

Free-living Ciliates of the Anzali Wetland of the Caspian Sea

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Received: 01.11.2005

Abstract: In this paper 8 ciliate species are described and figured. All these species were found in the Anzali Wetland of the Caspian Sea (Islamic Republic of Iran). The descriptions are based on the observations of living specimens and the analysis of slides impregnated with silver.

Key Words: Free-living ciliates, fauna, silver impregnated

Introduction

The fauna of free-living ciliates of the Caspian Basin have been investigated by Agamaliev (1983) applying modern cytological methods since 1970. The research has been summarized in the monograph *The Ciliates of the Caspian Sea*. Subsequently, we also conducted faunal investigations of the Caspian ciliates (Alekperev and Asadullayeva, 1996, 1997, 1999), which were a significant addition to the available data collected by Agamaliev (1983). It should be noted that during 20 years of investigation, Agamaliev (1983) found and described 20 new species, and we have found and described an additional 10 new species during 7 years of investigation. These data indicate, on the one hand, that changes occurred in the ecological conditions of different biocenoses of the Caspian Basin that led to the occupation of new ecological niches by an extremely small number of unrecorded species. On the other hand, it indicates insufficient research of the Caspian ciliate fauna, which were especially inaccessible during earlier investigations of bodies of water, including the Anzali Lagoon, which is situated on the territorial waters of Iran.

The Anzali complex is, in fact, a coastal lagoon in the southwestern part of the Caspian Sea and is situated south of Anzali, Islamic Republic of Iran. The average length of this complex is about 30 km and its average width is about 3 km, though in some places it exceeds 12 km. The area of this complex is subject to seasonal variations of water. About 60 years ago, it covered an area of 259 km²; now it is only 100 km². The depth of

Anzali is also subject to change. The average depth is about 3 m. This lagoon has a passage to the sea 426 m wide.

Total precipitation is about 1500 to 2000 mm per year and 11 tributary rivers flow into the Anzali complex. The complex is also connected to the sea by means of 5 river streams. Anzali marshes could be divided into 3 sections: the central section (in the east, including Sheyjan), the western section (west wetland), and the southern section (Siahkeshim).

The total amount of sediments carried to the wetland is estimated to be 390 tons per year. The waterbed of the complex is covered by sandy sediments and occasional shingles, which are mixed with rich mineral and organic matter. A total of 4898 tons of nitrogen and 378 tons of phosphorus are estimated to be transported to the complex each year, of which only 40% remains in the wetland, the remainder being carried to the sea. These minerals are used by multi-cellular plants of the marshes. In the Anzali wetland the occurrence of marsh blooms represents eutrophication.

Average temperature of the Anzali Wetland is about 16 °C, which ranges from 4.5 °C in February to 27.5 °C in August. The concentration of dissolved oxygen in the water depends on the depth of water, flow of water, and the amount and type of vegetation cover.

The dissolved oxygen ranges from 1 to 13 mg/l. COD ranges from 13.8 to 176.4 units and pH is also variable, ranging from 7.82 to 9.16. The alkalinity is reduced as

distance from the shore toward the open sea increases. The level of water hardness (Ca^{++} and Mg^{++}) is estimated to be 390.24 and increases with proximity to the sea water.

The salinity of the Anzali wetland has been recorded in different seasons and the following figures have been obtained:

Siahkeshim, salinity = 0.23 ppt;

Sheyjan, salinity = 0.43 ppt;

western wetland, salinity = 0.7-25 ppt;

channels, salinity = 1.57 - 2.1 ppt.

Prior to our investigation there was no information about the free-living ciliates of the Anzali Lagoon.

Materials and Methods

Samples were collected in November 2004 from the Anzali Wetland, situated in the southwestern part of the Caspian Sea. The specimens were collected by the generally accepted methods (Aleksperov et al., 1996). Specimens were immediately observed with a microscope and then delivered to the protistology laboratory of the Institute of Zoology at the National Academy of Sciences of Azerbaijan.

The topology of kinetomes was determined by a wet method of silver nitrate impregnation (Chatton and Lwoff, 1930) and protargol impregnation (Aleksperov, 1992). The nuclei were stained by Feulgen nuclear reaction. All the measurements were obtained from at least 10 specimens. The terminology mainly follows Corliss (1979).

Results and Discussion

Order Prostomatida Schewiakoff, 1896

Prorodon aklitalophon Hiller and Bardele, 1988

(Figure 1)

This species was first found and distinguished from the freshwater aquarium at the Zoology Department of Tubinglensk University in Germany. Later *P. aklitalophon* was studied and described as a new species.

After the original description, *P. aklitalophon* had not been found in other parts of the world. Below is a description of *P. aklitalophon* found in the Anzali Wetland.

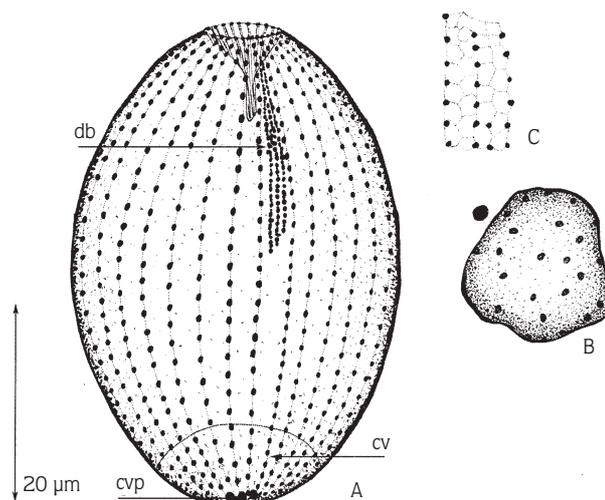


Figure 1. A-C. *Prorodon aklitalophon* after silver nitrate impregnation. (A) Ventral view; (B) nuclear apparatus; (C) details of argyrome. db: dorsal brush; cv: contractile vacuole; cvp: pore of contractile vacuole.

Size of living ciliates 70-100 µm, fixed cells 65-75 µm. Body oval. Apical cytostome armed by 18-21 nemadesms passing into a narrow pharynx. Long dorsal brush arranged in 3 rows beginning at the cytostome and ending between rows of kineties in the middle part of the body. Somatic ciliature composed of 30 bipolar rows located at the caudal end of the body.

The system of argentophilic lines covering the body surface consists of multi-angular shaped argyromes. Endoplasm is transparent, without inclusions. Macronuclei are bean-shaped to spherical, with single micronuclei. Large contractile vacuole located at the caudal end of the body. There are 1-3 impregnated pores on it.

Order Haptorida Corliss, 1974

Lacrymaria binucleata Song and Wilbert, 1989

(Figure 2)

This species was first discovered and described from freshwater in Germany (Song and Wilbert, 1989). To the best of our knowledge, prior to our investigation it has not been recorded in other parts of the world.

Size of living ciliates 55-79 µm, fixed cells are up to 50 µm. Body shape elongated, anterior part narrows. Body slightly contracted. Apical cytostome armed with 3-

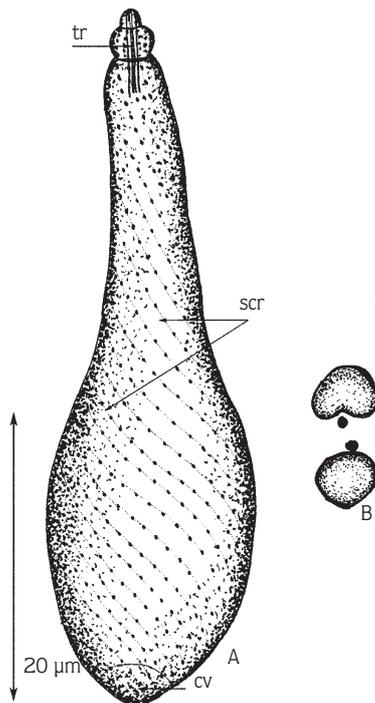


Figure 2. A,B. *Lacrymaria binucleata*, after protargol impregnation. (A) Ventral view; (B) nuclear apparatus. cv: contractile vacuole; scr: somatic ciliary rows; tr: trichites.

7 trichites. There are 10-15 spiral somatic rows beginning from the small brush located below the cytostome. Each row is united by argironem. Endoplasm is transparent, without inclusions. Nuclear apparatus consist of 2 macronuclei and 2 micronuclei, which is a characteristic sign of this species.

Of the few species of the genus *Lacrymaria* having 2 macronuclei, 2 species are known (*L. clavarioides* Alekperov, 1984 and *L. issykhulica* Alekperov, 1997) that are similar to the above-mentioned species. *L. binucleata* differs from *L. clavarioides* in body shape and from *L. issykhulica* in the spiral somatic ciliature and closely adjacent macronuclei.

Order Synhymeniida de Puytorac et al., 1974

Zosterodasys debilis Alekperov, 1984

(Figure 3)

The genus *Zosterodasys* belongs to the class *Nassophorea* Small and Lynn, 1981, order *Synhymeniida* De Puytorac et al., 1974, and family *Orthodonellidae*

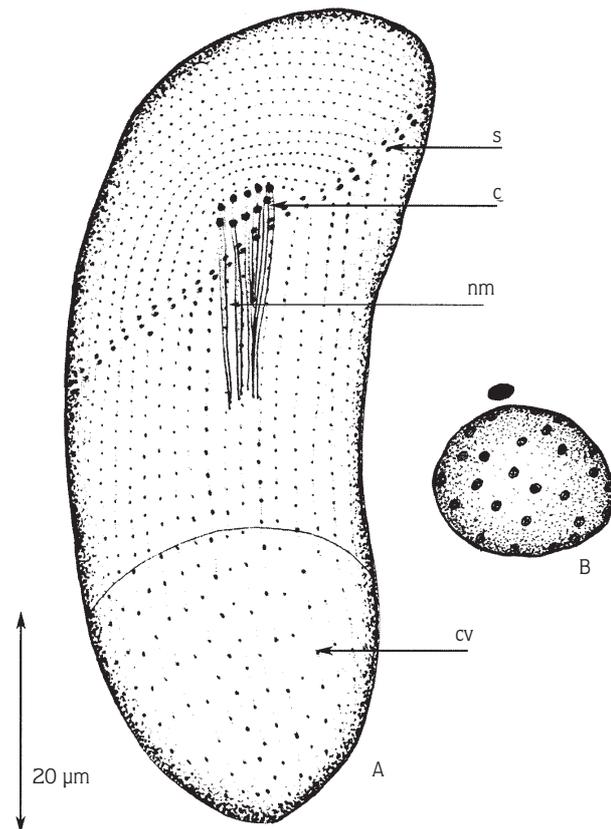


Figure 3. A,B. *Zosterodasys debilis* after silver nitrate impregnation. (A) Ventral view; (B) nuclear apparatus. c: cytostome; cv: contractile vacuole; nm: nematodesmata; s: synhymenium.

Jankowski 1968 (Corliss, 1979). The genus was erected by Deroux (1978).

Following the latest revision (Fernandez-Leborans and Alekperov, 1996), the genus *Zosterodasys* currently includes 16 species. Below we describe *Z. debilis*.

Body elongated, 60-90 µm long, 40-50 µm wide, with anterior and posterior ends rounded, dorsoventrally flattened. Cytostome with 10-12 nematodesmata. There are 35-45 somatic kineties, 20-25 of which are ventral and 10-15 dorsal. Synhymenium with 35-40 dikinetids. In the caudal part there is a large contractile vacuole occupying a quarter of the body. Spherical macronucleus 23-26 µm diameter with a single oval micronucleus.

Before this investigation this species was found only from inland freshwater reservoirs of the Apsheron Peninsula. This is the first record for the Caspian fauna.

Order Hymnostomatida Delage et Herouard, 1896

Lembadion bullinum (Muller, 1786)

(Figure 4)

This is one of the most common and widespread freshwater species. Prior to our investigation this species had not been noted among the Caspian Sea fauna. Below is a description of *L. bullinum* found in the periphyton of the Anzali Wetland.

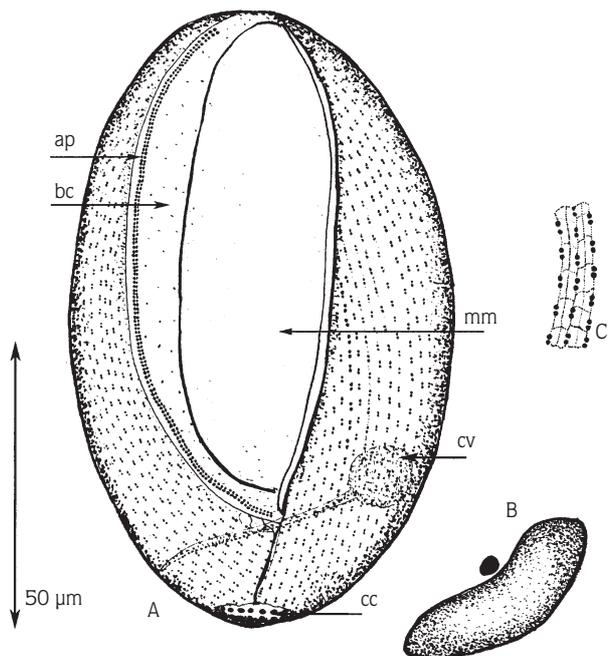


Figure 4. A-C. *Lembadion bullinum* after silver nitrate impregnation. (A) Ventral view; (B) nuclear apparatus; (C) details of argyrome. ap: adoral polykinety; bc: buccal cavity; cc: caudal cirri; cv: contractile vacuole; mm: merged membranelles M₁, M₂, and M₃.

Size of living ciliates 110-140 µm, that of fixed cells up to 110 µm. Body ellipsoid with hypertrophied buccal cavity occupying most of the ventral side of the body. At the right margin of the buccal cavity there is an adoral polykinety formed by double rows of large kinetosomes. The disk formed by merged membranelles M₁, M₂, and M₃ is situated over most of the buccal cavity. Somatic ciliature composed of 18-20 rows of dikinetids on the ventral side and 35-40 ones on the dorsal side of the body. Caudal ciliary tuft consists of 15 pairs of kinetosomes. The silverline system is represented by argyrosomes in an approximately quadrangle form.

Endoplasm transparent, without inclusions. Contractile vacuole is typical for this genera located to the left right of the buccal cavity and opened on to the surface of the right side through the derivation canal. Nuclear apparatus represented by one bean-shaped macronucleus with single micronucleus.

The above-mentioned specimens differ from the previously found and described forms in Azerbaijan freshwaters as they have both more rows of somatic ciliature and cilia of the caudal tuft (Table 1).

Lembadion lucens (Maskell, 1887)

(Figure 5)

It is a freshwater species that prior to our investigations had not been recorded among the Caspian Sea fauna.

Size of living ciliates 50-80 µm, that of fixed cells to 50 µm. Body elliptical with the large buccal cavity occupying most of the ventral side of the body.

The adoral polykinety consists of a double row of kinetosomes at the right margin of the buccal cavity. The

Table 1. Morphological comparison between *L. bullinum* and *L. lucens*. All data based on silver nitrate impregnated specimens. Measurements are given in µm.

Species	Body length	Number of somatic ciliary rows		Number of caudal cirri	Habitat
		ventral	dorsal		
<i>L. bullinum</i>	110-140	18-20	35-40	15	marine
	110-130	10-15	30-35	26	freshwater
<i>L. lucens</i>	50-80	10-12	18	7	marine
	50-70	7-8	12-15	7	freshwater

Order Heterotrichidae Stein, 1859

Blepharisma hyalinum Perty, 1849

(Figure 6)

This species was recently described for the first time from the coastal waters of the Caspian Sea (Aleksperov, 2005). It was found in the periphyton of the Khudat coast, in the vicinity of the Azerbaijan-Russia border. The features of *B. hyalinum* found in the Anzali Wetland of Iran are described below.

Size of fixed cells is up to 65 μm . Body lancet-shaped with sharp and turned up apical end. Adoral zone consists of 30-32 membranelles and goes along the left margin of the buccal cavity. To the left of the adoral zone of the right margin of the buccal cavity there is an undulating membrane.

Somatic ciliature consists of 12-16 rows of dikinetids. To the right of the buccal cavity there are 5 bipolar, 5

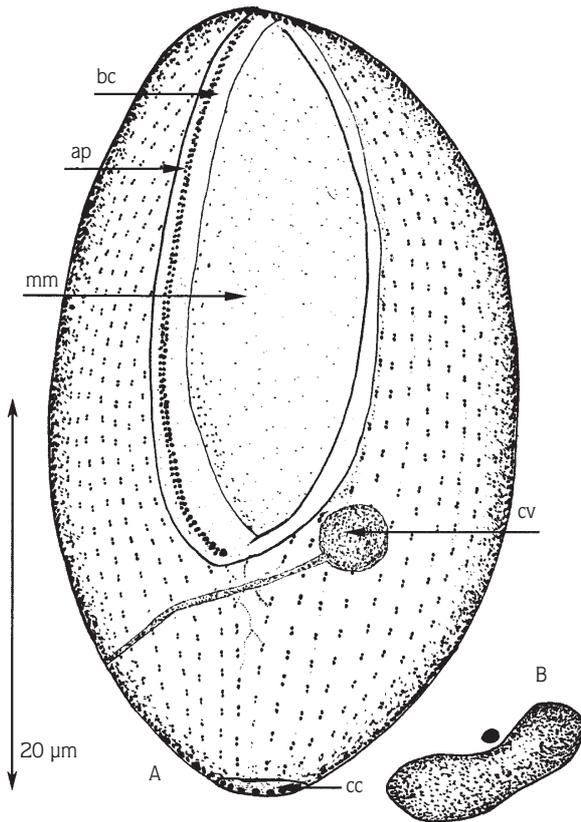


Figure 5. A,B. *Lembadion lucens* after silver nitrate impregnation. (A) Ventral view; (B) nuclear apparatus. ap: adoral polykinety; bc: buccal cavity; cc: caudal cirri; cv: contractile vacuole; mm merged membranelles M_1 , M_2 , and M_3 .

disk formed from merged membranelles M_1 , M_2 , and M_3 occupies the rest of the buccal cavity.

Somatic ciliature is represented by 10-12 rows of dikinetids on the ventral side and 18 rows on the dorsal side. The entire cell's surface is covered by quadrangle shaped argirococts. There is a caudal tuft from 7 single kinetosomes.

Endoplasm is transparent with some food vacuoles. The contractile vacuole and derivation canal has the same structure as *L. bullinum*.

The above-described specimens differ from freshwater forms as they have more rows of somatic ciliature. *L. lucens* differs from *L. bullinum* in size and number of somatic ciliature rows and cilia of the caudal tuft (Table 1).

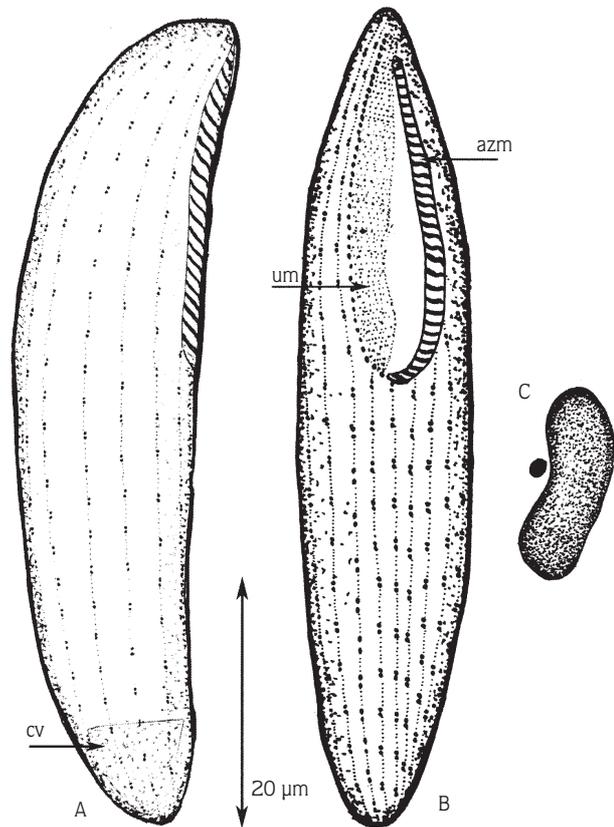


Figure 6. A-C. *Blepharisma hyalinum* after silver nitrate impregnation. (A) Dorsal view; (B) ventral view; (C) nuclear apparatus. azm: adoral zone of membranelles; cv: contractile vacuole; um: undulation membrane.

unipolar (beginning from the lower margin of the buccal cavity), and 6 bipolar rows to the left of the adoral zone of membranelles.

Endoplasm transparent, without inclusions. Large contractile vacuole typical of this species located at the posterior part of the body. Nuclear apparatus consisting of elongated macronuclei with single micronuclei is in the equatorial part of the body.

The above described specimens of *B. hyalinium* differ from Khudatian samples as they are smaller and have fewer adoral membranelles.

Order Oligotrichida Bütschli, 1887

***Strombilidium conicum* Kahl, 1932**

(Figure 7)

Prior to our investigation this was known only as a freshwater species (Mirabdullayev, 1985; Alekperov, 2005) and it has been recorded for the first time in the Caspian Sea fauna.

Size of fixed cells 90-110 µm. Body is conical with a flattened anterior end having a closed ring of 40-45 adoral (collar) membranelles. There are 10 buccal membranelles before the cytostome. Somatic ciliature is represented by 8 short longitudinal rows of kineties, each of which consists of 10-11 elements.

Endoplasm transparent, without inclusions. Elongated horseshoe-shaped macronuclei with single micronuclei located at the anterior part of the body.

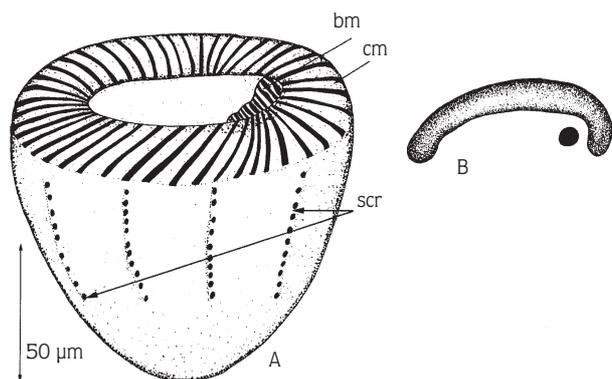


Figure 7. A-B. *Strombilidium conicum* after silver nitrate impregnation. (A) Ventral view; (B) nuclear apparatus. bm: buccal membranelle; cm: collar membranelle; scr: somatic ciliary rows.

The above-described specimens from the Anzali Wetland differ from freshwater ones as they are larger and have twice as many collar and buccal membranelles.

Order Hypotrichida Stein, 1859

***Stylonychia putrina* Stokes, 1885**

(Figure 8)

This is a widespread freshwater species, but previous to this investigation it had not been reported among the Caspian Sea fauna. The brief description of *S. putrina* found in the desalinated Anzali Wetland is given below.

Size of living cells is 80-150 µm. Body oval, rather enlarged anterior end, and very flat dorsoventrally. Large peristome occupies more than half of the body. To its left there is an adoral zone of membranelles consisting of 40-

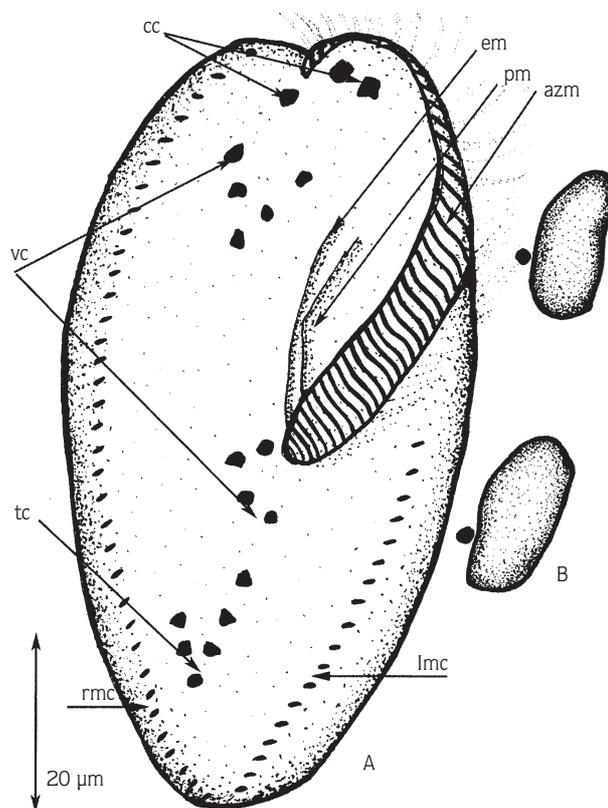


Figure 8. A-B. *Stylonychia putrina* after protargol impregnation, (A) Ventral view; (B) nuclear apparatus. azm: adoral zone of membranelles; cc: coronal cirri; em: endoral membrane; lmc: left marginal cirri; pm: paroral membrane; rmc: right marginal cirri; tc: transverse cirri; vc: ventral cirri.

45 elements. The paroral (left) and endoral (right) membranes are located to the right of the adoral zone. There are 3 coronal cirri at the anterior part of the ventral side. Below it is a group including 5 upper ventral cirri located at an angle, the top of which turns down. There is an additional C-formed group of lower ventral cirri at the lower margin of the adoral zone.

Below it there are 6 transversal cirri.

There are 2 rows of marginal cirri; the right one consists of 35 and the left one of 18 cirri. Five rows of

bristle and 3 caudal cirri are located on the dorsal side of the body.

Endoplasm transparent, without inclusions. Nuclear apparatus is represented by 2 oval macronuclei and 2 micronuclei.

Acknowledgment

This work was supported by the McArthur Foundation (grant no. 04-81290-000-GSS).

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