Protistology 13 (3), 133–151 (2019)

Protistology

# Free-living ciliates in different coastal zone biotopes at the Azerbaijan sector of the Caspian Sea

Ilham Kh. Alekperov and Elyana N. Tahirova

*Institute of Zoology, Azerbaijan National Academy of Sciences, Baku, Azerbaijan*

| Submitted June 06, 2019 | Accepted July 03, 2019 |

**Summary**

Samples of plankton, periphyton, benthos and phytocyliocenoses (coastal thickets of aquatic plants with associated ciliates) were collected during 2010–2017 from 7 collection points (from north to south) along the Azerbaijan sector of the Caspian Sea coastal zone. In total, 463 species of free-living ciliates were found. The highest number of ciliate species was noted in the Divichi firth (214) and on the Absheron coast (203). The species composition in Nabran (179 species) and on the coast of Lankaran (107) and Astara (110) was much lower. Minimal species diversity was observed in the Kyzyl-Agach Bay (96) and estuary of the Kura River (72). The similarity of the free-living ciliate species composition of the seven stationary points along the Azerbaijan sector of the Caspian Sea depends on the similarity of environmental conditions at these collection points, as well as on a certain distance between them. Species diversity in different biotopes of each of the seven stationary collection points showed that, despite the strong differences in the total number of the ciliate species found therein, approximately the same ratio of species diversity in various biotopes is characteristic for all collection points. It was established that in plankton communities there are from 9% to 16% of the total number of ciliate species, in periphyton – from 10% to 25%, in benthos - from 30% to 40%, and in phytocyliocenoses communities – from 33% to 44%. The obtained data indicate a general pattern of the distribution of ciliate species richness among different biotopes, even considering the presence of many ciliate species simultaneously in several habitats.

**Key words:** Azerbaijan, biotopes, Caspian Sea, ciliates, coastal area

## Introduction

The Caspian Sea is a closed salty-water basin with a relatively high degree of endemism of its animal world. The beginning of modern study period of free-living ciliates in the Caspian Sea was inspired by the works of F.Q. Agamaliev, who had studied this group during many years starting from the middle of the XX century. While earlier only a few ciliate species were known in the Caspian Sea, already in the early 1980-s Agamaliev (1983) provided a list of 439 species.

The study of the total biodiversity of free-living protozoans of Azerbaijan, including the ciliates of the Caspian Sea, has continued in consecutive stages throughout the subsequent years, and the summarized results of those long-term investigations are presented in the recently published monograph (Alekperov et al., 2017).

doi:10.21685/1680-0826-2019-13-3-3

In this article, we present the results of long-term study of the free-living ciliate species diversity in various biotopes of the coastal zone of Azerbaijan sector of the Caspian Sea.

## Material and methods

Samples of plankton, periphyton, benthos and phytocyliocenoses (coastal thickets of aquatic plants with associated ciliates) were collected in 2010–2017 at 7 collection points along the Azerbaijan sector of the Caspian coastal zone (Fig. 1). Plastic bottles were used to collect benthic samples, plankton samples were collected using plankton net with mesh size of 20-60 μm. The samples of periphyton and phytocyliocenoses were collected by scraping biofilm and picking up water among aquatic plants thickets.

The impregnation methods with silver nitrate (Chatton and Lwoff, 1930) and protargol (Alekperov, 1992) were used for determination of taxonomic identity of ciliates. Counting of ciliates was conducted in a Bogorov chamber *in vivo* in 5 ml of water or 1 $cm^2$ of benthos on surface under binocular followed by recalculation for 1 L or 1 $dm^2$. Bray-Curtis cluster analysis was used to compare the similarity of species diversity at different sites. All data were calculated by PC Software programme "Biodiversity Professional 2".

## Results

The data related to the total species diversity of free-living ciliates at seven stationary points located in the Azerbaijan sector of the Caspian Sea coast are shown in Table 1. In total, 463 species of free-living ciliates were found in the studied region (Table 1).

The first sampling station (# 1) was located near the Nabran settlement, not far from the Russian state border. Here, silty sand biotopes predominated in the bottom of the coastal zone. In total, 179 species of ciliates were registered in this area, most of them were found in benthic (72 species) biotopes and coastal phytociliocenoses (61 species).

The next sampling station (# 2) was located in the Divichi firth - the low-salinity (4-5‰) area, which is connected with the sea in spring only. A characteristic feature of this stationary sampling point is the presence of a wide variety of benthic biotopes, as well as large sites overgrown with

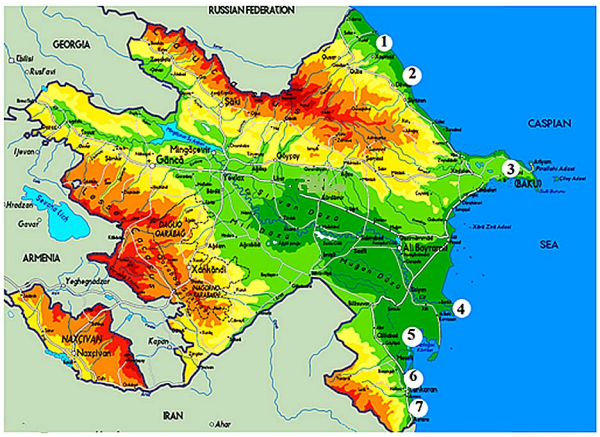


**Fig. 1.** Location of seven constant sampling points in the coastal zone along the Azerbaijan sector of the Caspian Sea: 1 – Nabran settlement, 2 – Divichi firth, 3 – Absheron Peninsula, 4 – Estuary of the Kura river, 5 – Kyzyl-Agach Bay, 6 – Lankaran coast, 7 – Astara coast of the Caspian Sea.

aquatic plants (phytociliocenoses). Of course, it is necessary to take into account that many ciliate species are found in two or more biotopes at the same time. It should be noted that in addition to the true planktonic species - *Cyclotrichium ovatum, Halte-ria grandinella, H. maxima, Pelagohalteria viridis, Limnostrombidium viride, Spirostrombidium coronatum, Strombidium nabranicum*, etc., we have identified many facultative planktonic species that are commonly found in shallow water phytociliocenoses and other biotopes. This fact can be explained by the shallow water and the presence of huge thickets of aquatic plants in the Divichi firth. Such species as *Euplotes harpa, E. eurystomus, Aspidisca binucleata, A. turrita, Holophrya vorax, H. salinarum, Lembadion magnum, Paramecium woodruffi, Ophryoglena atra,* etc. can be noted as facultative planktonic species. In total, 214 species were found at site # 2.

The next largest ciliate species diversity was registered at the Absheron peninsula (sampling site # 3). There is a significant difference in the coastal zone water quality between the northern and southern coasts of Absheron. The northern coast is less polluted with both marine oil production and domestic wastewaters, as compared with the southern coast. On the northern coast, there are still areas of pure psammon, and in the coastal zone there are many rocks with well-developed periphyton. The southern coast is heavily polluted by products of the

**Table 1.** Species composition and distribution of free-living ciliates at stationary collection points of the Azerbaijan sector of the Caspian coast.

| | Taxonomic composition | Distribution by regions* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | **Phylum Ciliophora Doflein, 1901** | | | | | | | |
| | **Class Kariorelictea Corliss, 1974** | | | | | | | |
| | **Order Trachelocercida Jank., 1978** | | | | | | | |
| | **Fam. Trachelocercidae Kent, 1880** | | | | | | | |
| 1 | *Trachelocerca cylindricolis* Lepsi, 1962 | | | + | | | | |
| 2 | *T. incaudata* Kahl, 1933 | | | + | | | | |
| 3 | *Kovalevaia sulcata* (Kovaleva, 1966) | | + | | | | | |
| 4 | *K. teissieri* (Dragesco, 1960) | | + | | | | | |
| 5 | *Tracheloraphis binucleata* Dragesco,1960 | | | | + | | | + |
| 6 | *T. conformis* Wright,1982 | | | | + | | | + |
| 7 | *T. discolor* Raikov,1962 | | | | + | | | + |
| 8 | *T. gracilis* Dragesco, 1960 | | | + | | | | |
| 9 | *T. nivea* Wright, 1982 | | | + | | | | |
| 10 | *T. oligostriata* (Raikov, 1962) | | | | + | | | + |
| | **Order Loxodida Jankowski, 1980** | | | | | | | |
| | **Fam. Kentrophoridae Jankowski, 1980** | | | | | | | |
| 11 | *Kentrophorus canalis* Wright, 1982 | | | | | | + | + |
| 12 | *K. faurei* (Dragesco, 1954) | | | | | | + | + |
| 13 | *K. flavus* Raikov et Kovaleva, 1968 | | | | | | + | + |
| 14 | *K. latus* Raikov, 1962 | | | | | | + | + |
| 15 | *K. trichocistis* (Dragesco,1954) | | | | | | + | + |
| 16 | *K. uninucleatus* Raikov, 1962 | | | | | | + | + |
| | **Fam. Loxodidae Bütschli, 1889** | | | | | | | |
| 17 | *Loxodes kahli* Dragesco et Njine, 1971 | + | | | | | | |
| 18 | *L. penardi* Dragesco, 1960 | + | + | | | | | |
| 19 | *L. rostrum (*Müller,1773) | + | | | | | | |
| 20 | *L. striatus (*Engelmann, 1862) | + | + | | | | | |
| 21 | *L. vorax* Stokes, 1887 | + | | | | | | |
| | **Fam. Cryptopharyngidae Jankowski, 1980** | | | | | | | |
| 22 | *Cryptopharynx multinucleatum* Dragesco, 1960 | + | | + | | | | + |
| 23 | *C. setigerus* Kahl, 1928 | + | | | | | | + |
| | **Order Protoheterotrichida Nouzarede, 1977** | | | | | | | |
| | **Fam. Geleiidae Foissner, 1998 nec. Kahl, 1933** | | | | | | | |
| 24 | *Geleia acuta* (Dragesco, 1960) | | | | | | + | |
| 25 | *G. fossata* (Kahl, 1933) | | | | | | | + |
| 26 | *G. luci* (Dragesco, 1960) | | | + | | | | |
| 27 | *G. major* (Dragesco,1954) | | | | + | | | |
| 27 | *G. nigriceps* (Kahl, 1933) | | | | + | | | |
| 29 | *G. simplex* (Fauré-Fremiet, 1951) | | | + | | | | |
| | **Fam. Aveliidae Dragesco, 1999** | | | | | | | |
| 30 | *Avelia arcachonense* (Nouzarede, 1975) | | | | | | + | + |
| 31 | *A. gigas* (Dragesco,1954) | | | | | | + | + |
| | **Order Heterotrichida Stein, 1859** | | | | | | | |
| | **Fam. Blepharismidae Jank. in Small et Lynn, 1985** | | | | | | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 32 | *Anigsteinia salinara* (Florentin, 1899) | + | + | | | + | + | + |
| 33 | *Blepharisma dawsoni* Christie et Hirshfield, 1967 | + | | | | | | |
| 34 | *B. dileptus* Kahl, 1928 | + | | | | | | |
| 35 | *B. falcatum* Gelei, 1954 | + | | | | | | |
| 36 | *B. hyalinum* Perty, 1849 | + | | | | | | |
| 37 | *B. tardum* Kahl, 1928 | + | + | | | | | |
| 38 | *B. undulans* Stein, 1868 | + | + | | | | | |
| | **Fam. Spirostomatidae Stein, 1867** | | | | | | | |
| 39 | *Spirostomum ambiquum* (Müller, 1786) | + | | + | | + | | + |
| 40 | *S. loxodes* Stokes, 1885 | + | + | | | | | |
| 41 | *S. minus* Roux, 1901 | + | + | | | | | |
| | **Fam. Climacostomidae Repak, 1972** | | | | | | | |
| 42 | *Fabrea salina* Hennequy, 1890 | | | + | | | | |
| | **Fam. Condylostomatidae Kahl in Dofflein and Reichenov, 1927** | | | | | | | |
| 43 | *Condylostoma arenarium* Spiegel, 1926 | | | + | | | | |
| 44 | *C. fieldi* Hartwig, 1973 | + | + | | | + | | |
| 45 | *C. granulosum* Bullington,1940 | + | + | | | + | | |
| 46 | *C. magnum* Spiegel, 1926 | + | + | | | + | | |
| 47 | *C. psammophila* Bock, 1954 | + | | | | | | |
| 48 | *C. reichi* Wilbert et Kohan, 1981 | + | | | | | | |
| 49 | *C. spatiosum* Ozaki and Yagiu in Yagiu, 1944 | | + | | | + | | |
| 50 | *C. subterraneum* Lepsi, 1962 | + | | | | | | |
| 51 | *Linostomella vorticella* (Ehrenberg, 1833) | | + | | | + | | |
| | **Fam. Stentoridae Carus, 1863** | | | | | | | |
| 52 | *Stentor coeruleus* Ehrenberg,1830 | + | | | + | | | |
| 53 | *S. gallinulus* Penard, 1922 | | | | + | | | |
| 54 | *S. mulleri* Ehrenberg, 1831 | | | | + | | | |
| | **Classis Spirotrichea Bütschli, 1889** | | | | | | | |
| | **Fam. Phacodiniidae Corliss, 1979** | | | | | | | |
| 55 | *Phacodinium muscorum* Prowazek, 1900 | + | | | | | | |
| | **Order Stichotrichida Fauré-Fremiet, 1961** | | | | | | | |
| | **Fam. Amphisiellidae Jankowski, 1979** | | | | | | | |
| 56 | *Amphiziella annulata* (Kahl, 1928) | + | | + | | | | |
| 57 | *A. marioni* Wicklow, 1982 | | + | | + | + | | |
| 58 | *A. milnei* Kahl, 1932 | + | | + | | | | |
| 59 | *A. quadrinucleata* Berger et Foissner, 1989 | + | + | | | | | |
| 60 | *A. turanica* Alekperov and Asadullaeva, 1999 | | | + | | | | |
| 61 | *A. vitiphila* (Foissner, 1987) | + | + | | + | + | | |
| 62 | *Pseudouroleptus caudatus* Hemberger, 1985 | | | + | | | | |
| 63 | *Paragastrostyla lanceolata* Hemberger, 1985 | + | | + | | | | |
| | **Fam. Kahliellidae Tuffrau, 1979** | | | | | | | |
| 64 | *Kahliella acrobates* Horvath, 1932 | + | | | | | | |
| 65 | *K. bacilliformis* (Gelei,1954) | + | | + | | | | |
| | **Fam. Oxytrichidae Ehrenberg, 1838** | | | | | | | |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 66 | *Tachysoma ovata* Song et Wilbert, 1997 | + | | + | | | | |
| 67 | *Stylonychia bifaria* (Stokes, 1887) | + | + | | + | + | | |
| 68 | *S. notophora* Stokes, 1885 | | + | | | + | | |
| 69 | *S. putrina* Stokes, 1885 | + | + | | | | | |
| 70 | *S. quadrinucleata* Alekperov et Musaev, 1988 | | | + | | | | |
| 71 | *S. vorax* Stokes, 1885 | + | + | | + | | | |
| 72 | *Histriculus complanatus* (Stokes, 1887) | + | + | | + | | | |
| 73 | *H. similis* (Quennerstedt, 1867) | + | | | | | | |
| 74 | *H. steini* (Sterki, 1878) | + | + | | + | | | |
| 75 | *H. vorax* (Stokes, 1991) | | | + | | + | | |
| 76 | *Paraurostyla granulifera* Berger et Foissner, 1989 | + | | + | + | | | |
| 77 | *P. polynucleata* Alekperov, 1993 | | | + | + | | | |
| 78 | *P. wessei* (Stein, 1859) | + | | + | + | + | | |
| 79 | *Oxytricha aeruginosa* Wrzesniovski, 1870 | + | + | | | | | |
| 80 | *O. balladina* Song et Wilbert, 1989 | + | | | + | | | |
| 81 | *O. fallax* Stein, 1859 | + | + | + | + | | | |
| 82 | *O. marina* Kahl, 1932 | + | | + | | | + | + |
| 83 | *O. pellionella* (Müller, 1773) | + | | + | + | | | |
| 84 | *O. setigera* Stokes, 1891 | | + | | + | | | |
| 85 | *O. tenella* Song and Wilbert, 1989 | + | | | | | | |
| 86 | *Wallaskia schiffmanni* Foissner, 1976 | | | + | | | | |
| 87 | *Gonostomum affinis* (Stein, 1859) | | | + | | | | |
| 88 | *G. gonostomoida* (Hemberger, 1985) | | | + | | | | |
| 89 | *G. kuehnelti* Foissner, 1987 | | | + | | | | |
| | **Fam. Keronidae Dujardin, 1841** | | | | | | | |
| 90 | *Paraholosticha flava* (Berger, 2006) | + | | | | | | |
| 91 | *P. herbicola* (Kahl, 1932) | + | | | | | | |
| 92 | *P. polychaeta* Borror,1966 | + | | | | | | |
| 93 | *Keronopsis arenivorus* Dragesco, 1954 | + | + | | | | | + |
| 94 | *K. gracilis* Dragesco, 1954 | + | + | | | | + | + |
| 95 | *K. helluo* (Penard, 1922) | + | | | | | + | |
| 96 | *K. longissima* Dragesco and Dr.-Kerneis, 1986 | | + | + | | | | + |
| 97 | *K. pernix* Wrzesniowski, 1877 | + | | | | + | | + |
| 98 | *Strongylidium crassum* Sterki, 1878 | + | | + | | | | |
| 99 | *S. wilberti* Foissner, 1982 | | | | | + | | + |
| | **Order Urostylida Jankowski, 1979** | | | | | | | |
| | **Fam. Pseudokeronopsidae Borror et Wicklow, 1983** | | | | | | | |
| 100 | *Pseudokeronopsis carnea* (Cohn, 1866) | | + | | | | | |
| 101 | *P. flava* (Cohn, 1866) | + | + | + | | | + | + |
| 102 | *P. rubra* (Ehrenberg, 1838) | + | + | + | | + | + | + |
| 103 | *P. sepetibensis* Wanick et Da Silva Neto, 2004 | | | | | | + | |
| | **Fam. Bakuellidae Jankowski, 1979** | | | | | | | |
| 104 | *Bakuella crenata* Agam. et Alekperov, 1976 | + | + | + | | | | |
| 105 | *B. imbricata* Alekperov, 1982 | | | + | | | | |
| 106 | *B. marina* Agam. and Alekperov, 1976 | + | | + | | | + | + |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 107 | *B. polycirrata* Alekperov, 1988 | + | | + | | | | |
| 108 | *Metabakuella perbella* Alekperov et Musaev, 1988 | | + | + | | | | |
| 109 | *Pseudobakuella gracilis* Alekperov, 1992 | | + | | | + | | |
| 110 | *P. walibonensis* (Song, Wilbert, Berger, 1992) | | | | | | | + |
| | **Fam. Pseudourostylidae Jankowski, 1979** | | | | | | | |
| 111 | *Pseudourostyla cristata* (Jerka-Dziadosz, 1964) | + | | + | | | | |
| 112 | *Trichototaxis crassus* (Clap. et Lachm., 1858) | | | | | | + | + |
| 113 | *T. pulchra* Borror, 1972 | + | | | | | | |
| 114 | *T. velox* (Quennerstedt,1869) | | | | | | + | + |
| | **Fam. Urostylidae Bütschli, 1889** | | | | | | | |
| 115 | *Anteholosticha adami (Foissner, 1982)* | | | + | | | | |
| 116 | *A. grisea (Kahl, 1932)* | | | + | | | + | + |
| 117 | *A. manca (Kahl,1932)* | | + | | | + | | |
| 118 | *A. muscicola (Gellert, 1956)* | + | | | | | | |
| 119 | *Birojimia terricola Berger et Foissner, 1989* | + | | | | | | |
| 120 | *Holosticha foissneri Petz et al., 1995* | | + | + | + | | | |
| 121 | *H. pullaster (Müller, 1773)* | | + | | | | | |
| 122 | *Pseudoamphisiella alveolata (Kahl,1932)* | | + | | + | | | |
| 123 | *Urostyla dispar Kahl, 1932* | + | + | + | | | | |
| 124 | *U. grandis Ehrb., 1830* | + | | + | | | | |
| 125 | *U. marina Kahl, 1932* | + | + | | | + | + | + |
| 125 | *U. viridis Stein, 1859* | + | | | | | | |
| | **Order Euplotida Jankowski, 1980** | | | | | | | |
| | **Fam. Kiitrichidae Nozawa,1941** | | | | | | | |
| 127 | *Musajevella minima* Alekperov, 1984 | | + | | | | + | + |
| | **Fam. Euplotidae Ehrenberg, 1838** | | | | | | | |
| 128 | *Euplotes alatus* Kahl, 1932 | + | | | | | | |
| 129 | *E. apsheronicus* Agamaliev, 1966 | | | + | | | | |
| 130 | *E. balteatus* Dujardin, 1842 | | | + | | | + | |
| 131 | *E. charon* (Müller, 1786) | | | + | | | | |
| 132 | *E. corsica* Berger et Foissner, 1989 | | | | | | + | |
| 133 | *E. dogieli* Agamaliev,1967 | + | | | | | | |
| 134 | *E. eurystomus* Wrzesniowski, 1870 | | + | | | | | |
| 135 | *E. focardii* Valbonesi and Luporini, 1990 | | + | | | | | |
| 136 | *E. gracilis* Kahl, 1932 | | | + | | | | |
| 137 | *E. harpa* Stein, 1859 | | + | + | + | + | | |
| 138 | *E. kasymovi* Aliev, 1987 | | + | | | | | |
| 139 | *E. khazarica* Alekperov, Buskey, Snegovaya, 2006 | + | | | | | | |
| 140 | *E. minuta* Yocom, 1930 | | | + | | | | |
| 141 | *E. muscicola* Kahl, 1932 | | | + | | + | | |
| 142 | *E. octocirratus* Agamaliev, 1967 | | + | | | | | |
| 143 | *E. patella* (Müller, 1773) | | | + | | | | |
| 144 | *E. poljanskyi* Agamaliev, 1966 | | + | | | | | |
| 145 | *E. pseudoraikovi* Alekperov, 2005 | + | | | | | | |
| 146 | *E. raikovi* Agamaliev, 1966 | | | + | + | + | | + |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 147 | *E. rariseta* Curds, West, Dorahy, 1974 | | + | | | | | |
| 148 | *E. trisulcatus* Kahl, 1932 | | | + | | | | |
| 149 | *E. vannus* (Müller, 1786) | + | | + | | | | |
| | **Fam. Aspidiscidae Ehrenberg, 1838** | | | | | | | |
| 150 | *Aspidisca aculeata* (Ehrg., 1838) | | | + | | + | | |
| 151 | *A. binucleata* Kahl, 1932 | | + | | | | | |
| 152 | *A. caspica* Agamaliev, 1967 | | + | + | | | | |
| 153 | *A. cicada* Müller, 1786 | + | | | | | | |
| 154 | *A. dentata* Kahl, 1928 | | | | | + | | |
| 155 | *A. fusca* Kahl, 1928 | + | | + | | | | |
| 156 | *A. leptaspis* Fresenius, 1865 | | | | | + | | |
| 157 | *A. poljanski* Alekperov, 1985 | | | + | | | + | + |
| 158 | *A. polystyla* Stein, 1859 | | | | + | | + | + |
| 159 | *A. pulcherrima* Kahl, 1932 | | + | | | | | |
| 160 | *A. steini* Buddenbrock, 1920 | + | | + | | | | |
| 161 | *A. turrita* (Ehrenberg, 1838) | | + | | | | | |
| | **Fam. Uronychiidae Jankowski, 1975** | | | | | | | |
| 162 | *Diophrys kasymovi* Agamaliev, 1971 | | | + | | | | |
| 163 | *D. multicirratus* Alekperov, 1984 | | | + | | | | |
| 164 | *D. oligothrix* Borror,1965 | | + | | | | + | + |
| 165 | *D. polycirratus* Alekperov, 1984 | | | + | | | | |
| 166 | *D. scutum* Dujardin, 1841 | + | + | + | | | + | + |
| 167 | *Uronychia binucleata* Young, 1922 | | + | | | | + | |
| 168 | *U. bivalvorum* Fenchel, 1965 | | | + | | | + | |
| 169 | *U. caspica* Alekperov et Asadullayeva, 1999 | | | | | | + | |
| 170 | *U. heinrothi* Buddenbrock,1920 | | + | | | + | | |
| 171 | *U. magna* Pierantoni, 1909 | + | | + | | | | |
| 172 | *U. setigera* Calkins, 1902 | | | | | | + | + |
| 173 | *U. transfuga* (Muller, 1776) | + | | + | | | + | + |
| | **Class Oligotrichea Bütschli,1887** | | | | | | | |
| | **Order Halteriida Jankowski, 2007** | | | | | | | |
| | **Fam. Halteriidae Clap. et L., 1858** | | | | | | | |
| 174 | *Halteria grandinella* (Müller, 1786) | + | + | + | | + | + | |
| 175 | *H. maxima* Szabo, 1934 | + | + | | | | | |
| 176 | *H. oviformis* Gelei, 1950 | | | | | + | | |
| 177 | *Pelagohalteria cirrifera* Kahl, 1932 | | + | | | | | + |
| 178 | *P. viridis* (Fromentel, 1876) | | + | | | | | |
| | **Order Strombidiida Jankowski, 1980** | | | | | | | |
| | **Fam. Strombidiidae Fauré-Fremiet, 1970** | | | | | | | |
| 179 | *Omegastrombidium elegans* (Florentin, 1901) | + | | | | | | |
| 180 | *Arcostrombidium grande* (Levander,1894) | | + | | + | + | | |
| 181 | *Heterostrombidium calkinsi* Fauré-Fremiet, 1932 | + | | | | | | |
| 182 | *H. clavellinae* (Buddenbrock, 1922) | + | | | | | | |
| 183 | *H. faurei* (Dragesco, 1960) | + | | | | | | |
| 184 | *Limnostrombidium viride* (Stein,1867) | | + | + | | | | |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 185 | *Novistrombidium testaceum* (Anigstein, 1914) | | + | + | | | | |
| 186 | *Spirostrombidium cinctum* Kahl, 1932 | + | | | + | | | |
| 187 | *S. coronatum* Sauerbrey, 1928 | | + | | + | | | |
| 188 | *Pelagostrombidium mirabile* (Penard, 1916) | | | + | | | + | + |
| 189 | *P. fallax* (Zacharias, 1896) | | + | | | | + | + |
| 190 | *Strombidium apsheronicum* Alekperov et Asadullayeva, 1997 | + | | + | | | + | + |
| 191 | *S. arenicola* Dragesco, 1960 | | | | | | + | + |
| 192 | *S. caspicum* Alekperov et Asadullayeva, 1997 | | | + | | | + | + |
| 193 | *S. conicoides* (Leegaard, 1915) | + | | + | | | + | |
| 194 | *S. elatum* Alekperov, 1985 | | | + | | | | |
| 195 | *S. elegans* Florentin, 1899 | + | | | | | | |
| 196 | *S. kahli* Bock, 1952 | | + | | + | | | |
| 197 | *S. nabranicum* Alekperov, Buskey, Snegovaya, 2005 | + | + | | | | | |
| 198 | *S.obtusum* Alekperov et Mamaeva, 1992 | | | | | | + | + |
| 199 | *S. obliquum* Kahl, 1932 | | + | | | | | |
| 200 | *S. oculatum* Gruber, 1888 | | + | | | | + | |
| | **Order Strobilidiida Jankowski, 1980** | | | | | | | |
| | **Fam. Strombidinopsidae Small et Lynn, 1985** | | | | | | | |
| 201 | *Strombidinopsis azerbaijanca* Alekperov et Asad., 1997 | | | + | | | | |
| 202 | *S. claparedi* Kent,1881 | | + | + | + | | | |
| 203 | *S. elegans* Song et Bradbury,1998 | | | + | | | | + |
| 204 | *S. elongata* Song et Bradbury, 1998 | | | + | | | + | + |
| 205 | *S. spinifera* (Leegaard,1915) | | + | | + | | | |
| | **Fam. Strobilidiidae Kahl in Doflein et Reich., 1929** | | | | | | | |
| 206 | *Strobilidium caudatum* (Fromentel, 1876) | + | | | | + | + | |
| 207 | *S. humile* Penard, 1922 | + | + | | | | | + |
| 208 | *S. marinum* Fauré-Fremiet, 1924 | | | | | | + | + |
| 209 | *S. velox* Fauré-Fremiet, 1924 | + | + | + | | | + | + |
| 210 | *Pelagostrombidium neptunii* Montagnes et Taylor, 1994 | | | | | | + | + |
| 211 | *P. spirale* (Leegaard,1915) | | | | | | + | + |
| | **Class Armophorea Lynn,2002** | | | | | | | |
| | **Order Metopida Jankowski,1980** | | | | | | | |
| | **Fam. Metopidae Kahl,1927** | | | | | | | |
| 212 | *Metopus acidiferus* Kahl,1935 | | + | | + | | | |
| 213 | *M. caucasicus* Alekperov, 1984 | | + | | + | | | |
| 214 | *M. contortus* (Quennerstedt, 1867) | | | | + | | | |
| 215 | *M. es* (Müller, 1786) | | + | | | | | |
| 216 | *M. fuscoides* Alekperov, 1984 | | + | | + | | | |
| 217 | *M. halophilus* Kahl,1932 | | | | | + | | |
| 218 | *M. major* Kahl,1932 | | + | | | | | |
| 219 | *M. propagatus* Kahl, 1927 | | + | | | | | |
| 220 | *M. vestitus* Kahl, 1935 | | + | | | | | |
| 221 | *Brachonella darwini* (Kahl, 1927) | | + | | | | | |
| 222 | *B. elongata* Jankowski, 1964 | | + | | | | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 223 | *B. mitriformis* Alekperov, 1984 | | + | | + | | | |
| 224 | *B. spiralis* (Smith, 1897) | + | | | + | | | |
| | **Order Armophorida Jankowski, 1964** | | | | | | | |
| | **Fam. Caenomorphidae Poche, 1913** | | | | | | | |
| 225 | *Caenomorpha lauterborni* Kahl, 1927 | | + | | | | | |
| 226 | *C. levanderi* Kahl, 1927 | | | | + | | | |
| 227 | *C. medusula* Perty, 1852 | | + | | | | | |
| | **Order Odontostomatida Sawaya, 1940** | | | | | | | |
| | **Fam. Epalxellidae Corliss, 1960** | | | | | | | |
| 228 | *Pelodinium rotundum* Kahl, 1926 | | + | | + | | | |
| 229 | *Epalxella antiquorum* (Penard, 1922) | | + | | + | | | |
| 230 | *E. mirabilis* (Roux, 1899) | | | | + | | | |
| 231 | *E. striata* (Kahl, 1926) | | + | | | | | |
| 232 | *E. triangula* (Kahl,1932) | | + | | + | | | |
| 233 | *Saprodinium halophilum* Kahl, 1932 | | + | | | | | |
| 234 | *S. mimeticum* (Penard, 1922) | | + | | | | | |
| 235 | *S. putrinum* Lackey, 1925 | | + | | | | | |
| 236 | *S. spinigerum* Kahl, 1932 | | + | | | | | |
| | **Fam. Mylestomatidae Kahl in Doflein et R., 1929** | | | | | | | |
| 237 | *Mylestoma bipartitum* (Gourret et Roeser, 1886) | | | | | | + | + |
| 238 | *M. flagellatum* Penard,1922 | | | | | | + | |
| 239 | *M. pusillum* Kahl, 1932 | | | | | + | | |
| 240 | *M. uncinatus* (Penard, 1922) | | | | | + | | |
| | **Class Litostomatea Small et Linn, 1981** | | | | | | | |
| | **Order Haptorida Corliss,1974** | | | | | | | |
| | **Fam. Enchelyidae Ehrenberg, 1838** | | | | | | | |
| 241 | *Enchelys marina* (Meunier, 1910) | + | + | | | | | |
| 242 | *E. pectinata* Kahl, 1930 | + | + | | | | | |
| 243 | *Lagynophrya halophila* Kahl, 1930 | | | | | | | + |
| 244 | *L. maxima* Burkovski, 1970 | | | | | | | + |
| 245 | *L. mutans* Kahl, 1927 | + | | | | | | |
| | **Fam. Trachelophyllidae Kent, 1882** | | | | | | | |
| 246 | *Trachelophyllum clavatum* Stokes, 1886 | + | | | | | | |
| | **Fam. Lacrymariidae Fromentel, 1876** | | | | | | | |
| 247 | *Lacrymaria acuta* Kahl, 1933 | | + | | | + | | |
| 248 | *L. clavarioides*, Alekperov, 1984 | + | | + | | | | |
| 249 | *L. cucumis* Penard, 1922 | + | | + | | | | |
| 250 | *L. delmarei* (Dragesco, 1954) | + | + | | | | + | |
| 251 | *L. issykkulica* Alekperov, 1997 | + | | | | + | + | |
| 252 | *L. kahli* Dragesco,1954 | + | | | | + | + | + |
| 253 | *L. marina* Kahl, 1933 | + | + | + | | + | + | + |
| 254 | *L. minuta* Dragesco, 1963 | | + | + | | | + | + |
| 255 | *L. olor* (Müller,1786) | + | + | | | + | + | |
| 256 | *L. pulchra* Wenzel, 1953 | + | | + | | | | |
| 257 | *L. spiralis* Corliss and Snyder, 1986 | + | + | | | | | |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 258 | *Pelagolacrymaria conifera* (Burkovsky, 1970) | | | | | | + | + |
| 259 | *P. moserae* Foissner et al., 1999 | | + | | | | | |
| 260 | *P. ovata* (Burkovsky, 1970) | | | | | | + | + |
| 261 | *P. rostrata* Kahl,1935 | | + | | | | | |
| | **Fam. Spathidiidae Kahl, 1929** | | | | | | | |
| 262 | *Spathidium moniliforme* Bhatia, 1920 | | + | + | | | | |
| 263 | *Protospathidium muscicola* Dragesco et Dragesco-Kerneis, 1979 | + | | | | | | |
| 264 | *P. terricola* Foissner,1998 | + | | | | | | |
| 265 | *Perispira oligospira* Gelei, 1954 | | + | | | + | | |
| 266 | *P.ovum* Stein, 1859 | | + | | | | | |
| | **Fam. Didiniidae Poche, 1913** | | | | | | | |
| 267 | *Monodinium alveolatum* Kahl, 1930 | + | + | | | | | |
| 268 | *M. balbianii* Fabre-Dom., 1888 | | + | + | | | | |
| 269 | *M. chlorelligerum* Krainer, 1995 | | + | | | | | |
| 270 | *M. perrieri* Delphy,1925 | | + | + | | | | |
| 271 | *Didinium. chlorelligerum* Kahl, 1935 | + | | + | | | | |
| 272 | *D. gargantua* Meinier, 1907 | | + | | | | + | + |
| 273 | *D. nasutum* (Müller,1773) | + | + | + | | | | |
| | **Fam. Trachelidae Ehrenberg, 1838** | | | | | | | |
| 274 | *Dileptus breviproboscis* Foissner, 1981 | + | | | | | | |
| 275 | *D. mucronatus* Penard, 1922 | + | | | | | | |
| 276 | *D. orientalis* Song, Pakroff et Wilbert, 1988 | | + | + | | | | |
| 277 | *Paraspathidium fuscum* Kahl, 1928 | + | + | + | | | + | + |
| 278 | *P. longinucleatum* Czapik et Jordan, 1976 | | + | | | | | |
| 279 | *P. obliquum* Dragesco,1963 | + | + | + | | | + | + |
| | **Order Cyclotrichida Jankowski, 1980** | | | | | | | |
| | **Fam. Mesodiniidae Jankowski, 1980** | | | | | | | |
| 280 | *Askenasia chlorelligera* Krainer and Foissner, 1990 | | + | | | | + | |
| 281 | *A. confunis* Alekperov, 1984 | | | + | | | | |
| 282 | *A. elegans* (Fauré-Fremiet, 1924) | + | | | | | + | |
| 283 | *A. volvox* (Eichwald, 1852) | | + | | | | + | |
| 284 | *Mesodinium acarus* (Clap. et Lach., 1859) | + | + | + | | + | + | + |
| 285 | *M. apsheronicum* Alekperov et Asadullaeva, 1996 | | | + | | | + | + |
| 286 | *M. cinctum* Kahl, 1930 | + | + | | | | + | + |
| | **Fam. Cyclotrichiidae Jankowski, 1980** | | | | | | | |
| 287 | *Cyclotrichium cyclokaryon* Meunier, 1910 | + | | | | | | |
| 288 | *C. gigas* Fauré-Fremiet, 1924 | | | | | | + | + |
| 289 | *C. ovatum* Fauré-Fremiet, 1924 | | + | | | + | | |
| | **Order Pleurostomatida Schewiakoff, 1896** | | | | | | | |
| | **Fam. Amphileptidae Bütschli, 1889** | | | | | | | |
| 290 | *Amphileptus claparedii* Stein, 1867 | | | + | | | | |
| 291 | *A. falcatus* Song et Wilbert, 1989 | + | | | | | | |
| 292 | *Litonotus crystallinus* (Vuxanovici,1960) | + | | | | | | |
| 293 | *L. helus* Stokes, 1884 | | + | + | | | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 294 | *L. hyalinum* Vacelet, 1961 | | + | | | + | | |
| 295 | *L. mononucleatus* Song et Wilbert, 1989 | | + | | | + | | |
| 296 | *L. obtusus* Maupas, 1888 | + | | | | | | |
| 297 | *L. semilunare* Vuxanovichi, 1960 | | + | | | + | | |
| 298 | *L. triqueter* Penard, 1922 | + | | | | | | |
| 299 | *L. undulatum* Sauerbrey, 1928 | | + | | | + | | |
| 300 | *L. vorax* Stokes, 1886 | | + | | | | | |
| | **Class Phyllopharyngea Puytorac et al., 1974** | | | | | | | |
| | **Order Chlamidodontida Deroux,1976** | | | | | | | |
| | **Fam. Chilodonellidae Deroux, 1970** | | | | | | | |
| 301 | *C. aplanata* Kahl, 1932 | + | | | + | | | |
| 302 | *C. capucina* (Penard, 1922) | + | | | + | | | |
| 303 | *Trithigmostoma hialina* (Kidder et Summers, 1935) | | + | | | + | | |
| | **Fam. Chlamydodontidae Stein,1859** | | | | | | | |
| 304 | *Chlamydodon mnemosyne* Ehrenberg, 1835 | + | + | + | | | + | + |
| 305 | *C. obliquus* Kahl, 1931 | + | + | + | + | + | | + |
| 306 | *C. rectus* Ozaki et Yagiu, 1941 | | | + | | | + | + |
| | **Order Dysteriida Deroux, 1976** | | | | | | | |
| | **Fam. Dysteriidae Claparede et Lachmann, 1858** | | | | | | | |
| 307 | *Dysteria armata* Huxley, 1857 | | | | | | + | + |
| 308 | *D. calkinsi* Kahl, 1931 | | | | | | + | |
| 308 | *D. marioni* Gourret et Roeser, 1887 | | | | | | | + |
| 310 | *D. monostyla* (Ehrenberg, 1838) | | + | + | | | | |
| 311 | *D. navicula* Kahl, 1928 | | | + | | | | + |
| 312 | *D. ovalis* (Gourret and Roeser, 1886) | | | | | | + | + |
| 313 | *D. parovalis* Wilbert and Song, 2003 | | | | | | + | + |
| 314 | *D. pectinata* (Nowlin, 1910) | | + | + | | | | |
| 315 | *D. procera* Kahl, 1931 | | + | + | | | | |
| 316 | *D. sulcata* Claparede et Lachmann, 1885 | | | | | | + | |
| | **Fam. Hartmanulidae Poche, 1913** | | | | | | | |
| 317 | *Hartmanula acrobates* Brodsky, 1908 | | | + | | | + | + |
| 318 | *H. angustipilosa* Deroux et Dragesco, 1968 | | | + | | + | + | + |
| 319 | *H. entzi* Kahl, 1931 | | | | | | + | + |
| 320 | *H. ocellata* Tucolesco, 1962 | | | | | | + | + |
| | **Class Nassophorea Small et Lynn, 1981** | | | | | | | |
| | **Order Synhymeniida Puytorac et al., 1974** | | | | | | | |
| | **Fam. Orthodonellidae Jankowski, 1968** | | | | | | | |
| 321 | *Chilidontopsis depressa* (Perty, 1852) | | + | | | | | |
| 322 | *C. vermiformis* Deroux, 1978 | | | | | | + | |
| 323 | *Zosterodasys cantabrica* Fern.-Leb. et Alekperov, 1995 | | + | + | | | | + |
| 324 | *Z. caspica* Fern.-Leb. et Alekperov, 1995 | | | + | | | + | |
| 325 | *Z. debilis* Alekperov, 1984 | | + | | | | | |
| 326 | *Z. fluviatilis* Fern.-Leb. et Alekperov, 1995 | | | | | | + | |
| 327 | Z. *mirabilis* Alekperov, 1984 | | | + | | | + | |
| 328 | *Z. vorax* (Stokes, 1887) | | | + | | | | + |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | **Order Nassulida Jankowski, 1968** | | | | | | | |
| | **Fam. Furgasoniidae Corliss, 1979** | | | | | | | |
| 329 | *Furgasonia blochmanni* Fauré-Fremiet, 1967 | + | + | + | | | | |
| | **Fam. Nassulidae Fromentel, 1874** | | | | | | | |
| 330 | *Nassula argentula* Biernacka, 1963 | | | | + | | | |
| 331 | *N. marina* Alekperov et Asadullaeva, 1997 | | | + | + | | | + |
| 332 | *N. ornata* Ehrenberg,1834 | + | | | | | | |
| 333 | *N. parva* Kahl, 1928 | + | | | | | | |
| | **Order Microthoracida Jankowski, 1967** | | | | | | | |
| | **Fam. Pseudomicrothoracidae Jankowski, 1967** | | | | | | | |
| 334 | *Pseudomicrothorax agilis* Mermod, 1914 | + | | + | | | | |
| 335 | *P. dubius* Maupas, 1883 | + | | + | | | | |
| | **Fam. Microthoracidae Wrzesniowski, 1870** | | | | | | | |
| 336 | *Microthorax elegans* Kahl,1931 | | | + | | | | |
| 337 | *M. pusillus* Engelmann,1862 | | | + | | | | |
| 338 | *M. penicillata* Vuxanovici,1961 | + | | | | | | |
| 339 | *M. spiniger* Penard,1922 | + | | | | | | |
| 340 | *Leptopharynx costatus* Mermod,1914 | + | | + | | | | |
| 341 | *Trochiliopsis opaca* Penard,1922 | + | | | | | | |
| | **Class Colpodea Small et Lynn, 1981** | | | | | | | |
| | **Order Colpodida Puytorac et al., 1974** | | | | | | | |
| | **Fam. Colpodidae Bory de St. Vincent, 1826** | | | | | | | |
| 342 | *Colpoda cucullus* (Müller,1773) | + | + | + | | | | |
| 343 | *C. inflata* (Stokes, 1884) | + | | + | | | | |
| 344 | *C. maupasi* Enriques,1908 | + | | + | | | | |
| | **Order Bursariomorphida Fernandez-Galiano, 1978** | | | | | | | |
| | **Fam. Bursariidae Foissner, 1993** | | | | | | | |
| 345 | *Bursaria truncatella* **Müller,1773** | | | | | | | |
| | **Order Cyrtolophosidida Foissner, 1978** | | | | | | | |
| | **Fam. Cyrtolophosididae Stokes, 1888** | | | | | | | |
| 346 | *Cyrtolophosis mucicola* Stokes,1885 | + | | | | | | |
| | **Fam. Platyophryidae Puytorac, Per.-Pan. et P.-Silva, 1979** | | | | | | | |
| 347 | *Platyophrya dubia* Foissner,1980 | | | + | + | | | |
| 348 | *P. vorax* Kahl, 1926 | + | | | | | | |
| | **Order Thylakidiida, Jankowski, 1980** | | | | | | | |
| | **Fam. Thylakidiidae Jankowski, 1980** | | | | | | | |
| 349 | *Thylakidium macrostomum* Alekperov,1991 | + | | | | | | |
| 350 | *T. magnum* Alekperov,1991 | + | | | | | | |
| 351 | *T. truncatum* Schewiakoff, 1892 | + | | | | | | |
| | **Class Prostomatea Small et Lynn,1985** | | | | | | | |
| | **Order Prorodontida Corliss,1974** | | | | | | | |
| | **Fam. Colepidae Nitzsch, 1827** | | | | | | | |
| 352 | *Coleps amphacanthus* Ehrenberg, 1833 | | + | + | | | | |
| 353 | *C. arenicolus* Dragesco, 1965 | | + | + | | + | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 354 | *C. elongatus* Ehrenberg, 1833 | | + | + | | | | |
| 355 | *C. hirtus* Nitzsch, 1921 | + | + | + | | | | |
| 356 | *C. nolandi* Kahl, 1930 | | + | + | | + | | |
| 357 | *C. pulcher* Spiegel, 1926 | | | + | | | | + |
| 358 | *C. remanei* Kahl,1933 | + | | + | | | + | + |
| 359 | *C. tesselatus Kahl,1930* | + | + | | | + | | + |
| 360 | *C. spiralis* Noland,1937 | + | | | | + | + | |
| 361 | *C. trichotus* Savi, 1913 | | + | | | + | | + |
| 362 | *C. spinosus* Vacelet, 1961 | + | + | + | | + | | |
| | **Fam. Holophryidae Perty, 1852** | | | | | | | |
| 363 | *Holophrya salinarum* Foissner, Agata et Berger, 2002 | | + | + | | + | | |
| 364 | *H. vorax* Dragesco, 1960 | | + | + | | + | | |
| | **Fam. Placidae Small et Lynn,1985** | | | | | | | |
| 365 | *Placus longinucleatus* Song and Wilbert, 1989 | | + | | | + | | |
| | **Fam. Prorodontidae Ehrenberg, 1834** | | | | | | | |
| 366 | *Prorodon niveus* Ehrenberg, 1834 | + | + | | | + | | |
| 367 | *P. platyodon* Blochmann, 1895 | + | + | + | | + | | |
| | **Fam. Urotrichidae Small et Lynn, 1985** | | | | | | | |
| 368 | *Urotricha apsheronica* Alekperov, 1984 | | | + | | | | |
| 369 | *U. armata* Kahl, 1927 | | | + | | | | |
| 370 | *U. pelagica* Kahl, 1932 | | | + | | | | |
| | **Class Plagiopylea Small et Lynn,1985** | | | | | | | |
| | **Order Plagiopylida Jankowski, 1978** | | | | | | | |
| | **Fam. Plagiopylidae Schewiakoff, 1896** | | | | | | | |
| 371 | *Sonderia macrochilus* Kahl, 1931 | | + | | | + | + | + |
| 372 | *S. megalabiata* Alekperov et Asadullaeva, 1996 | | | + | | | + | + |
| 373 | *S. paralabiata* Small et Lynn, 1985 | | + | | + | + | | |
| 374 | *S. sinuata* Kahl, 1931 | | + | | + | + | | |
| 375 | *Plagiopyla nasuta* Stein, 1860 | | + | + | + | | | |
| 376 | *P. ovata* Kahl, 1931 | | | + | | + | | |
| 377 | *P. stenostoma* Alekperov et Asadullayeva, 1999 | | | + | | | | |
| 378 | *P. vestita* Kahl, 1928 | | + | | | | | |
| | **Class Oligohymenophora Puytorac et al., 1974** | | | | | | | |
| | **Order Peniculida Fauré-Fremiet in Corliss, 1956** | | | | | | | |
| | **Fam. Frontoniidae Kahl, 1926** | | | | | | | |
| 379 | *Frontonia arenaria* Kahl, 1933 | | | + | | | + | + |
| 380 | *F. macrostoma* Dragesco, 1960 | + | | | | | + | + |
| 381 | *F. marina* Fabre-Domerque, 1891 | | | + | | | + | + |
| 382 | *F. salmastra* Dragesco et Dragesco-Kerneis, 1986 | + | | | | | + | + |
| | **Fam. Lembadionidae Jankowski in Corliss,1979** | | | | | | | |
| 383 | *Lembadion magnum* (Stokes, 1887) | | + | | | | | |
| | **Fam. Urocentridae Claparede et Lach., 1859** | | | | | | | |
| 384 | *Urocentrum turbo* (Müller, 1786) | | + | + | | + | | |
| | **Fam. Parameciidae Dujardin, 1840** | | | | | | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 385 | *Paramecium calkinsi* Woodruff, 1922 | | + | + | | | | |
| 386 | *P. caudatum* Ehrenberg, 1832 | + | + | + | | | | |
| 387 | *P. jenningsi* Diller et Earl, 1958 | | + | + | | | | |
| 388 | *P. multimicronucleatum* Pow. et Mitchell, 1910 | | + | + | | | + | + |
| 389 | *P. putrinum* Clap. et Lach., 1858 | | + | + | | | | |
| 390 | *P. woodruffi* Wenrich, 1928 | + | + | + | | | | |
| | **Order Tetrahymenida Fauré-Fremiet in Corliss, 1956** | | | | | | | |
| | **Fam. Turaniellidae Didier,1971** | | | | | | | |
| 391 | *Colpidium colpoda* (Losana, 1829) | | + | + | | | | |
| | **Fam. Spirozonidae Kahl, 1926** | | | | | | | |
| 392 | *Stegochilum fusiforme* Schewiakoff, 1893 | | + | + | | | | |
| | **Fam. Glaucomidae Corliss, 1971** | | | | | | | |
| 393 | *Glaucoma scintillans* Ehrenberg, 1830 | | + | + | | + | | |
| 394 | *G. chattoni* Corliss, 1959 | | + | + | | | | |
| | **Fam. Ophryoglenidae Kent, 1881** | | | | | | | |
| 395 | *Ophryoglena acuminata* Ehrenberg, 1838 | | | + | | | | |
| 396 | *O. atra* Ehrenberg,1838 | | + | + | | | | |
| 397 | *O. catenula* Savoie, 1965 | | + | + | | | | |
| 398 | *O. flava* (Ehrenberg, 1838) | | + | + | | | | |
| 399 | *O. mugardi* Savoie, 1962 | | + | | | | | |
| 400 | *O. ovata* Stokes, 1885 | | + | + | | | | |
| | **Order Scuticociliatida Small,1967** | | | | | | | |
| | **Fam. Loxocephalidae Jankowski, 1964** | | | | | | | |
| 401 | *Dexiotricha kahli* (Tucolesco, 1962) | | + | | | | | |
| 402 | *D. lucida* (Smith, 1897) | | | | + | | | |
| 403 | *D. polystyla* Foissner, 1987 | | + | | | | | |
| 404 | *D. raikovi* Jankowski, 1964 | | | | + | | | |
| 405 | *D. simplex* Penard, 1922 | | + | | | | | |
| 406 | *Loxocephalus intermedius* Kahl, 1928 | + | + | + | | | | + |
| 407 | *Platynematum denticulatum* (Kahl,1933) | | + | | | | + | + |
| 408 | *P. hyalinum* (Kahl,1931) | | | | | + | | |
| 409 | *P. marinum* (Kahl,1933) | | | + | | + | + | + |
| 410 | *Sathrophilus granulatus* Czapik,1968 | | | + | + | | | |
| 411 | *Cinetochilum marinum* Kahl, 1931 | | + | + | | | | |
| | **Order Philasterida Small, 1967** | | | | | | | |
| | **Fam. Cyclidiidae Ehrenberg,1838** | | | | | | | |
| 412 | *Cristigera fusiformis* Penard,1922 | | + | | + | + | | |
| 413 | *C. media* Kahl,1928 | | + | + | + | + | | |
| 414 | *C. phoenix* Penard,1922 | | | + | | + | | |
| 415 | *C. vestita* Kahl,1928 | | | + | + | + | | |
| 416 | *Caspionella bergeri* (Agamaliev,1972) | | + | + | | | | |
| 417 | *Cyclidium borrori* Small et Lynn,1985 | | | + | | | + | + |
| 418 | *C. citrullus* Cohn,1865 | + | + | + | | + | | + |
| 419 | *C. glaucoma* Müller,1786 | + | + | + | | | + | + |

**Table 1.** (Continuation).

| | Taxonomic composition | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 420 | *C. marinum* Borror,1963 | | | + | | | + | + |
| | **Fam. Pseudocohnilembidae Evans et Thompson, 1964** | | | | | | | |
| | **Fam. Uronematidae Thompson,1964** | | | | | | | |
| 421 | *Uronema acutum* Buddenbrock,1920 | | | + | + | + | | + |
| 422 | *U. elegans* (Maupas,1883) | + | + | + | + | + | | + |
| 423 | *U. marinum* Dujardin,1841 | + | + | + | + | + | + | + |
| 424 | *U. nigricans* (Müller,1786) | + | | + | + | + | + | |
| 425 | *U. parduczi* Foissner ,1971 | | + | + | | + | | |
| | **Fam. Gymnociclidiidae Alekperov, 2009** | | | | | | | |
| 426 | *Gymnocyclidium nabranicum* Alekperov, 2009 | + | | | | | | |
| | **Order Parastomatida Jankowski, 2007** | | | | | | | |
| | **Fam. Pleuronematidae Kent, 1881** | | | | | | | |
| 427 | *Pleuronema coronatum* Kent,1881 | | | + | + | | | + |
| 428 | *P. crassum* Dujardin,1841 | | | + | + | | + | |
| 429 | *P. marinum* Dujardin,1841 | + | | + | | | + | + |
| 430 | *P. nana* Tucolesco, 1962 | + | + | + | + | + | | |
| 431 | *P. oculata* Dragesco,1960 | + | | + | | | + | + |
| | **Order Sessilida Kahl, 1933** | | | | | | | |
| | **Fam. Epistylidae Kahl, 1933** | | | | | | | |
| 432 | *Epistylis anastatica* (Linne,1767) | | + | + | + | + | | |
| 433 | *E. coronata* Nusch,1970 | + | + | + | | | | |
| 434 | *E. cyclopi* Banina,1977 | | + | + | | | | |
| 435 | *E. dafniae* Fauré-Fremiet,1905 | + | + | | + | + | | |
| 436 | *E. nympharum* Engelmann, 1862 | + | + | + | | | | |
| 437 | *E. plicatilis* Engelmann, 1830 | | | + | | + | | |
| 438 | *E. rotatorium* Kahl,1935 | | + | + | | + | | |
| | **Fam. Vorticellidae Ehrenberg, 1838** | | | | | | | |
| 439 | *Vorticella alba* Fromentel, 1874 | | + | + | | | | + |
| 440 | *V. chlorellata* Stiller, 1940 | + | | + | | + | | |
| 441 | *V. microstoma* Ehrenberg, 1830 | + | + | + | | + | | |
| 442 | *V. octava* Stokes, 1885 | + | | + | | + | | |
| 443 | *V. similis* Stokes,1887 | | + | | | + | | |
| 444 | *V. spuripicta* Song et Wilbert, 1889 | | + | + | | + | | |
| 445 | *Carchesium brevistylum* Stiller, 1941 | | | + | + | + | | |
| 446 | *C. prechti* Banina, 1977 | + | + | | | | | |
| 447 | *C. umbilicatum* Stiller,1941 | | + | + | | | | |
| 448 | *C. wassenum* Viljoen et Reinecke, 1988 | | + | + | | + | | |
| | **Fam. Zoothamniidae Sommer, 1951** | | | | | | | |
| 449 | *Zoothamnium adamsi* Stokes, 1885 | | + | + | + | + | | |
| 450 | *Z. arbuscula* Ehrenberg, 1831 | | + | + | + | | + | + |
| 451 | *Z. balticum* Biernacka, 1963 | + | + | + | | + | + | |
| 452 | *Z. carcini* Kent, 1881 | | + | | + | | | |
| 453 | *Z. cupiferum* Stiller, 1986 | + | + | | | | | |
| 454 | *Z. glesnicum* Claparede et L.,1859 | | | + | | + | | |

**Table 1.** (Continuation).

| Taxonomic composition | | Distribution by regions | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 455 | *Z. haplocaulis* Stiller, 1953 | | + | | | + | | |
| 456 | *Z. kenti* Leidy, 1874 | + | + | + | | | + | |
| 457 | *Z. marinum* Mereschekowski, 1877 | + | + | + | | | + | |
| 458 | *Z. plumosum* Wright, 1860 | + | + | | | + | | |
| 459 | *Z. triophilum* Stiller, 1946 | | + | | | + | | |
| 460 | Z. *vermicola* Precht, 1935 | | + | + | | + | | |
| | **Fam. Telotrochidiidae Foissner, 1978** | | | | | | | |
| 462 | *Telotrochidium crateriforme* (Müller, 1773) | + | + | + | | | | + |
| 463 | *T. cylindricum* Foissner, 1978 | + | | + | | | + | |
| | **Total: 463** | **179** | **214** | **203** | **72** | **96** | **107** | **110** |

* ***Note***. 1 - Nabran, 2 - Divichi firth (Agzybir Lake), 3 - Absheron Peninsula, 4 - Estuary of the Kura River, 5 - Kyzyl-Agach Bay, 6 - Lankaran coast of the Caspian Sea, 7 - Astara coast of the Caspian Sea.

offshore oil production (although in recent years the results of monitoring of the sea water quality have become noticeable), but the main problem is related to the discharge of the wastewater (Kasymov, 2004).

In the plankton of the Absheron Peninsula coastal zone, we can mention such ciliate species as *Euplotes gracilis, E. minuta, Aspidisca poljanski, Lacrymaria olor* and *L. marina* that are common in shallow water areas, as well as *Novistrombidium testaceum* and *Askenasia confunis*, which prefer the plankton of the deeper (3–12 m) sections of the Absheron coast. In total, 203 species we found at this site. Large concentrations of species of the genus *Dysteria* were observed in the periphyton of the coastal zone of Absheron and especially in the sampling areas on the Lankaran and Astara coasts (sites ##6 and 7, respectively). In addition, common in periphyton species, such as *Chlamydodon mnemosyne, C. obliquus* and representatives of the genus *Hartmanula* (*H. ocellata, H. entzi* and *H. angustipilosa*) were also found in these areas.

The coast of the southern part of the Caspian Sea, not far from Lankaran and Astara cities near the Iranian border, is traditionally considered clean from oil pollution and domestic wastewaters, although the discharge of the latter has increased due to the intensive construction of tourist camps and private houses in this region.

Data on the species diversity of different groups of benthic ciliates showed that the species of the family Trachelocercidae (*Kovalevaia sulcata, K. teissieri*) as representatives of the typical marine psammon were found on the northern Absheron coast, and the remaining four species (*Tracheloraphis discolor, T. conformis, T. binucleata, T. obigostriata*) were discovered only in the psammon of the Lankaran and Astara coasts of the Caspian Sea.

Representatives of the second typical for psammon family, Kentrophoridae (K*entrophoros canalis, K. uninucleatus, K. trichocistis, K. faurei, K. flavus* and *K. latus*) were noted exclusively in Astara and Lankaran study areas. These sites of the Caspian Sea coast are located not far from the Lankaran and Astara cities. Such local distribution of representatives of typical inhabitants of the present marine psammon is likely related to their demands for the cleaner environment. In addition, their distribution is affected by the higher salinity (13.90 ‰) of the Southern Caspian Sea (Kasymov, 2004). Altogether, 107 and 110 species, respectively, were found here.

In the Kyzyl-Agach Bay (sampling site #5), the free-living ciliate species diversity was represented by 96 species. This area is located on the migration routes of many waterfowl and wading birds; it is shallow and heavily overgrown with aquatic plants. Typical for this site is a strong increase of nutrients concentration in water and formation of sapropel silt plots in the shallow waters in summer, due to the high concentration of birds. Occurrence of the representatives of the sapropelebionts that are capable of existing at minimal oxygen concentration in the water and in the presence of hydrogen sulfide should also be noted among the specific benthic communities of free-living ciliates.

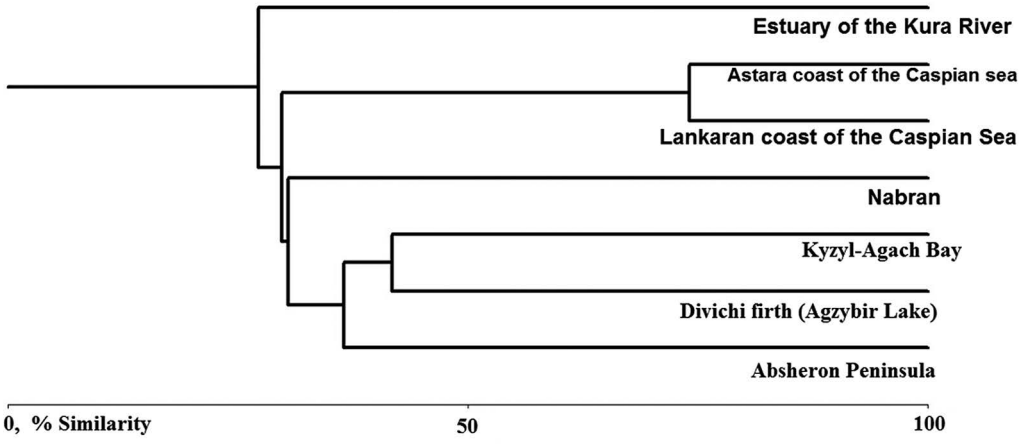


**Fig. 2.** Cluster analysis of the similarity of the free-living ciliate species composition between seven stationary collection points along the Azerbaijan sector of the Caspian Sea.

Such black and sapropel silt biotopes are most typical for the Divichi firth and the estuary of Kura River, and to a lesser extent – for the Kyzyl-Agach Bay. Representatives of the family Metopidae (*Metopus acidiferus, M. caucasicus, M. fuscoides, M. contortus*, *M. es*), as well as members of the genus *Brachonella* (*B. mitriformis, B. spiralis, B. darwini, B. elongata*), predominate in the silt biotopes quantitatively. Representatives of the genus *Caenomorpha* (*C. medusula, C. levanderi, C. lauterborni*) and such well-known sapropelebionts as *Pelodinium rotundum, Epalxella mirabilis, E. antiquorum, E. triangula, Saprodinium halophilum, S. mimeticum*, etc. were also registered at those sites. All these species form the basis of the benthic ciliate communities of black and sapropelic silts.

Communities of sapropelebiont benthic ciliates are most diverse and abundant (qualitatively and quantitatively) in the middle of summer, when in the shallow water the processes of destruction of dead organic matter are actively taking place as a result of the suffocation phenomena. In addition, most of the sapropelebiont ciliates are thermophilic and are found from late spring to autumn. Of course, in addition to sandy biotopes (psammon), as well as black and sapropelic silts, there were also mixed areas combining the features of various biotopes, which also affected the species diversity of free-living ciliates. Overall, 96 ciliate species were found there.

In the desalinated estuary of the Kura River (sampling site #4), only 72 ciliate species were found. It should be kept in mind that most of the ciliates in this area were found in small shallow bays overgrown with higher aquatic plants, and only a few species were found directly in the sea.

The similarity of the species composition of free-living ciliates of different stationary collection points along the Azerbaijan sector of the Caspian Sea was carried out using theBray-Curtis cluster analysis. The results are presented in Fig. 2.

As can be seen from Fig. 2, the highest similarity of the species composition is observed between the Lankaran and Astara coasts (74%). We explain this fact by the closest location of these sampling points, as well as by their similar environmental conditions.

High similarity of the ciliate species composition was also noted for the areas of the Divichi firth and Kyzyl-Agach Bay (41.7%). In this case, although these sampling sites are quite distant from each other, the environmental conditions therein are also similar. Both sites are highly desalinated and have large areas overgrown with aquatic plants.

The similarity of the ciliate species composition in other areas ranges from 38–39% (Nabran-Absheron and Divichi-Absheron) to a minimum of 14.3–4.47% (Kura River estuary and the coasts of Astara and Lankaran). In our opinion, the minimum similarity in the ciliate species composition can be, to certain extent, due to sharp differences in the salinity of the almost fresh Kura River estuary and the most saline southern part of the Caspian Sea, where the salinity reaches 13.9‰.

Thus, as a result of the analysis, two clusters can be distinguished – first, the highest similarity of ciliate communities was found for the Lankaran and Astara coasts of the Caspian Sea, and the second greatest similarity – of the Divichi firth and the Kyzyl-Agach Bay (Fig. 2).

The results show that the similarity of the species composition of the free-living ciliates of

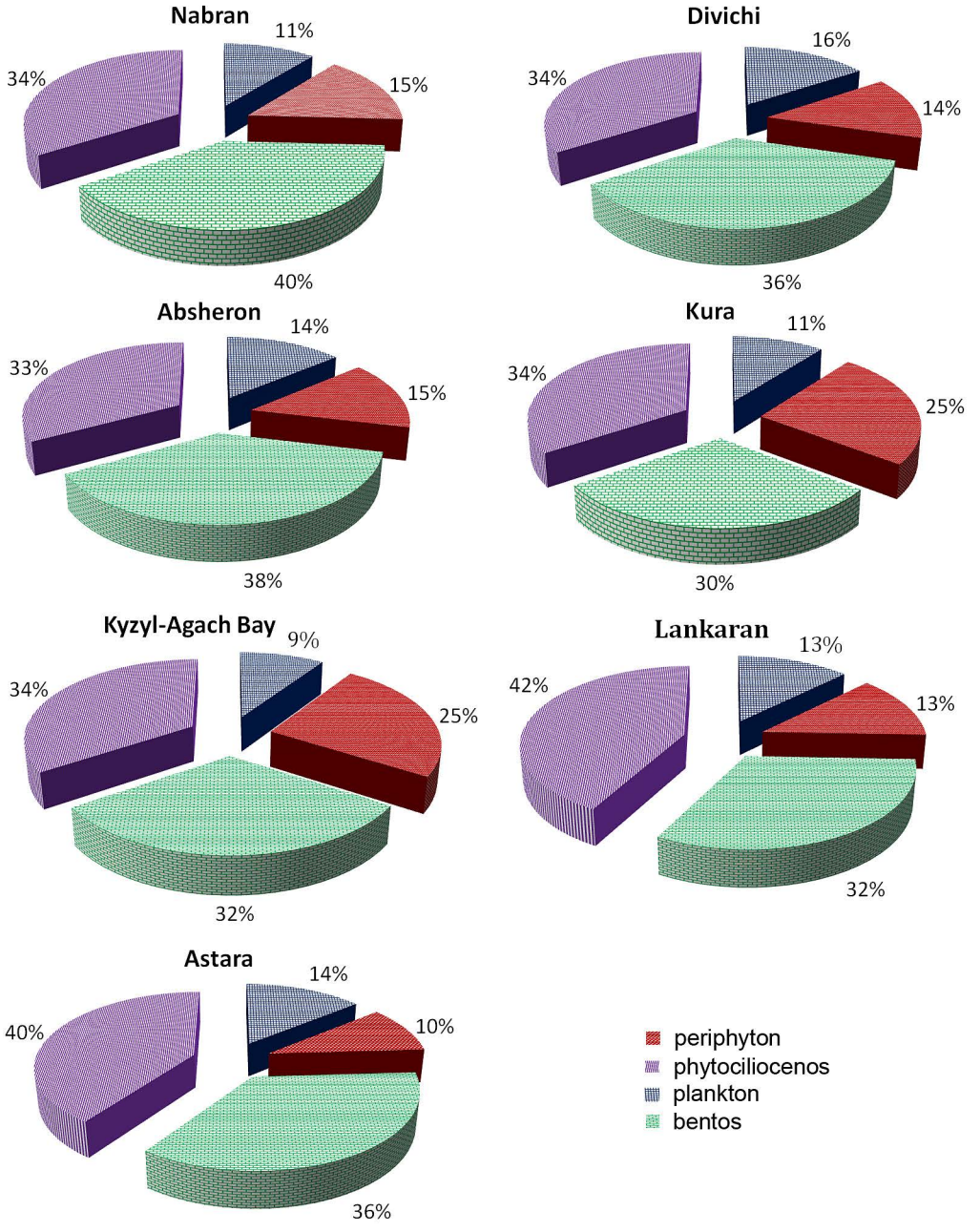


**Fig. 3.** The ratio of species diversity of ciliates in various biotopes at stationary collection points along the Azerbaijan sector of the Caspian Sea coast.

seven stationary points along the Azerbaijan sector of the Caspian Sea depends on the similarity of environmental conditions at these collection points, as well as on the distance between them.

In addition, important results were obtained by the assessment of data on the percentage distribution of the total species diversity of free-living ciliates in each research area at different biotopes (Fig. 3).

The percentage ratio of the free-living ciliate species composition between biotopes has certain differences at each stationary collection point. For example, the percentage of plankton ciliates in relation to the periphyton, benthos and phytociliocenoses communities was the highest in the Divichi firth, accounting for 16% of the total species diversity of this area. Interestingly enough, the minimum ratio of species diversity in the plankton ciliates was noted in Kyzyl-Agach Bay (9%), where

environmental conditions are largely the same as in the latter region. In the remaining collection points, the proportion of the planktonic ciliates in the total species diversity was rather stable, ranging from 11% to 14%.

The maximum percentage ratio of periphyton ciliates was observed at the Kyzyl-Agach Bay areas and the Kura River estuary (25% both), and the minimum percentage ratio – on the Astara coast (10%). In the remaining areas, the share of periphyton ciliates of the total species diversity was 13%–15%.

The maximum ciliate species diversity in benthic biotopes (40%) was observed at the sampling point of Nabran, at the Absheron site: it was 38%, and the minimum (30%) was revealed at the Kura River estuary. In the remaining sampling points, the share of benthic ciliates in total species diversity was within 32%-36%. It was found that the community of free-living ciliates in the coastal thickets of plants (phytocyliocenoses) is most close in percentage to benthic ciliate communities, being equal to the maximum value of 42% and 40%, respectively, on Lankaran and Astara coasts. The percentage of ciliate community of phytocyliocenoses at the remaining areas was fairly stable, totaling 33–34%.

The above data showed that the total species diversity of free-living ciliates in each specific part of the Caspian Sea coast is distributed in a certain proportion in accordance with its main biotopes. Further comparative studies on other marine and fresh waters will show whether this is a local rule or it is also valid for other regions.

## References

Agamaliev F.Q. 1983. Ciliates of the Caspian Sea: taxonomy, ecology, zoogeography. Nauka, Leningrad (in Russian).

Alekperov I.Kh. 1992. A new modification of the impregnation of the ciliates kinetoma with silver proteinate. Zool. zh. (Moscow). 71, 130–133 (in Russian).

Alekperov I.Kh., Snegovaya N.Y. and Tahirova E.N. 2017. The cadastre of free-living ciliates and testate amoebae of Azerbaijan. Protistology. 11, 57–129.

Chatton E. and Lwoff A. 1930. Imprégnation, par diffusion argentique, de l'infraciliature des ciliés marins et d'eau douce, après fixation cytologique et sans desiccation. Comptes Rendus des Séances de la Société de Biologie et de ses Filiales. 104, 834–836.

Kasymov A. G. 2004. Ecology of the Caspian Sea plankton. Publ. house "Adiloglu", Baku.

**Address for correspondence:** Ilham Kh. Alekperov. Laboratory of Protozoology, Institute of Zoology, Azerbaijan National Academy of Sciences, Baku; e-mail: *i_alekperov@yahoo.com.*