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Species diversity and quantity dynamics of freeliving ciliates of Agzibir Lake

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Abstract

In 2012-2016, the species diversity and dynamics of quantity and biomass of freeliving ciliates of Agzibir Lake were studied. Totally 161 species were discovered, of which 34 species were observed for the first time for Caucasus fauna. It is noted that, the greatest species diversity was observed in benthos on gray silt (78 species), then on the silt with plant residues (72 species) and further among the thickets of aquatic plants (phytociliocenosis-59 species). The minimum species diversity was observed in plankton (28 species), as well as in periphyton (24 species) and in benthos on black silt (33 species). Seasonal dynamics is characterized by a consistent change in seasonal species composition, and seasonal changes in the quantity have two maxima (in spring and autumn) and two minima (in winter and summer) in plankton and 3 maxima (in spring, summer and autumn) in benthos. The investigations showed that the role of free-living ciliates in the food chain of the reservoir is very high, and during the investigation of trophic connections in aquatic ecosystems, this group must be taken into account.

Keywords: ciliates, species diversity, seasonal changes, Agzibir Lake

1. Introduction

Agzibir Lake is located in 120 km to the north of Baku, on the western coast of the Middle Caspian (46^0 16^1 - 41^0 19^1North, 49^0, 03^1 -49^0 07^1 East). It is quite big (area 3600ha), shallow, the greatest depth is 3 m, brackish water body is 3.5‰, pH 7.2-8.3, i.e. weakly alkaline [1].

Currently, the Agzibir Lake is fed by atmospheric precipitation, ground water and the waters of three rivers - Shabranchay, Devechichay and Takhtakorpuchay. Accordingly, the maximum water level in Agzibir is observed in the spring, with the increase in the flow of rivers water. Due to the canal connecting it with the sea,this water body has a connection with the Caspian Sea in the spring. The biological and practical importance of Agzibir Lake is very great, since it and the canal connecting it with the sea includes valuable commercial fishes spawning [2] and their further development and growth from the larval stage to the fry. It is known that, free-living ciliates periodically developing to very high values of the quantity and biomass, are of great importance for the production and destruction processes of organic matter in water bodies [3, 4]. Being bacteriophages and algophages, on the one hand freeliving ciliates are active participants in the bio-purification process in the water body, and on the other hand, mass development with optimum temperature and abundance of food organisms, free-living ciliates themselves are food objects for small size groups of multicellular (Rotifera, Copepoda), as well as the larvae of many fish in the early stages of ontogenesis [5].

Based on the above mentioned, the investigation of species diversity and amount of the freeliving ciliates of Agzibir Lake has been carried out for the seasons of the year.

2. Material and Methods

Sampling was carried out on seasons in 2014-2016 in various parts of Agzibir Lake (Fig.1). Totally, 120 samples of plankton, benthos and coastal aquatic plants were collected for the determination of the ciliates species diversity. In addition, 115 more samples were collected, which were delivered and processed in the laboratory within the shortest possible time for the quantitative analysis.

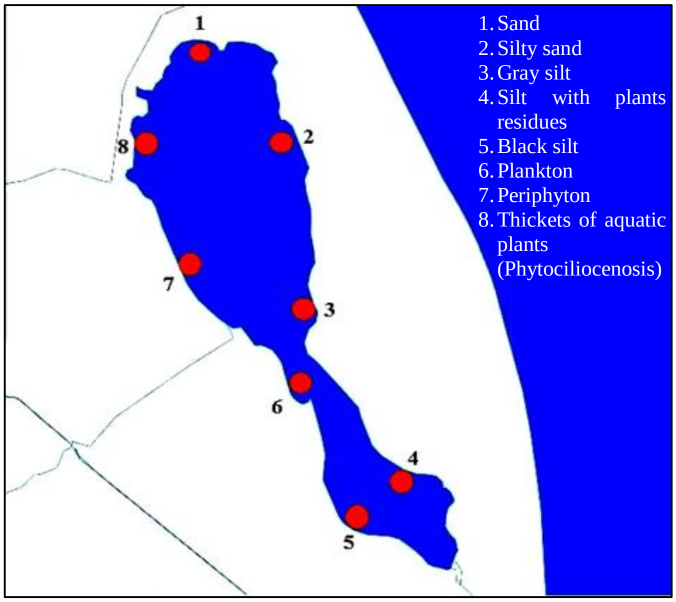

Fig 1: Sample points on the different biotopes of Agzibir Lake

A part of the samples was examined on the site, and the bulk of the collected material was processed in the Laboratory of Protozoology in the Institute of Zoology of the National Academy of Sciences of Azerbaijan. Ciliates were caught by microcapillaries, then studied *in vivo*. The methods of nitrate [6] and silver proteinate [7] impregnation were widely used for the detailed taxonomic processing. The determination of species composition was carried out in comparison with our impregnated preparations with a lot modern publications and major monographs, the authors of which used these mandatory in modern research methods [8, 9, 10].

Quantitative accounting was carried out by means of the modern cytometer "Flow Cam" (USA), and in some cases by counting live ciliates in Bogorov's chamber in 5 ml of each sample, followed by recalculation into 1 liter of water or 1 dm^2 of the bottom surface.

The comparison of the species diversity community was carried out by the Bray-Curtis cluster analysis method, a pairwise comparison of the species richness of various biotopes was carried out according to Chekanovsky-Sørensen [11].

3. Results and Discussion.

Totally, 161 species of freeliving ciliates were discovered during the investigation, of which 34 species were observed for the first time for the Caucasus fauna. Ciliates species composition and distribution are presented in Table 1.

Table 1: Ciliates species composition and distribution in the biotopes of Agzibir Lake.

Phylum Ciliophora Doflein, 1901	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Classis Kariorelictea Corliss,1974								
Order Loxodida Jankowski, 1980								
Fam. Loxodidae Butschli,1889								
1.*Loxodes rostrum (*Muller,1773)		+	+	+	+			
2.*L. kahli* Dragesco et Njine, 1971			+					
3.*L.rex* Dragesco,1970			+					
4.*L. vorax* Stokes, 1887 *		+						
Order Heterotrichida Stein, 1859								
Fam. Blepharismidae Jank. in Small et Lynn,1985			+					
5.*Anigsteinia salinara* (Florentin, 1899)								+
6.Blepharisma hyalinum Perty, 1849				+				
7.B.dileptus Kahl, 1928				+				
8.B.salinarum Florentin, 1899			+					
9.*B.undulans* Stein, 1868			+					
10.*Spirostomum minus* Roux, 1901					+			
11.*S. ambiquum* (Müller, 1786)			+		+			
Fam. Climacostomidae Repak,1972								
12.*Climacostomum virens (*Ehrenberg,1833*)*			+	+				
Fam. Condylostomatidae Kahl in Dofflein and R., 1927								
13.*Condylostoma fieldi* Hartwig,1973 *			+					
14.*C. granulosum* Bullington,1940				+				
15.*C. psammophila* Bock, 1954		+	+					
16.*C. reichi* Wilbert et Kohan, 1981	+							
17.*C. subterraneum* Lepsi, 1962		+	+	+				
18.*C. kasymovi* Alekperov, 1984			+	+				
19.*C.arenarium* Spiegel, 1926			+					
20.C.magnum Spiegel, 1926	+	+	+	+				
21.C.spatiosum Ozaki and Yagiu in Yagiu, 1944 *		+						
22. *Linostomella vorticella* (Ehrenberg,1833)						+		+
Fam. Stentoridae Carus,1863								
23. Stentor amethistinus Leidy,1880				+				+
24. S. polymorphus Muller, 1773)					+			
25. S. gracilis Maskell,1887			+					
26. S. roeselii Ehrenberg, 1835			+			+		
27.*S. mulleri* Ehrenberg,1831 *			+					
Order Stichotrichida Faure-Fremiet, 1961								
Fam. Amphisiellidae Jankowski,1979								
28.Amphiziella annulata (Kahl, 1928)		+	+	+				
29.A.turanica Alekperov and Asad., 1999			+	+				
30.A.milnei Kahl, 1932								+
31.*A.quadrinucleata* Berger et Foissner, 1989	+	+						+
32.*A. vitiphila* (Foissner, 1987) *		+						+
33. *A.marioni* Wicklow, 1982	+	+	+					
34.*Hemiamphisiella terricola* Foissner,1988								+
35.*Paramphisiella acuta* Foissner,1994						+		
36.*Paragastrostyla lanceolata* Hemberger,1985 *	+	+	+	+				
37.*Pseudouroleptus caudatus* Hemberger,1985			+	+				
Fam. Kahliellidae Tuffrau,1979								
38.*Kahliella acrobates*, Horvath, 1932								+
39.K. microstoma Alekperov,*1985*								+
40. *K. costata* Kahl, 1932	+		+	+				
41. *K. bacilliformis* (Gelei,1954)						+		
42. *K. costata* (Kahl, 1932) *		+	+					

Phylum Ciliophora Doflein, 1901	1	2	3	4	5	6	7	8
Fam. Oxytrichidae Ehrenberg, 1838								
43.Tachysoma rigescens (Kahl, 1932) *				+				
44.T. ovata Song et Wilbert, 1997			+					
45.Stylonychia bifaria (Stokes, 1887)				+				
46.*S. vorax* Stokes, 1885					+			
47.*S.quadrinucleata* Alekperov et Musaev,1988				+	+			
48.O.halophila Kahl, 1932			+					
49. O.ovalis Kahl, 1932	+	+						
50.O.discifera Kahl, 1932 *			+	+				
51. *G. kuehnelti* Foissner, 1987 *		+	+					
Fam. Keronidae Dujardin,1841								
52.*Kerona pediculus* (Muller, 1773) *	+							
53.*Paraholosticha herbicola* Kahl,1932	+	+	+	+				+
54.*Keronopsis longissima* Dragesco and Dragesco-Kerneis, 1986	+			+				+
55.*K. arenivorus* Dragesco, 1954		+	+					+
Fam.Pseudokeronopsidae Borror et Wicklow,1983								
56.*Pseudokeronopsis rubra* (Ehrenberg,1838)	+	+	+					
57.*P. sepetibensis* Wanick et Da Silva Neto,2004 *			+					
Fam. Bakuellidae Jankowski, 1979								
58. Bakuella marina Agam. and Alekperov, 1976			+	+				
59.B. crenata Agamaliev et Alekperov 1976		+	+	+				+
60.*B. polycirrata* Alekperov, 1988			+					
61. *B. munsterlandii* Alekperov,1992				+				
Fam. Pseudourostylidae Jankowski,1979								
62. *Pseudourostyla cristata* (Jerka-Dziadosz,1964)	+	+	+	+	+			
Fam. Urostylidae Bütschli, 1889								
63.*Urostyla marina* Kahl, 1932	+		+	+				
64.*U.grandis* Ehrb., 1830	+	+	+	+				+
65.*M. raikovi* (Alekperov, 1987)		+						
66.*A. pulchra* (Kahl, 1932)			+					
67. *A. randani* (Gluliere,1975) *				+				
68. *A. manca* (Kahl,1932)	+	+	+	+				
Order Euplotida Jankowski,1980								
Fam. Kiitrichidae Nozawa,1941								
69. *Musajevella minima* Alekperov,1984				+				
Fam. Euplotidae Ehrenberg, 1838								
70.*Euplotes raikovi* Agamaliev, 1966	+	+	+					+
71.E.harpa Stein, 1859		+	+	+	+			+
72.E.balteatus Dujardin, 1842		+	+	+	+			+
73.E.eurystomus Wrzesniowski, 1870				+				
74.E.gracilis Kahl, 1932	+	+						+
75.*E.haron* (Müller, 1786)			+					+
76.*E.alatus* Kahl, 1932 *				+				+
Fam. Aspidiscidae Ehrenberg, 1838								
77.Aspidisca fusca Kahl, 1928	+	+		+				
78.A.leptaspis Fresenius, 1865								+
79.A.pulcherrima Kahl, 1932			+	+				+
Fam. Uronychiidae Jankowski, 1975								
80. *Diophrys scutum* Dujardin, 1841	+		+	+				
81. *D.multicirratus* Alekperov, 1984			+	+				
82. *D.polycirratus* Alekperov, 1984								+
83. *D. oligothrix* Borror,1965		+						
84. *Uronychia transfuga* (Muller, 1776)			+	+				
85. *U. invicta* Alekperov, 1985			+	+				
86. *U. magna* Pierantoni,1909 *				+				
Classis Oligotrichea Butschli,1887								
Order Halteriida Jankowski, 2007								
Fam. Halteriidae Clap. et L. 1858								
87. *Halteria grandinella* (Müller,1786)			+			+		+
88.*H. maxima* Szabo,1934						+		
89.*H. bifurcata* Tamar,1968 *						+		+
90. *P. cirrifera* Kahl,1932 *						+		+

Phylum Ciliophora Doflein, 1901	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Order Strombidiida Jankowski, 1980								
Fam. Strombidiidae Faure-Fremiet,1970								
91.*Anthostrombidium rapulum* (Yagiy,1933) *			+			+		
92.*Arcostrombidium grande* (Levander,1894)						+		+
93.*A. clavellinae* (Buddenbrock,1922) *								+
94. *Limnostrombidium viride* (Stein,1867)						+		+
95. *Novistrombidium testaceum* (Anigstein,1914) *						+		+
96. *Pelagostrombidium mirabile* (Penard,1916)						+		
97. *S. obtusum* Alekperov et Mamaeva,1992						+		+
98. *S. cinctum* Kahl,1932								+
99. *S. kahli* Bock, 1952 *								+
Order Strobilidiida Jankowski, 1980								
Fam. Strombidinopsidae Small et Lynn,1985								
100. *Strombidinopsis claparedi* Kent,1881						+		+
101. *S. elongata* Song et Bradbury, 1998 *						+		+
Fam. Strobilidiidae Kahl in Doflein et R.,1929								
102.*Strobilidium caudatum* (Fromentel,1876)				+				+
103.*S.humile* Penard, 1922						+		
104.*S.conicum* Kahl,1932						+		+
Classis Armophorea Lynn,2002								
Order Metopida Jankowski,1980								
Fam. Metopidae Kahl,1927								
105. *Metopus acidiferus* Kahl,1935 *				+	+			
106. *M. caucasicus* Alekperov,1984					+			
107. *M. fuscoides*Alekperov, 1984				+	+			
Order Armophorida Jankowski, 1964								
Fam. Caenomorphidae Poche, 1913								
108. *Caenomorpha medusula* Perty,1852					+			
Order Haptorida Corliss,1974								
Fam.Encheliodontidae Foissner, Ag. et Ber.,2002								
109. *Encheliodon armatides* Foissner et al.,2002 *				+				
110. *E. nodosus* Berger et al., 2002 *			+					
Fam. Enchelyidae Ehrenberg,1838								
111. *Enchelys gasterosteus* Kahl,1926				+	+			
112. *E. marina* (Meunier,1910)			+					
113. *E. pectinata* Kahl, 1930 *			+					
Fam. Lacrymariidae Fromentel,1876								
114. *Lacrymaria olor* (Muller,1786)	+	+	+	+				
115. *L. marina* Kahl, 1933	+	+						
116. *L.issykkulica* Alekperov, 1997		+	+	+				
117. *L.acuta* Kahl, 1933								+
Fam. Spathidiidae Kahl,1929								
118.*Spathidium procerum* Kahl, 1930			+	+	+			+
119.*S.cetiforme* Alekperov,1984		+						
120. *Epispathidium ascendens* (Wenzel,1953) *		+	+					
Fam. Didiniidae Poche, 1913								
121. *Monodinium balbianii* Fabre-Dom.,1888	+	+		+	+			+
122. *Didinium nasutum* (Muller,1773)		+	+	+				
123. *D. chlorelligerum* Kahl,1935						+		+
Fam. Trachelidae Ehrenberg, 1838								
Fam. Amphileptidae Butschli,1889								
124. *Amphileptus claparedii* Stein,1867	+	+	+					
125. *L.triqueter* Penard,1922 *			+	+				
Classis Phyllopharyngea Puytorac et al.,1974								
Order Chlamidodontida Deroux,1976								
Fam. Chilodonellidae Deroux,1970								
126. *Chilodonella uncinata* (Ehrenberg,1838)		+						
127. *Trithigmostoma steini* (Blochmann,1895)	+	+	+	+			+	+
128. *T. cucullulus* (Muller,1786)	+	+	+	+			+	
Classis Nassophorea Small et Lynn,1981								
Order SynhymeniidaPuytorac et al., 1974								
Fam. Orthodonellidae Jankowski, 1968								
129. *Zosterodasys mirabilis* Alekperov,1984		+	+	+		+	+	
130. *Z. caspica* Fern.-Leb. et Alekperov,1995							+	

Phylum Ciliophora Doflein, 1901	1	2	3	4	5	6	7	8
131. *Z. cantabrica* Fern.-Leb. et Alekperov, 1995	+		+				+	+
Fam. Nassulidae, Fromentel,1874								
132. *Nassula ornata* Ehrenberg,1834			+	+			+	+
133. *N. parva* Kahl,1928	+	+						
Classis Prostomatea Small et Lynn,1985								
Order Prorodontida Corliss,1974								
Fam. ColepidaeNitzsch, 1827								
134.*Coleps remanei* Kahl,1933	+	+	+	+	+	+	+	+
135. *C. trichotus* Savi, 1913 *	+	+	+	+	+	+		+
136. *C. spiralis* Noland,1937 *	+				+			+
Fam. Holophryidae Perty,1852								
137. *Holophrya gracilis* Penard,1922							+	+
138. *H. nigricans* Lauterborn,1894			+	+			+	
139. *H. vorax* Dragesco, 1960	+	+	+	+				
Fam. Prorodontidae Ehrenberg,1834								
140. *Prorodon pluvatilis* Dragesco,1962 *		+						+
141.*P.lucens* Alekperov, 1985							+	+
Fam. Urotrichidae Small et Lynn,1985							+	+
142.*U.baltica* Czapik and Jordan, 1977							+	+
143. *U.turanica* Alekperov, 1977							+	+
144.*U.pelagica* Kahl, 1932			+				+	+
Classis OligohymenophoraPuytorac et al.,1974								
Order Peniculida Faure-Fremiet in Corliss,1956								
Fam. Frontoniidae Kahl,1926								
145.*F.leucas* (Ehrenberg,1833)	+	+	+	+	+			+
146.*F.elliptica* Beardsley,1902	+	+	+	+	+		+	
147.*F.obtusa* Song and Wilbert,1989 *								+
Fam. Lembadionidae Jankowski in Corliss,1979								
148. *Lembadion bullinum* Perty,1849	+	+	+	+	+			
149. *L. lucens* (Maskell,1887)			+	+			+	+
Fam. UrocentridaeClaparede et Lach.,1859								
150. *Urocentrum turbo* (Muller, 1786)				+	+			+
Fam Parameciidae Dujardin,1840								
151.*Paramecium caudatum* Ehrenberg,1832			+	+	+			
152. *P. woodruffi* Wenrich,1928	+		+					+
153. *P. calkinsi* Woodruff,1922			+	+	+			
Fam. Cyclidiidae Ehrenberg,1838								
154. *Cyclidium citrullus* Cohn,1865							+	+
155. *C. borrori* Small et Lynn,1985 *		+	+				+	
156. *Cristigera vestita* Kahl,1928	+			+			+	
157. *C. media* Kahl,1928 *	+							
158. *C. constricta* Madsen,1931 *	+			+			+	
Order Parastomatida Jankowski, 2007								
Fam. Pleuronematidae Kent,1881								
159. *Pleuronema crassum* Dujardin,1841	+	+	+	+	+		+	+
160. *P. marinum* Dujardin,1841	+	+	+	+	+		+	+
IN ALL:	**40**	**50**	**78**	**72**	**33**	**28**	**24**	**59**

1. Sand, 2. Silty sand, 3. Gray silt, 4. Silt with plants residues, 5. Black silt, 6. Plankton, 7. Periphyton, 8. Thickets of aquatic plants (Phytociliocenosis), *Species observed for the first time of the Caucasus fauna.

As it is seen from the table, the ciliates species diversity of Agzibir Lake represented in 161 species, relating to 42 families. 34 species were observed for the first time of the Caucasus fauna.

The analysis of the obtained data showed that the greatest species richness was observed in benthos in gray silt (78 species) and in silt with plant residues (72 species). Some small species richness was observed among the thickets of aquatic plants (*Chara* sp.) denoted by the term "phytociliocenosis", where 59 species were observed. 50 species were observed in the biotope of silty sand, 40 species in the sand, and the minimum species richness was observed in plankton (28 species) and periphyton (24 species).

Thus, species diversity was dominated by benthic biotopes, with the exception of black silt biotope (33 species), where due to specific conditions, including low oxygen content, and at times the presence of hydrogen sulfide, the species diversity of the ciliates was significantly smaller and represented by a characteristic of sapropel species community.

A pairwise comparison of the species richness community of freeliving ciliates of various biotopes in Agzibir Lake was carried out. The obtained results showed the greatest similarity of the species richness of benthic biotopes of sand with silty sand (62%) and silty sand with biotopes of gray silt and silt with plant residues, the similarity with which formed 44%. The species richness community of the gray silt biotope with plant residues is also great (56%).

Consequently, the obtained results indicate a great similarity of the species richness of freeliving ciliates between different benthic biotopes. The exception was only black silt biotope, the similarity of which with the species richness of ciliates communities of other benthic biotopes formed 28% to 34%. This is due to the specific environmental conditions of black silt biotope, mainly low oxygen content, and at times the presence of hydrogen sulfide. Naturally, such a gas regime is favorable only for the so-called "sapropelebiotic" ciliates group such us *Caenomorpha* and *Metopus* species, as well as some eurybiontic representatives of *Loxodes*, *Spirostomum*, *Euplotes* species and so on. Comparison of the species richness of various benthos biotopes with plankton showed its minimal similarity with black silt biotope (6%) and silty sand (7%). Some higher similarity were with the biotope of silt with plant residues (10%) and then gray silt (13%).

The similarity of the species richness of ciliates plankton community with the biotopes of periphyton and phytociliocenosis is much bigger and forms 23% and 39%.

Comparison of the ciliates species richness of periphyton with various benthic biotopes showed their similarity in the range from 24% to 31%. Some higher ones were the ciliates species richness of periphyton with the phytociliocenosis, forming 38%.

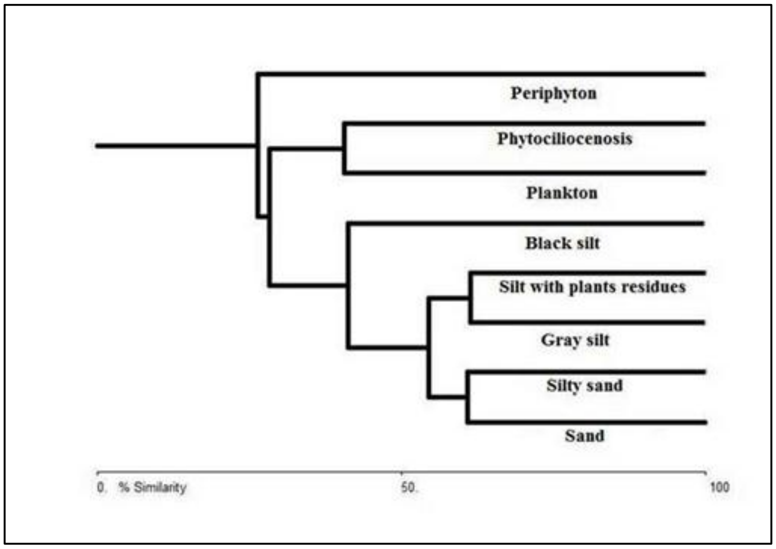

Fig 2: The similarity of ciliates species richness on different biotopes Agzibir Lake

In order to obtain more representative data, a cluster analysis of the species richness similarity of freeliving ciliates of all investigated biotopes was carried out. As it is seen from Fig.2 the greatest similarity is observed in the cluster that combines benthic biotopes and slightly less similarity with black silt biotope, which, as already mentioned, is due its specific conditions.

The next cluster unites the biotopes of plankton, periphyton and phytociliocenosis, although the ciliates species richness of these three biotopes is lower.

The seasonal dynamics of the development of various biotopes communities of freeliving ciliates in Agzibir Lake differs noticeably depending on the species of the biotope (plankton, periphyton, phytociliocenosis, benthos). In addition, the features of this water body (shallow water and connection with the Caspian Sea in spring) as well influence on the seasonal succession of species composition, changes in the structure of communities, seasonal changes in total quantity in freeliving ciliates communities of different biotopes.

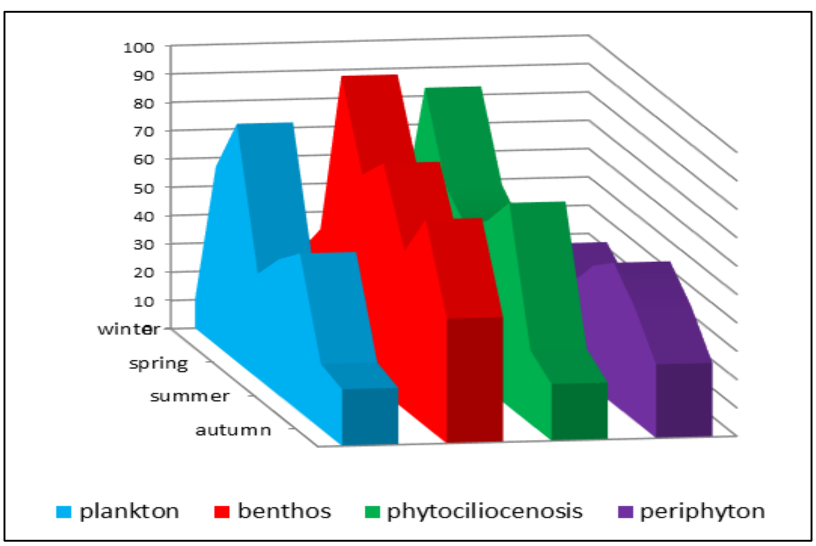

Fig 3: Seasonal dynamics of the total amount of ciliates in various biotopes of Agzybir Lake (average 2014-2016)

Generally, planktonic ciliates of Agzibir Lake have two maxima development noted in spring, with increase in water temperature to +10-13^{0}C and in autumn. Usually, the spring peak is observed in a few days, after the spring increase in the water flow of the rivers. The spring water is a source of biogenic elements which together with a number of other factors are impetus to the rapid development of small unicellular algae and bacteria, forming the food basis for the organisms of the first consumers, including ciliates.

At this time, almost complete replacement of the dominant species occurs in the plankton of Agzibir Lake usually represented by small size species of ciliates as *Halteria*, *Arcostrombidium*, *Strombidiopsis*, *Coleps* and *Holophrya*. Generally, these ciliates are dominant in plankton communities in early spring. From late April, the number of dominants increases not only due to true planktonic species, but also the shallow water of the reservoir and the mixing of water masses by winds; plankton communities also have numerous temporary planktonic, i.e. species are common in other biotopes, mainly in phytociliocenosis, periphyton and benthos. Among them big size *Linostomella vorticella, Stentor roeselii,* some *Paraamphisiella, Kahliella* and *Urotricha* can be mentioned.

In summer, because of the massive development of unicellular algae,with the increase in temperature to 25-29^{0}, the water transparency decreases (up to 15-26 cm) and the content of dissolved oxygen reduces. This leads to impoveishment of the species richness of plankton communities of freeiving ciliates in all places Agzibir Lake. At this time, from true plankton species only specimens of *Halteria bifurcata* and *H.cirrifera, Limnostrombidium viride* and Pelagostrombidium mirabile, as well as temporary (facultative) species from benthos as *Zosterodasys mirabilis* and species of *Cristigera* can be discovered.

In plankton communities the autumn maximum firstly is due to the development of phytophages and histophages, among which the representatives of *Coleps* are especially prominent.

Unlike planktonic, the benthic communities of free-living ciliates in Agzibir Lake have 3 peaks of development. The first once is observed in the spring usually in May, following the development of plankton communities. The change in species composition occurs following the summer increase in water temperature. The basis of the spring benthic ciliates community is formed by such background species as representatives of *Loxodes, Blepharisma, Paragastrostyla, Euplotes, Enchelys, Lacrymaria* and so on. In the summer, as water temperature rises to 21^{0} and above, destruction processes of organic matter begin to predominate on some benthic biotopes caused by the decrease in the content of oxygen dissolved in water and extinction of aquatic vegetation. This is especially noticeable in the biotopes of the silt with plant residues and black silt. In the latter case, the presence of hydrogen sulfide was noted at times. During this period, active replacement of dominant species takes place in freeliving ciliates community of the both biotopes.

In summer, the dominants firstly become the representatives of "sapropele-bionts" group among which are representatives of *Metopus* and *Caenomorpha*. In addition to them, such eurybionts as representatives of *Uronema, Cyclidium, Urocentrum*, as well as some representatives *Frontonia* become dominant. All of the above mentioned ciliates form the core of the summer benthic community and cause the summer comparatively not having a high peak of abundance.

In autumn, many of the summer benthic ciliates species either completely disappear from the communities, or their numbers greatly reduce. At this time, another replacement in species composition takes place and the benthic communities are dominated by the representatives of *Condylostoma*, *Stentor*, *Aspidisca, Euplotes, Spathidium, Trithigmostoma* and others.

The analysis of the seasonal change results in the ciliates species composition of the phytociliocenosis biotope showed that, in this case these changes are similar to those in the plankton. Two maxima development is observed in spring and autumn with the spring peak usually is in advance of the peak in plankton for 8-12 days. Apparently, this is explained by the large and faster heating of water in the thickets of shallow aqvatic plants. Moreover, the ciliates species richness of the phytociliocenosis is higher than in plankton and periphyton and it is due to large part of numerous benthic species presence willingly inhabiting this biotope. On the other hand, many rare plankton species as *Frontonia obtusa*, *Lembadion lucens*, *Lacrymaria acuta*, *Amphisiella milnei,*and so on also occur in the phytociliocenosis.

Conclusion

Summarizing all the above mentioned data, certain conclusions can be drawn. The ciliates species diversity of Agzybir Lake turned out to be quite rich and was represented by 161 species, relating to 42 families. 32 species observed for the first time for the Caucasus fauna on the one hand indicate that,the investigation of freeliving ciliates insufficient in our region, and on the other hand, generally, favorable conditions for the development of this group of Protozoa are in Agzibir Lake.

On the grounds prevailing in the lake, the absolute majority of the discovered species (sand, silty sand, gray oily silt with plant residues and black silt) with the largest species diversity was observed in the ciliates benthic community of the gray silt biotope (78 species) and the biotope of silt with plant residues (72 species).

Ciliates species diversity of sand biotope and silty sand relatively is much smaller 40 and 50 species, and the minimum ciliates species diversity observed in the biotope of black silt.

This is explained unfavorable for most ciliates species gas regime - low oxygen content and the presence of hydrogen sulfide at times, usually in summer, whose presence is able to transmit ciliates–sapropelebionts, as well as some other species of eurybionts.

The minimum ciliates species diversity was observed in the plankton and periphyton, respectively, 28 and 24 species. One more specific biotope of thickets of aquatic vegetation was identified, for which the term "phytociliocenosis" (Alekperov, 1997) was proposed, having similarity of species richness to the planktonic and periphyton ciliates communities, relatively, 23 and 39%.

In quantitative terms, two maxima (in spring and autumn) and minima (winter and summer)were observed in the seasonal dynamics of total quantity of plankton ciliates, and benthic ciliates community were characterized by three-vertex development, with an additional third summer maximum. In all the studied biotopes of Agzibir Lake, sequential seasonal succession of species diversity was observed depending on the season, a constant change of some species by others was observed.

In our opinion, this is primarily explained by the trophic factor - the presence of food objects for a particular species, as well as by more general causes as the temperature factor and gas regime. The obtained data testifies the important role of freeliving ciliates in the production and destruction processes of water bodies, which must be taken into account in general hydrobiological investigations.

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