Т. 9. №5. 2023
https://doi.org/10.33619/2414-2948/90

UDC 593.17
AGRIS L20
https://doi.org/10.33619/2414-2948/90/08

CILIOPLANKTON COMMUNITIES AS AN INDICATOR OF THE POLLUTION DEGREE IN THE CASPIAN SEA

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ЦИЛИОПЛАНКТОННЫЕ СООБЩЕСТВА КАК ИНДИКАТОР СТЕПЕНИ ЗАГРЯЗНЕНИЯ КАСПИЙСКОГО МОРЯ

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Abstract. During 2014-2021 years a study of the species diversity of planktonic ciliates of the Caspian coast of the Absheron Peninsula was conducted. As a result of research in planktonic communities of free-living ciliates, 62 species, belonging to 22 families were observed. Among the recorded families, Strombidiidae takes first place in terms of the number of species. The families Uronychiidae, Nassulidae, Epistylidae, and Zoothamniidae were represented by only one species. A correlation between similarity of the planktonic ciliates species diversity and the degree of organic pollution of coastal area marine water has been established. The results of the cluster analysis showed that the highest similarity of the species diversity (95.5%) was noted for two collection points on the northern coast of Absheron, near the settlements of Novkhani and Bilgah. This is due to the fact that the northern coast is less polluted by oil products and domestic sewage. Thus, according to the similarity of species diversity of planktonic communities of ciliates on the coast of the Absheron Peninsula, the two clusters are clearly distinguished. One unites the cleanest sites (Novkhani and Bilgah — 95.5%), and all the other 4 stationary points of the collection (Sumgait, Turkan, Shikh, Sangachal — more than 50%) are combined into the second cluster.

Аннотация. В период 2014–2021 гг. проведено исследование видового разнообразия планктонных инфузорий каспийской литорали Апшеронского полуострова. В результате исследований в планктонных сообществах свободноживущих инфузорий было отмечено 62 вида инфузорий принадлежащих к 22 семействам. Среди отмеченных семейств Strombidiidae занимает первое место по количеству видов. Семейства Uronychiidae, Nassulidae, Epistylidae и Zoothamniidae были представлены только одним видом. Установлена корреляция сходства видового разнообразия планктонных инфузорий со степенью органического загрязнения морской воды данного участка побережья. Результаты проведенного нами кластерного анализа показали, что наибольшее сходство видового разнообразия (95,5%) было отмечено для двух точек сбора на северном побережье Апшерона, вблизи населенных пунктов Новханы и Бильгях. Это связано с тем, что северное побережье меньше загрязнено как продуктами морской нефтедобычи, так и бытовыми сточными сбросами. Таким образом, по сходству видового разнообразия планктонные сообщества инфузорий на побережье Апшеронского полуострова четко различаются два кластера. Один объединяет наиболее чистые участки (Новханы и Бильгях — 95,5%), а все остальные 4 стационарные точки сбора (Сумгаит, Тюркян, Шихов, Сангачал — более 50%) объединены во второй кластер.

Т. 9. №5. 2023
https://doi.org/10.33619/2414-2948/90

Keywords: Caspian Sea, anthropogenic factors, pollution.

Ключевые слова: Каспийское море, антропогенные факторы, загрязнение.

It is known that the Caspian Sea is the largest inland brackish water body that has no connection with the World Ocean, but nevertheless has all the features of the seas. The modern study of the ciliates of the Caspian Sea was started in the 60s of the XX century by F. Agamaliev, who summarized the long-term results in his monograph [1]. Subsequently, faunistic and ecological studies of free-living ciliates of the Caspian Sea, including planktonic ones, were carried out regularly for many years and were published in the monograph "Cadastre of free-living ciliates and testate amoebae of Azerbaijan" [2].

The species diversity of the Caspian planktons has been exposed to severe anthropogenic stress for many years, which is the result of long-term pollution of the Caspian Sea. Long-term exploration and production of oil in the Caspian Sea has led to severe hydrocarbonic pollution of many water areas of the Absheron Peninsula.

Despite a significant decrease in the level of anthropogenic pressure in recent years, the problem of pollution of the Absheron coast of the Caspian Sea is still relevant. At present, due to the sharply increased process of urbanization of Absheron, sewage pollution is becoming increasingly important.

As is known, free-living protozoa, primarily ciliates, react extremely quickly qualitatively and quantitatively to the slightest changes in the environment, including the degree of technogenic pollution. This feature of ciliates makes it possible to use them for biotesting the degree of pollution of a particular area of marine and freshwater bodies.

Based on the foregoing, a comparative study of the species diversity of communities of planktonic ciliates in various parts of the Caspian littoral of Absheron and a preliminary assessment of the quality of the environment according to the state of planktonic communities of free-living ciliates were conducted.

Material and methods

The material was collected seasonally in 2014-2021 from 6 stationary points on the Absheron coast of the Caspian Sea (Figure 1).

Figure 1. Stationary collection points of plankton samples on the Absheron coast. 1 — Sumgait, 2 — Novkhani, 3 — Bilgah, 4 — Turkan, 5 — Shikh, 6 — Sangachal

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A total of 190 plankton samples were collected and processed. To determine the taxonomic affiliation of ciliates, the methods of impregnation with nitrate [3] and silver proteinate [4] were widely used. Bray-Curtis cluster analysis was used to compare the similarity of species diversity in different parts of the coast. The calculations were carried out using the Biodiversity Professional v. 2 computer program.

Results and Discussion

During our research, in the communities of planktonic ciliates of the coastal waters of Absheron, 62 species of ciliates belonging to 22 families were recorded. The composition and distribution of these species are given in Table.

Table

SPECIES COMPOSITION AND DISTRIBUTION OF PLANKTONIC CILIATES ON COLLECTION POINTS IN DIFFERENT COASTAL AREAS OF THE ABSHERON PENINSULA

	Species composition	*Occurrence of species in different points*					
		1	*2*	*3*	*4*	*5*	*6*
	Ciliophora						
	Amphisiellidae						
1	*Amphisiella annulata* Kahl, 1928		+			+	
2	*A. turanica* Alekperov et Asadullayeva, 1999		+			+	
	Euplotidae						
3	*Euplotes apsheronicus* Agamaliev, 1966		+	+	+	+	
4	*E. baleatus* Dujardin, 1842	+			+		+
5	*E. gracilis* Kahl, 1932		+	+			
6	*E. charon* (Müller, 1773) Ehrenberg, 1830	+			+		+
	Aspidiscidae						
7	*Aspidisca fusca* Kahl, 1928	+			+	+	+
8	*A. steini* Buddenbrock, 1920		+	+			
9	*A. poljanski* Alekperov,1985		+	+			
	Halteriidae						
10	*Halteria grandinella* (Müller, 1773) Dujardin, 1841		+	+	+		
11	*Pelagohalteria viridis* (Fromentel, 1876) Foissner, Skogstad et Pratt, 1988		+	+		+	
	Uronychiidae						
12	*Diophrys scutum* (Dujardin, 1841) Kahl, 1932	+			+	+	+
	Strombidiidae						
13	*Limnostrombidium viride* (Stein, 1867) Krainer, 1995		+	+			+
14	*Novistrombidium testaceum* (Anigstein, 1914) Song et Bradbury, 1998		+	+			
15	*Pelagostrombidium mirabile* (Penard, 1916) Krainer, 1991		+	+			
16	*Spirostrombidium cinctum* (Kahl, 1932) Petz, Song et Wilbert, 1995					+	+
17	*S. apsheronicum* Alekperov et Asad., 1997		+	+			

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	Species composition	*Occurrence of species in different points*					
		1	*2*	*3*	*4*	*5*	*6*
18	*S. elegans* (Florentin, 1901) Petz, Song et Wilbert, 1995					+	
19	*S. elatum* Alekperov, 1985		+	+			
20	*S. caspicum* Alekperov et Asadullayeva, 1997		+	+			+
21	*Strombidium conicoides* (Leegaard, 1915) Kahl, 1932		+	+			
22	*Strombidium claparedi* Kent, 1881					+	
	Strombidinopsidae						
23	*Strombidinopsis elongata* Song et Bradbury, 1998		+	+			
24	*S. elegans* Song et Bradbury, 1998						+
25	*S. azerbaijanica* Alekperov et Asad., 1997		+	+			+
	Strobilidiidae						
26	*Rimostrombidium velox* (Faure-Fremiet, 1924) Jankowski, 1978		+	+			
27	*R. humile* (Penard, 1922) Petz et Foissner, 1992		+				
	Lacrymariidae						
28	*Lacrymaria olor* (Müller, 1786) Bory, 1824	+					+
29	*Phialina macrostoma* Foissner, 1983				+		+
	Didiniidae						
30	*Monodinium balbianii* Fabre-Domergue, 1888	+			+		+
31	*M. perrieri* Delphy, 1925		+	+	+		
32	*Didinium nasutum* (Müller, 1773) Stein, 1859	+	+	+			
33	*D. chlorelligerum* Kahl, 1935				+		
34	*D. gargantua* Meunier, 1910		+	+			
	Trachelidae						
35	*Paraspathidium obliquum* Dragesco, 1963	+			+		+
36	*P. fuscum* (Kahl, 1928) Fjeld, 1955	+			+		+
	Mesodiniidae						
37	*Mesodinium acarus* Stein, 1867		+				
38	*M. apsheronicum* Alekperov et Asadullayeva, 1996		+	+	+		
39	*Mesodinium cinctum* Calkins, 1902		+	+			
	Nassulidae						
40	*Nassula marina* Alekperov et Asadullaeva, 1997		+	+	+		
	Colepidae						
41	*Coleps remanei* Kahl, 1933	+			+	+	+
42	*C. arenicolus* Dragesco, 1965	+				+	
43	*C. lacustris* Faure-Fremiet, 1924	+			+	+	+
44	*C. nolandi* Kahl, 1930	+	+	+		+	
	Urotrichidae						
45	*Urotricha farcta* Claparède et Lachmann, 1859			+		+	
46	*U. armata* Kahl, 1927		+	+			+

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	Species composition	*Occurrence of species in different points*					
		1	*2*	*3*	*4*	*5*	*6*
47	*U. pelagica* Kahl, 1935		+	+			
	Parameciidae						
48	*Paramecium woodruffi* Wenrich, 1928	+				+	+
49	*P. putrinum* Claparède & Lachmann, 1859	+			+	+	+
	Cyclidiidae						
50	*Cristigera vestita* Kahl, 1928		+	+			
51	*C. fusiformis* Penard, 1922		+	+			
52	*Caspionella bergeri* (Agamaliev, 1972)					+	+
53	*C. marinum* Borror, 1963		+	+			
	Uronematidae						
54	*Uronema marinum* Dujardin, 1841	+				+	+
55	*U. acutum* Buddenbrock, 1920		+	+		+	+
	Pleuronematidae						
56	*Pleuronema coronatum* Kent, 1881		+	+		+	+
57	*P. marinum* Dujardin, 1841		+	+		+	
	Epistylidae						
58	*Epistylis nympharum* Engelmann, 1862		+	+		+	
	Vorticellidae						
59	*Carchesium brevistylum* Stiller, 1931					+	
60	*C. umbilicatum*	+	+	+		+	
61	*C. wassenum*		+	+			+
	Zoothamniidae						
62	*Zoothamnium marinum* Mereschkowski, 1879	+	+	+	+		+
	Total:	18	39	36	18	24	25

Note: 1 — Sumgait, 2 — Novkhani, 3 — Bilgah, 4 – Turkan, 5 — Shikh, 6 — Sangacha

As can be seen from Table 1, the greatest species diversity was observed in the plankton communities of ciliates in the Novkhani (39 species) and Bilgah (36 species) territories. Next in terms of species diversity are the Sangachal (25 species) and Shikh (24 species) sites. The minimum species diversity was noted in the planktonic communities of the Caspian coast at the Sumgait and Turkan territories, where in both cases only 18 species of planktonic ciliates were recorded.

It should be noted that the northern and southern coasts of Absheron differ significantly, primarily in the cleanliness of the coastal zone. The northern coast is less polluted by both oil products and domestic sewage. On the northern coast, areas of pure psammon are still preserved, in the coastal zone there are many rocks with well-developed biofouling. The southern part is heavily polluted by oil products (although in recent years the results of increased monitoring over the cleanliness of the sea have been noticeable). And most importantly, the largest part of all domestic wastewater is discharged on the south coast.

The results of the cluster analysis of the similarity of the species diversity of planktonic ciliate communities are shown in Figure 2. As can be seen from Figure 2, the highest similarity of species

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https://doi.org/10.33619/2414-2948/90

diversity (95.5%) was noted for two collection points on the northern coast of Absheron, near the settlements of Novkhani and Bilgah. These sections of the Absheron Peninsula are among the cleanest, despite the increase in the construction of hotels and private houses.

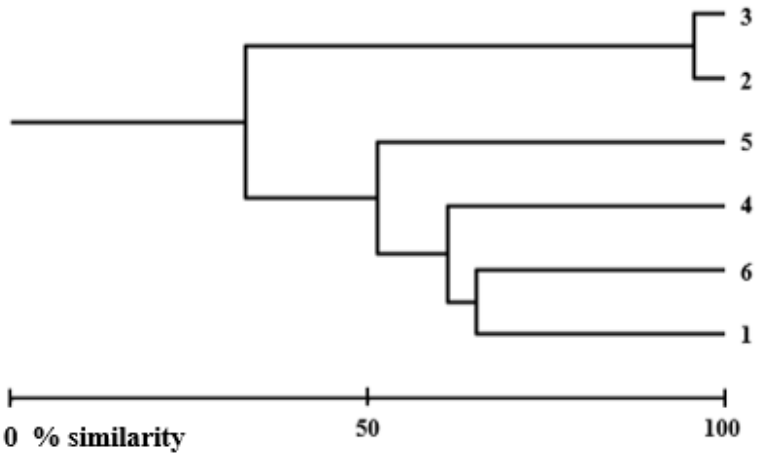

Figure 2. Similarity of species diversity of planktonic ciliate communities in different parts of the Absheron coast of the Caspian Sea (1 — Sumgait, 2 — Novkhani, 3 — Bilgah, 4 — Turkan, 5 — Shikh, 6 — Sangacha)

Comparison of more polluted sites showed the greatest similarity for the coasts of Sumgait and Sangachal (65%). Both of these zones, despite their remoteness, experience a fairly strong pressure of technogenic pollution common to both zones in Sumgait, these are the remains of long-term discharges of the industrial zone, and in Sangachal, a common rather noticeable pollution by both oil products and wastewater from the largest Sangachal oil terminal.

Relatively little similarity was recorded between the collection points listed above and Turkan settlement (61%). This zone, in principle, refers to fairly clean zones. Nevertheless, like all the southern coasts of Absheron, it is polluted by both oil and domestic wastewater due to the wind blowing from the sea.

When comparing these areas with the coast of Shikh, their similarity turned out to be quite close (51.2%), since the causes of the general pollution of the southern coast of the Absheron peninsula are the same in this area.

Conclusion

A comparison of the overall similarity of species diversity of plankton communities between all six stationary sampling points on Absheron showed that it cannot be called high (32.7%). Thus, as a result of the conducted analysis, it was determined that the similarity of species diversity of planktonic ciliate communities on the Absheron coasts clearly differs with two clusters. One combines the cleanest areas of the settlements of Novkhani and Bilgah (95.5%), and all other 4 stationary collection points are combined into the second cluster, the similarity of which is more than 50% for all areas. Characteristically, all collection points on the southern coast of the Absheron peninsula, with the exception of the coast of Sumgait, known as a zone of strong anthropogenic pollution, were included in the cluster that unites the more polluted areas.

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Работа поступила
в редакцию 10.04.2023 г.

Принята к публикации
17.04.2023 г.

Ссылка для цитирования:

Tahirova E. Cilioplankton Communities as an Indicator of the Pollution Degree in the Caspian Sea // Бюллетень науки и практики. 2023. Т. 9. №5. С. 68-74. https://doi.org/10.33619/2414-2948/90/08

Cite as (APA):

Tahirova, E. (2023). Cilioplankton Communities as an Indicator of the Pollution Degree in the Caspian Sea. *Bulletin of Science and Practice, 9*(5), 68-74. https://doi.org/10.33619/2414-2948/90/08