

CURRENT STATUS OF THE STUDY OF CILIATES IN THE CASPIAN SEA

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Abstract. The article presents the results of 43 years of research of free ciliates (microbenthos, periphyton, plankton) in the Caspian Sea. General species composition (580 species) and distribution of the ciliofauna of the Caspian Sea as a whole is established. Fauna of the ciliates over the main habitats is analyzed, influence of environmental factors on the fauna of ciliates is considered and common coefficient with other geographical areas of the world oceans is calculated.

Keywords: microbenthos, plankton, periphyton, ciliofauna.

Ciliates (*Ciliophora*) are the most highly organized, single movable or attached (often colonial) elementaries. They live in the oceans, seas, fresh water in the composition of the benthos and plankton, are also found in fouling, including other organisms. Many ciliates are found in soil and mosses. Free-living ciliates play an important role in the biological wastewater treatment plant; some species are indicators of the degree of water pollution. Many ciliates in the benthos, periphyton and plankton are involved in the food chain of reservoirs. Especially important is their role as the main connecting link between bacteria and animals. Some ciliates are a good subject to a number of cytological, genetic and biochemical experiments. Therefore, the study of reservoirs ciliates, in particular the Caspian Sea is of great theoretical and practical interest.

For a long time (until 1963) ciliates of the Caspian Sea were not studied. The first data on this problem were found in the works of Grimm (1876) and Bening (1938), but they were very fragmentary. Since 1967, we have carried out detailed studies of the Caspian Sea ciliates (Agamaliev F.G., 1966, 1967, 1969, 1983, 1999, 2003, 2006, 2007, and a series of works of the author published in international journals (2008-2016). In these studies, fauna, systematics of all environmental groups of ciliates (benthos, periphyton, plankton) of the Caspian Sea have been analyzed. It was found out that the fauna of ciliates of the Caspian Sea is a well-defined maritime character (93%) and does not show a significant endemism. The remaining 7% are freshwater and brackish-water forms. Thus, the Caspian Sea, including all bays and supralittoral zone, are found 580 species of ciliates, belonging to the three classes and 15 orders. Among them, one genus and 36 species were new to science, and the rest are identified for the Caspian Sea for the first time.

396 species from the found ciliates are marked in microbenthos 218 -in periphyton, 185 -in plankton. Among Caspian geographical areas the richest by ciliates is the South of Caspian Sea (474 species). In the Middle Caspian 364 species have been discovered and in the North 242 ones. 139 species were

common for all geographic areas (Table 1). The bays (Big Kyzylagach, Kazakh, Turkmen, Turkmenbashi, Kizlyar, and North Apsheron) were found 240 species of ciliates, 135 species in aquatic supralittoral areas. In the strongly freshened gulfs (Small Kyzylagach, Agrakhan and Divichi estuary) were found 112 species of ciliates. Common 48 species were identified as a common in the Caspian Sea. In the fauna of the ciliates bays basic background was created the freshwater species (70%). Marine forms are most found in Davachi estuary (32 species) (Agamaliev, 1986).

In the microbenthos of Caspian Sea generally psammophilous fauna prevails. Many psammophilous ciliates in addition of sea sand are often found in other habitats and are eurytopic forms. They constitute 37.3% of the total number of species. The specific psammophilous ciliates, for the most part were stenobiotic (highly specialized) form having similar adaptations to life in the capillary spaces in the sand. The greatest abundance and diversity of fauna of the psammophilous ciliates are in the upper cm layer of sand (0-4 cm). With the depth the total number of ciliates decreases. The maximum depth of penetration into the interior of fine sand ($M0 = 0,1-0,4\text{mm}$) is 8-9 cm in thickness coarse ($M0 = 0,8-1,3\text{mm}$) 20-25 cm, depending on the depth of the hydrogen sulfide of the layer. The highest development the ciliates in Caspian sea reach in May and September. Seasonal fluctuations in numbers are mainly related to temperature and food. Most ciliates of the Caspian sea are eurythermal types and occur when content of O_2 is from 2.96 to 8.79 cm^3/l .

In the Caspian Sea are also well represented periphyton ciliates (218 species). They settle on various substrates - stones, rocks, algae thalli, stems higher water plants, ship hulls, on abandoned logs and waterworks. Periphyton ciliates most richly represented fouling stones and waterworks. In ciliotsenozo dominate the representatives of *Peritricha*. It was found out that in experimental glass plates suspended in the water column, the process passes faster the shallow bays in the warmer months. The first on the plates settle the movable forms, then (3-5 days), sessile ciliates (*Vorticella*, *Zoothamnium*, *Cothurnia*) begin to develop. The most species are evrioksibionty and have three peaks (spring, summer, autumn) seasonal development. Periphyton ciliates also are inherent in daily vertical migrations.

In the plankton of the Caspian Sea 185 species have been discovered, of which 58 species (32%) were common to all geographic areas (North, Central, and South) of the Caspian Sea. The West Coast is richly presented. Typical plankton, exclusively marine groups are suborder of tintinnids. They are found in almost all studied areas of the Caspian Sea. The massive development of planktonic ciliates observed in coastal areas of the sea. The fauna here consists mainly of non-specific eurythermal forms. In the open sea (depth of 50-100 m and above) there are the most common form of cold-loving stenothermal ciliates (*Tintinnopsis* kinds of *Codonella* et al.). Vertical migration are regulated primarily by lighting. Most of the species (70-80%) are evrioksibionts that have two peaks of seasonal (spring and autumn).

The composition and distribution of ciliates of the Caspian Sea on the troops

Table 1.

Troops	The total number of species	Geographic areas			Ecological groups		
		North	Central	South	Benthos	Periphyton	Plankton
Класс Kinetofragminophora							
<i>Karyoreliktida</i>	48	24	28	37	35	8	0
<i>Prostomatida</i>	32	19	29	28	29	11	18
<i>Haptorida</i>	70	27	42	48	40	15	23
<i>Pleurostomatida</i>	20	12	17	19	18	5	5
<i>Trichostomatida</i>	9	4	9	8	6	5	2
<i>Colpodida</i>	4	0	1	3	1	0	0
<i>Synhymenida</i>	5	2	3	4	3	2	2
<i>Nassulida</i>	8	3	4	7	4	0	5
<i>Cyrtophorida</i>	36	16	18	28	18	20	9
Class of Oligohymenophora							
<i>Hymenostomata</i>	13	10	11	10	12	8	10
<i>Scuticociliatida</i>	30	10	18	22	19	10	10
<i>Peritrichida</i>	81	29	48	61	20	53	2
Class of Polyhymenophora							
<i>Heterotrichida</i>	26	14	16	25	21	13	5
<i>Oligotrichida</i>	48	20	35	45	35	2	33
<i>Hypotrichida</i>	151	52	85	129	135	37	44
Total:	580	242	364	474	396	179	168

The polluted areas (by oil, household and industrial waste) become depleted by species of the composition of ciliates. However, some types of polysaprobic (*Tracheloraphis prenanti*, *Paraspathidium fuscum*, *Spirostomum teres*, *Condylostoma arenarium*, *Frontonia marina*, *Keronopsis rubra*, *Eiplites eurytomus var. marinus*, *Diophys scutum*, *Uronychia transfuga* et al.) form in these areas the mass of the population (10.8 million.ekz/m²) and play an important role in the biological purification process, and are indicative for the degree of pollution of wastewater.

The place and role of ciliates in the food chain of the reservoir is determined by their trophic relationships with other organisms. The food for ciliates are dissolved and suspended organic matter, bacterial microflora, unicellular algae and protozoa. The ciliates are a food for the some small, large multicellular and fish fry. Thus, the ciliates are the link between the single-celled plants and multicellular animals.

A comparison of the list of species of Caspian ciliates and ciliates of other geographical world's oceans (North Atlantic, Equatorial Atlantic, the Mediterranean Sea, the Black Sea, the Baltic Sea, the Barents Sea, White Sea, the North Sea, Japan Sea) shows that factors of community of the fauna of ciliates of the Caspian Sea and other geographical regions vary in the number of species from 14% to 68%, and from 35% to 74% by number of genera. The highest community is in the Caspian Sea and Baltic Sea (68%). The next place is occupied by White Sea (51%), Black Sea (38%), the North Atlantic (34%), and the Mediterranean (32%). The lowest community is denoted with the Barents Sea (14%).

In the future, should be strengthen the faunal and ecological investigations of ciliates of the Caspian Sea in general, and research in areas of concentration of oil, drilling, domestic and industrial waste that can give a lot of valuable material for biodiversity in the Caspian Sea.

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