenuissima	FS		+	+				+
Aphanizomenon flos-aquae	FS	+			+			+
Oscillatoria sp.	FS	+	+	+	+	+	+	+
EUGLENOPHYTA								
Euglena polymorpha	FS		+		+	+	+	+
Euglena caudata	FS	+						
Euglena viridis	FS			+		+		+
Euglena sp.	FS			+				
Eutreptia lanowi	FS				+			
Phacus longicauda	FS		+					
Lepocinclis autumnalis	FS							+
CRYPTOPHYTA								
Chroomonas sp.	BS	+						+

The ecological survey of the phytoplanktonic communities of the shallow Tasaul Lake revealed the typical assemblages of eutrophic systems, and although the group of Cyanobacteria (Fig. 4) is not represented by a lot of species, their constancy and abundance throughout the seasonal cycles proves their dominance.

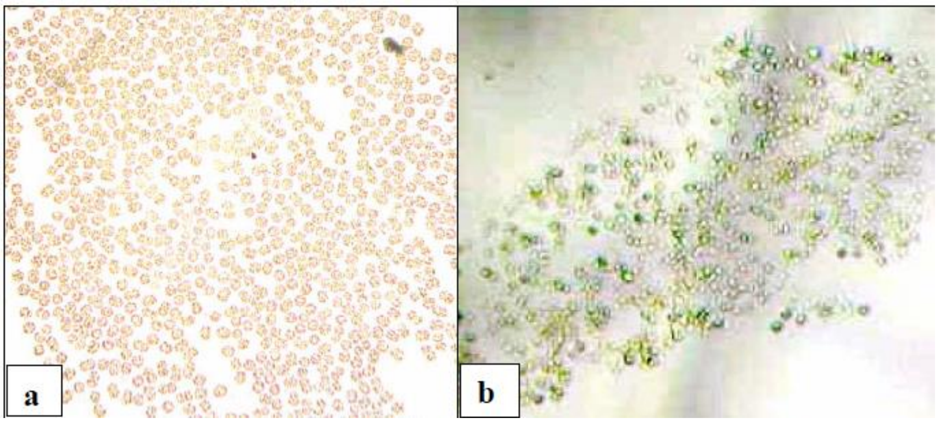

Fig. 4. Constant cyanobacteria species identified in Tasaul Lake;
a) *Microcystis aeruginosa* b) *Microcystis pulverea* (photo: Monica Iordan)

During the surveyed period phytoplanktonic communities registered seasonal variations for biomass (fig 5) and density (fig 6), as a normal response to environment parameters changes.

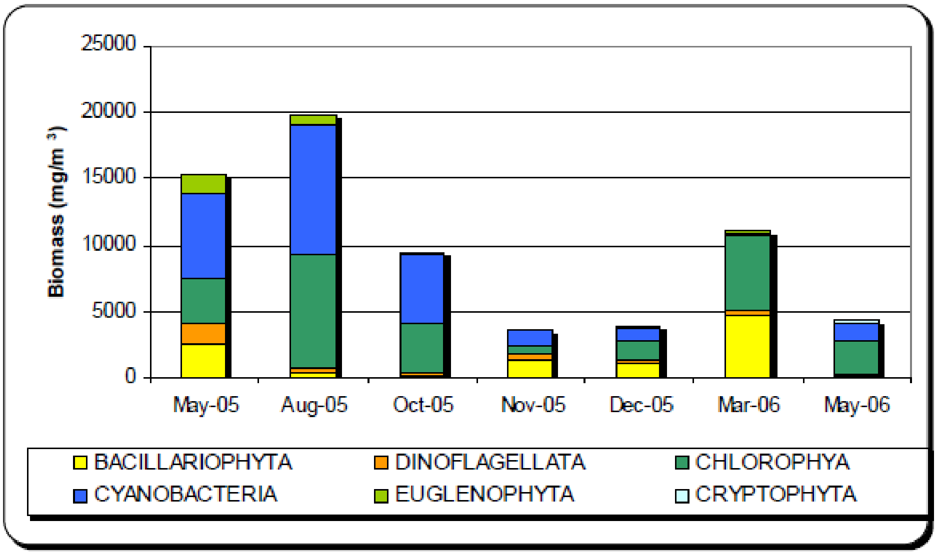

Fig. 5. Average biomass fluctuations of phytoplanktonic taxonomic groups through the period of study

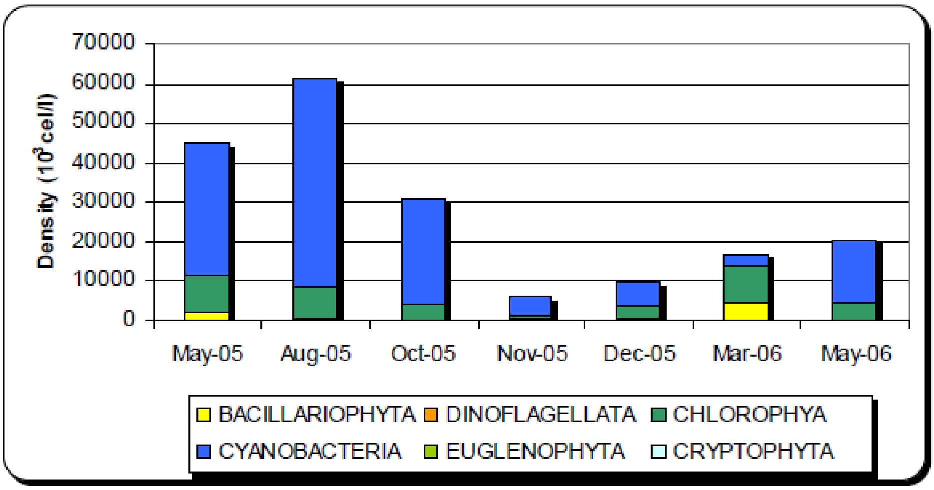

Fig. 6. Average density fluctuations of phytoplanktonic taxonomic groups through the period of study

As it is shown, although Chlorophyta species diversity is dominant (comprising 50% of the total number of species), Cyanobacteria species contribute to the high density registered especially in the warm season. Thus, in August 2005 species like *Microcystis aeruginosa* registered an average density of 30 400x103 cells/l, with a peak of high density for sampling station number 4, reaching up to 48 800x103 cells/l. This may be caused by the vicinity of a duck farm with the sampling station in discussion. An excess of nutrients caused by the fecal matters of a large number of ducks may cause algae blooms in the summer.

Table 2. Maximal densities of Tasaul Lake phytoplankton species

500-1000 x 10^3 cells/l   1000-10000 x 10^3 cells/l   >10000 x 10^3 cells/l

Species	Ecol. gr. [x)]	Density (10^3 cells/l)						
		May-05	Aug-05	Oct-05	Nov-05	Dec-05	Mar-06	May-06
Diatoma elongatum	FS	1880						
Fragilaria crotonensis	FS	950					7700	
Fragilaria capucina	FS	1890						
Pediastrum boryanum	FS		740	1380				
Ankistrodesmus minutissimus	FS						4760	
Hyaloraphidium contortum	FS		550					
Actinastrum hantzschii	FS					540	1820	
Scenedesmus quadricauda	FS		640	640				
Scenedesmus armatus	FS	14800	5600	2480	1520	5240	5280	5360
Scenedesmus intermedius	FS		6000	2520				620
Oocystis Borgei	FS	510						
Oocystis lacustris	FS						1200	
Merismopedia tenuissima	FS		3360	1920				
Microcystis pulverea	FS	73000	47600	13400	5000	8000	1000	9100
Microcystis aeruginosa	FS	17600	48800	39000	7700	4600		3130
Gomphosphaeria lacustris	FS			1000			5780	1860
Aphanizomenon flos-aquae	FS	15700						1700
Aphanothece sp.	FS	1940						
Oscillatoria sp.	FS	3000	8600		1000	2300	1000	14000

When nutrient inputs result in their enrichment in water and an unbalanced ecosystem, the relationships between the ecosystem compartments become intricate. For example, eutrophication can lead to an accelerated growth of phytoplankton. The result will very often be an increase in phytoplankton biomass and a subsequent reduction in the amount of light reaching the lake floor. It is well known that the effects of nutrient-driven eutrophication can be far less linear and more complicated in their expression. Understanding functional responses and stability in Tasaul Lake requires much basic research, which is still in an early phase. Thus, frequent summer cyanobacteria blooms can generate direct consequences (e.g. surface scum production, reduced water column transparency, increased oxygen consumption, nuisance odors, unpleasant aesthetics) as well as indirect events that may be related to biologic toxins released by some cyanobacteria species, changes in the trophic networks, alteration of the qualitative structure of the biotic communities, ecological unbalances.

Besides seasonal variations in phytoplanktonic communities, there was also observed a variation of numbers between the 8 sampling stations established (Fig. 7). This can be considered as a natural occurrence, as the shallow lake phytoplankton communities are homogenously mixed due to the lack of water column stratification, but we can also take into consideration the different point sources of pollution scattered around the lake perimeter.

Fig 7. Tasaul Lake phytoplankton biomass and density variation in the period of study, analyzed for each sampling station

On the whole, the biomass and density variations take place in normal limits, as a result of imposed environment conditions. Therefore the massive growth and development of some cyanobacteria species occur as a natural response to the combined stresses of the abiotic and biotic factors. Thus, the high temperatures, the input of nutrients, transparency decrease due to suspended organic matter, dissolved oxygen consumption, all favor the most adapted species, and in this case we are talking about highly resistant cyanobacteria.

The similarity coefficient used as a measure to determine the degree of association between biotic samples revealed a close similarity (Fig. 8) between the numbers of species of all the sampling stations, thus demonstrating the homogeneity of the phytoplanktonic communities, in spite of the different influences of the point sources identified. To this extent, the major differences between the sampling stations remain those concerning the density and biomass parameters.

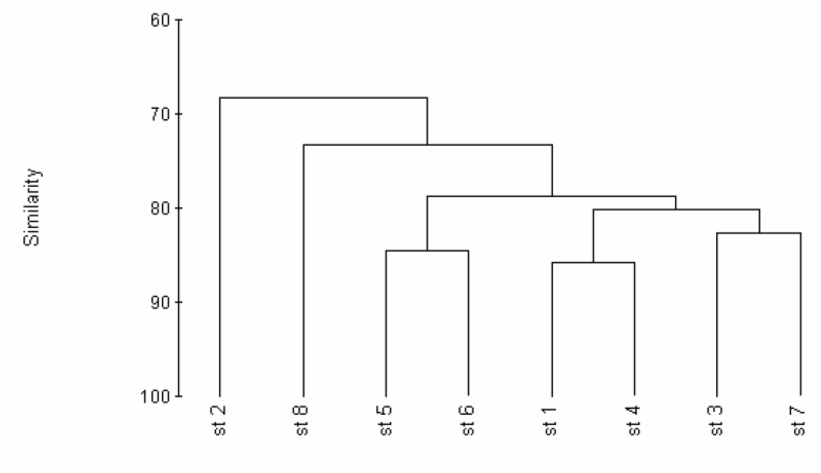

Fig. 8. Cluster analysis for the 8 sampling stations, May 2006

CONCLUSIONS

The purpose of the present study was to establish the phytoplanktonic community qualitative and quantitative structure, in order to outline the present trophic statute of Tasaul Lake, and also to keep a pertinent data base. Throughout the period of study 56 biological samples were examined. Close analysis of the samples revealed the presence of 84 phytoplanktonic species. The qualitative composition of the species draws the attention to the constant appearances of the cyanobacteria species *Microcystis aeruginosa* and *Microcystis pulverea*. These species, along with other cyanobacteria, *Oscillatoria* sp. and *Aphanisomenon flos-aquae*, are responsible for numerous blooms during summer months, with cell densities varying between 13.000 and 73.000 x 103 cells/l.

The unhealthy dominance of non-trophic phytoplanktonic species is the result of anthropogenic influences, and the main problem it is considered to be the substantial contribution with allochthonous substances in the lake water, substances through which the equilibrium of the ecosystem can be changed.

In order to establish the changes that may intervene in the lake system, a further approach of the lake parameters is imposed. Also, the lack of knowledge concerning the cyanobacteria toxins of the autochthonous species enforces a comprehensive study.

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