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Alekperov IKh
Institute of Zoology of National Academy of Sciences of Azerbaijan, Baku

Mansimova IF
Institute of Zoology of National Academy of Sciences of Azerbaijan, Baku

Correspondence
Alekperov I Kh
Institute of Zoology of National Academy of Sciences of Azerbaijan, Baku

The Ratio of trophic groups of free-living ciliates on the seasons of the year in the Agzybir Lake

Alekperov I Kh and Mansimova IF

Abstract
During the period of 2014-2016 we studied the food relationship of free living ciliates of Agzybir Lake. In all 162 species were found, 12 of them were marked for the first time the Caucasus fauna. The ciliates, differs for feeding process, were combined of five trophic groups (algophages, bacteriophages, non-selective omnivorous species, predators and histophages). The food relationship between ciliates and other various groups of aquatic organisms, has been studied. It was found the dominant factor in the development of various groups is the food relationship within community.

Keywords: ciliates, Caspian Sea, trophic groups, food relationship, seasons changes, Agzybir Lake

1. Introduction

The key role of freeliving ciliates in water ecosystems were good known. Though ciliates general roles as consumer of phytoplankton and bacteria and links to higher trophic levels are known, but less studies on the ecology of ciliates species are reported. Elucidating particular interactions among ciliates, their potential food organisms and predators, are still a major challenge in aquatic ecology [1].

The study of free-living ciliates of marine and fresh waters since long time attracted the attention of researchers [2-4]. this most highly organized group of single-celled animals over the last decade is studied mainly faunally, because even now there is no consensus on the taxonomy of this group among experts. With the accumulation of new modern data the taxonomy of ciliates changed much, and it is suffice to say that if before all ciliates included in the Ciliata classis, then in modern systems this group already forms the phylum Ciliophora [5].

It should be noted that the environmental studies of free-living ciliates are very little. This is mainly due to the large methodological difficulties of working with this group. Meanwhile, the latest figures show that the role of free-living ciliates in the biological processes of marine and fresh water is extremely high. Being mostly active bacteriophages the ciliates consume food in a huge number of bacteria, including many pathogenic species, thus contributing to the biological purification of waters On the other hand the role of free-living ciliates like food organisms for other groups of aquatic organisms was studied very poorly.

Summarizing all the above, the purpose of our research was to establish belonging of common species of free-living ciliates to certain trophic groups and on the basis of the obtained data, the determination of the percentage of representatives of different trophic groups on seasons year. Conducting this research is extremely important from a practical point of view, as Agzybir Lake having a link with the Caspian Sea in spring and fall is a place of spawning and the subsequent development of larvae of many commercially valuable fish of the Caspian Sea, for which ciliates are a valuable starting feed in the early stages of ontogenesis.

2. Material and Methods

Sampling and processing was conducted seasonally during 2014-2016 from different points of the Agzybir lake. Totally 115 samples were collected that were processed as far as possible in the shortest possible time. The collected samples were examined under a binocular microscope, ciliates were caught by micro-capillaries and studied *in vivo* by «Olympus» microscope. The contents of food vacuoles were viewed, swallowed algae and number of food vacuoles was taken into account. Representatives of multicellular hydrobionts were placed in

Petri dishes and watch glasses and then their feeding with ciliates was watched. To determine the taxonomic belonging of ciliates, widely used methods of impregnation ciliates kinetom with silver nitrate [6, 7]. Currently, the use of these methods is required in determining the ciliates species, because they reveal the invisible on living cells important taxonomic features. It is known only single complete ciliates key, published at 1930-1935 by Alfred Kahl, now absolutely out of date, because its ciliates drawings and descriptions were made only on the basis of intravital observations. We have used for ciliates identification a lot articles and several large modern monographs the different authors, which investigated the ciliates morphology, considering studying their infraciliature on total preparations, impregnated with silver nitrate and proteinate [8-10].

To determine the trophic groups of ciliates we used the results of our long-term observations living cells and count food objects in endoplasma fixed specimens. These data allowed us to classify the most abundant ciliate species, taking into account their preferred nutrition objekt.

3. Results and Discussion

In all, during our research 162 species of ciliates were found, 12 were used for the first time for the Caucasus fauna. It should be noted the more number of species (112 species) are typical representatives of benthos and periphyton. The share of plankton and facultative planktonic species is only 14 species. Moreover 65 species have been observed both in plankton and benthos. For the classification of ciliates on the type of food consumed, we used more modern division into five trophic groups: algophages, bacterio-detritophages, non-selective omnivorous species, predators and histophage. The following Table 1 presents 12 new species for the Caucasus fauna and ciliates different trophic groups.

Table 1: Ciliates of different trophic groups of Agzybir lake.

№	Ciliates	Algophages	Bacterio-detritophages	Non-selective omnivorous species	Predators	Histophages
1*	*Actinobolina radians* (Stein, 1867)				+	
2	*Askenasia mobilis* Alekperov 1984			+		
3	*Askenasia volvox* (Eichwald, 1852)			+		
4*	*Bursellopsis truncata* Kahl, 1927				+	
5*	*Bursellopsis pelagica Foissner*, Berger and Schaumburg, 1999				+	
6*	*Enchelys simplex* Kahl, 1926	+				
7	*Didinium chlorelligerum* Kahl, 1935				+	
8	*Didinium nasutum* (Müller, 1773)				+	
9*	*Epistylis anastatica* (Linnaeus, 1767)		+			
10*	*Epistylis gelei* Stiller, 1931		+	+		
11	*Coleps elongatus* Ehrenberg, 1831				+	+
12	*Coleps hirtus* Ehrenberg, 1831				+	+
13	*Coleps striatus* Smith, 1897				+	+
14*	*Ctedoctema acanthocryptum*, Stokes, 1884		+			
15*	*Cristigera phoenix* Penard, 1922		+			
16	*Cyclidium glaucoma* Müller, 1773		+			
17	*Cyclidium citrullus* Cohn, 1865		+			
18*	*Limno stombidium pelagicum* (Kahl) 1932	+				
19	*Euplotes patella* (Müller,1773)	+		+		
20	*Euplotes eurystomus* Wrzesniowski, 1870	+		+		
21	*Frontonia azerbaijanica* Alekperov,1983	+				
22*	*Frontonia angusta* Kahl, 1931	+				
23	*Frontonia leucas* (Ehrenberg, 1833)	+				
24	*Lacrymaria olor* (Müller, 1776)				+	
25	*Paradileptus elephantinus* (Svec, 1897)				+	
26*	*Pelagodileptus trachelioides* (Zacharias, 1894)				+	
27	*Rimostrombidium humile* (Penard, 1922)	+				
28	*Rimostrombidium lacustris* (Foissner, Skogstad, Pratt, 1988)	+				
29	*Spirostomum teres* Claparede and Lachmann, 1858		+			
30	*Stentor coeruleus* (Pallas, 1766)		+			
31	*Stentor roeseli* Ehrenberg, 1835		+			
32	*Uronema nigricans* (Müller, 1786)		+			
33	*Urotricha apsheronica* Alekperov, 1984	+				
34	*Urotricha furcata* Schewiakoff, 1892	+				
35	*Urotricha pelagica* Kahl, 1935	+				
36	*Nassula ambigua* Stei, 1854	+				
37*	*Nasulla tumida* Maskell, 1887	+				
38	*Nasulla aurea* Ehrenberg, 1833	+				
39	*Lembadion bullinum* Perty, 1852		+			
40	*Lembadion lucens* (Maskell, 1887)		+			
41	*Paramecium caudatum* Ehrenberg, 1833		+	+		
42	*Paramecium putrinum* Claparede and Lachmann, 1859		+	+		

*** -**Species new to the Caucasus fauna

As seen in Table 1, we noted only 42 freeliving ciliates species on feeding type. Of these, 15 and 14 species were registered as typical algo- and bacterio-detritophages and 11 species of predators, only 3 species histophages and 7 species that representatives non-selectively- *E. gelei*, *Paramecium* omnivorous group, some species of which are also members of other trophic groups, e.g. such as *caudatum* and *P. putrinum* (also bacterio-detritophages).

The composition and the ratio of trophic groups reflect the response of the community of free-living ciliates on the degree of organic pollution of Agzybir Lake, as indicated by the presence of a sufficiently large number of representatives of bacterio-detritophages groups, i.e. detritus food chain becomes one of the main. This is also indicated by the small number of non-selective omnivorous species, partly nourished with different groups of algae except blue-green. Among the predators the usual representatives of the *Didinium* and *Bursellopsis* dominate, developing well in shallow water among aquatic vegetation, and a few large predators and *Paradileptus elephantinum* and *Pelagodileptus trachelioides* were observed in open pelagic.

Extremely weak development of ciliates-histophages should be noted, too. Usually it happens due to the presence in water of small concentrations of toxicants, for which the simple one reacts with restructuring of species and trophic structure, and in some cases with a sharp decline in the number of this group of ciliates or complete removal from a community. On the other hand weak development of histophages canobe linked to poverty of crustacean zooplankton, the dying remnants of which form the basis of the diet of ciliates species *Coleps*. It should be noted that the range of food items in the diet of one and the same species preferred by free living ciliates may be quite varied depending on the environmental conditions. We have seen cases of feeding with diatom alga even of such well-known bacteriophage as *Paramecium caudatum*. Such cases have been noted on the collection points with more clean water, with betamezosa trial conditions, i.e. with a limited number of microorganisms. Such substitution in the food spectrum of *Paramecium* referred to as the forced transition to algophages and as well as to more clean water of the reservoir area. Overall, however, in the course of the study of feeding of ciliates their food selectivity was established, which is primarily due to the size of food items, size of cytostome of a particular type, the chemical and physical characteristics of the food, etc.

It is known that ciliates of *Didinium* species are predators and specialize in nutrition with ciliates *Paramecium*. We have noticed an interesting feature. At corroding in the samples of *Paramecium* ciliates, the number of predator *Didinium*, which seemingly should have been reduced, following the decrease in the number of food items, in fact increases greatly. A distinctive feature is the strong decrease in body size. On average, if in the cultures with a ratio of *Didinium*, *Paramecium* about 50/50, sizes of *Didinium* fluctuate in the range of 50-90 microns, but in cultures with single individuals of *Paramecium*, sizes of predator *Didinium* reduce to 25-35 microns, and the number increases 1,5- 2 times. In our opinion, this adaptation of *Didinium* aimed for survival of the species population at lack of food organisms. It should be noted that cases of substitution of food items at *Didinium* are extremely rare. However, with a lack of *Paramecium Didinium* predators are quite capable to replace them with ciliates of *Frontonia*, *Prorodon* species, although such cases are extremely rare.

We have observed under the microscope *Frontonia* specimens with 3-15 cells of diatoms in the cytoplasm.

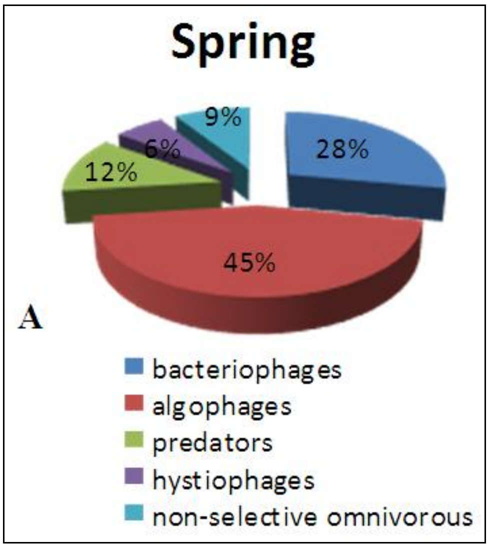
Given that sometimes ciliates *Frontonia* reach a total number of 35-50 thousand/dm^2, it is easy to calculate the consumption only by these ciliates of about half a million of diatom cells per 1 $dm.^2$

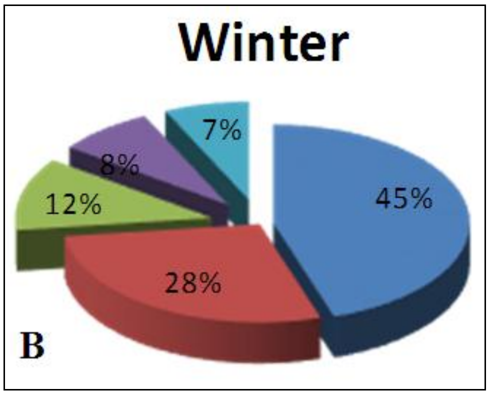
It should also be noted that such known histophages as ciliates of *Coleps* species move easily enough to predation under certain conditions. This is especially true with regard to the damaged lysing various specimens of ciliates. For example, 18 specimens of *Coleps hirtus* completely ate large (350mk) ciliates *Spirostomum* (8) for 24 hours.

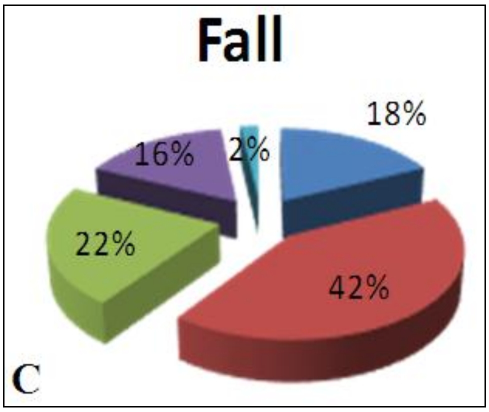
At the same time ciliates *Coleps* often attack damaged specimens of many species a small size multicellular hciliates *Spirostomum* [8] for 24 hours.

Aydrobionts (Tardigrada, Oligochaeta, etc.), i.e., actually moving from histophages to predation. In turn, many multicellular hydrobionts mainly are filtrators, which actively consume ciliates as food. Data on this issue because of the technically extremely complex technique is still very small; the conducted experimental studies on the extent of eating of ciliates by young specimens *Mnemiopsis leydei* may be noted, showing a high percentage of ciliates feed in diet of ctenophores, as well as the dependence of the degree of assimilation on the concentration of food objects in the environment, that in general, still remained outside the attention of researchers [9].

The ratio of trophic groups of ciliates significantly changes on seasons of year, too. Fig.1 shows the change in the percentage of representatives of different groups of ciliates.







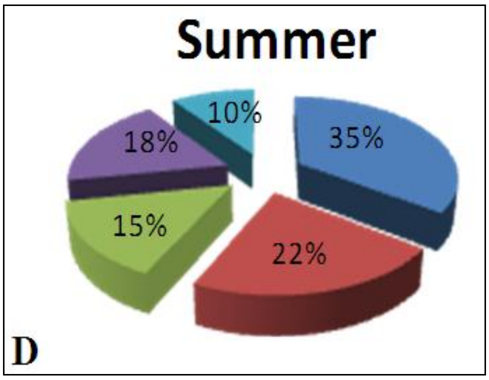


Fig 1: Seasonal ratio of trophic groups of ciliates in Agzybir lake.

As can be seen from Fig.1 in winter among the fauna of free-living ciliates in Agzybir lake representatives of the trophic group of bacteriophages (45%) dominated. Further, in quantitative terms, followed the representatives of algophages group (28%), followed by a group of predatory ciliates (12%) and, finally, a few trophic groups of ciliates-histophages (8%) and non-selective omnivorous species (7%).

In spring notice able changes occur in the trophic structure of ciliates community. For example, the number of algophages, with increase in water temperature and starting the rapid development of phytoplankton, is increased to 45% while, as representatives of trophic groups of bacteriophages were only 28%. The number of members of the group of predators remained at the same level (12%), and the differences in the groups of histophages (6%) and non-selective omnivorous species (9%) were not significant.

In summer, when the water temperature in the Agzybir lake in shallow water at times reaches 28-30ºC, many members of the phytoplankton are eliminated and fall out of the plankton community. Accordingly, their consuments, representatives of the trophic group of ciliates-algophages reduce to 22%.

In connection with the process of the withering away due to the high temperatures of many organisms, phytoplankton and zooplankton, there is massive growth of bacteria in the summer and as a result, ciliates of bacteriophage using them as food making at this time of year maximum of 35%. Due to the accumulation of a large number of dead organic matters, at this time the number of ciliates of histophages group (18%) using it in food grows. The ratio of trophic groups of ciliates (15%) and non-selective omnivorous (10%) were about at the same levels as in the spring.

In fall, due to reducing of water temperature for phytoplankton to the optimal (12°-16°C), respectively, the percentage of ciliates, consuming food in algae, is increasing rapidly up to 42%. Noteworthy is the maximum development of group of predatory ciliates (22%) in fall. Trophic group of bacteriophages was only 18%, the group of histophages (16%) was only about the same number as in the summer, but the number of non-selective group of ciliates of omnivorous species declined sharply and amounted to only 2% in the fall.

4. Conclusion

Summarizing all the above, we can draw the following conclusions: The species diversity of free ciliates Agdzhibir Lake represented by 162 species and quite peculiar, because noted 12 new species for the Caucasus fauna. On the basis of long-term observations *in vivo*, as well as the study of a large number (over 350 specimen) of total preparates of various ciliates species, impregnated with silver nitrate, we have identified five main ciliates trophic groups, belonging to five major trophic groups (algophages, bacterio-detritophages, non-selective omnivorous species, predators and histophages). Naturally, in the allocation of these groups served as the main sign of preference in some kind of specific feed type. Obviously with a deficiency in the environment preferred feed is its substitution of other food objects, such as ciliates belonging to the *Paramecium* genus, that are known bacteriophages, the shortage of food substitute its small green and diatoms algae.Food specialization reflected on freeliving ciliates seasonal quantitative development. For example ciliates, belonging to the *Nassula* genus able to eat blue-green algae, which massively reproduce in the summer season. The obtained data show a huge and important role of free living ciliates in the biological processes of aquatic ecosystems. Especially great is their role in the primary links of food chain, as the first consumers. Therefore the study of the productive capacity of water bodies must be considered freeliving ciliates, because they themselves are food for many small multicellular objects aquatic organisms, including larvae of many fish species in the early stages of ontogenesis.

5. Reference

1. Witzani G, Nowacki M. (Editors). Bio communication of Ciliates, Springer, 2016, 372.
2. Foissner W, Berger H. Schaumburg. Identification and Ecology of Limnetic Plankton Ciliates. Munich, November 1999; 3(99):793.
3. Alekperov IKh. Food Relationships of Freshwater Ciliates with other hydrobionts. Progress of Protistology: IV Inter. Congress of Protozoology, Warsaw, 1981, 9.
4. Zharikov VV, Bykova SV. Free-living ciliates. In collection. Protista and bacteria of the lakes of Samara region. ed. Cassandra, Taljati, (in Russian). 2009, 24.
5. Lynn DH. The Ciliated Protozoa (Characterization, Classification, and Guide to the Literature). Springer (Third Edition) 2008, 605.
6. Chatton E, Lwoff A. İmpregnation, par diffusion argentique, de l, infraciliature des Cilies marins et d, eau douse, après fixation cytologique et sans dessication. C.R. Soc. Biol. Paris, V. 104, 834-836.
7. Alekperov IKh. The new modification of impregnation ciliates kinetom with silver proteinate // Zool. J. Moscow, № 1992; 2:130-133(in Russian).
8. Alekperov IKh. Freshwater ciliates artificial reservoirs of Azerbaijan Abstract. Thesis of doctor of biological sciences. Baku, 1987, 34. (in Russian)
9. Alekperov İKh. Biodiversity and distribution of Planktonic Communities in the Middle-Western Part of the Caspian Sea // Proceedings of the "Man and Biosphere" (MaB, UNESCO) Azerbaijan National Committee. Ed. Təhsil, 2011, 237-251.
10. Dragesco J. Dragesco-Kerneis A. Cilie's libres de l'Afrique intertropicale. Fauna Tropicale, Paris, 1986; 26:559.

11. Foissner W, Blatterer H, Berger H, Kohmann F. Taxonomiche und ökologishe Revision der Ciliaten des Saprobiensystems. Band I: Cyrtophorida, Oligotrichida, Hypotrichia, Colpodea. Informationsberichte des Bayer Landesamtes für Wasserwirtschaft. Heft 1991; 1(91):478.
12. Foissner W, Berger H, Kohmann F. Taxonomische und ökologiche Revision der Ciliaten des Saprobiensystems. Band II: Peritricha, Heterotricha, Odontostomatida. Informationsberichte des Bayer Landesamtes für Wasserwirtschaft. Heft 1992; 5(92):502.
13. Alekperov IKh. An Atlas of the Freeliving Ciliates (Classes Kinetofragminophora, Colpodea, Oligohymenophorea, Polyhymenophora) pub. h. Borchali, Baku, 2005, 310.