

## Morphology of some species of heterotrophic flagellates from tundra soils (Protista: Kinetoplastea: Cercomonadida)

## Морфология некоторых видов гетеротрофных жгутиконосцев из тундровых почв (Protista: Kinetoplastea: Cercomonadida)

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Cell morphology and biodiversity of heterotrophic flagellates from soils of the south-eastern part of Khallerchinskaya Tundra were examined for the first time in literature. Species-specific features were analysed, and descriptions of the specie, based on drawings and photos of living cells, are given. The species *Cercobodo ovatus* Lemmermann, 1910 is transferred to the genus *Cercomonas* Dujardin, 1841.

Впервые исследованы морфология клеток и биоразнообразие гетеротрофных флагеллат из почв юго-восточной части Халлерчинской тундры. Проанализированы видоспецифичные признаки и приведены описания видов на основании рисунков и фотографий живых клеток. Вид *Cercobodo ovatus* Lemmermann, 1910 перенесен в род *Cercomonas* Dujardin, 1841.

**Key words:** heterotrophic flagellates, morphology, soil, tundra, Protista, Kinetoplastea, Cercomonadida, *Bodo*, *Cercomonas*, new combination

**Ключевые слова:** гетеротрофные жгутиконосцы, морфология, почва, тундра, Protista, Kinetoplastea, Cercomonadida, *Bodo*, *Cercomonas*, новая комбинация

## INTRODUCTION

Heterotrophic flagellates are an abundant group of Protozoa, which has a world-wide distribution in marine, freshwater and soil biotopes (Fenchel, 1987). Biodiversity and morphology of soil heterotrophic flagellates are poorly known (Ekelund & Patterson, 1997), and data on heterotrophic flagellates in tundra soils is absent from the literature. Many species of these organisms (especially, cercomonads and kinetoplastids) were described in 19th and the beginning of 20th centuries (Lemmermann, 1914), and their taxonomy needs urgent clarification and revision (Lee et al., 2003).

## MATERIAL AND METHODS

Samples were collected on August 6, 2007, from the upper horizon of podzolised sandy podbur (moss-dwarf-shrubs-Cetraria community) near the Akhmelo Lake (13 km to the west of Chersky), south-eastern part of Khallerchinskaya Tundra (interfluvium of Kon'kovaya and Kolyma Rivers, north-eastern Yakutia, Russia). Five grams of the soil from each sample were analysed in two replicates in Petri dishes with the sterile Pratt medium. Light microscopical observations were made using a Biolam-I microscope (Russia) equipped with phase contrast and water immersion objectives (the

total magnification 770x). The microscope was equipped with an analogous video camera AVT HORN MC-1009/S, which was connected to a video recorder Panasonic NV-HS 850.

## RESULTS

Five species of heterotrophic flagellates were found in the investigated samples. Species descriptions are presented below.

**RHIZARIA** Cavalier-Smith, 2002

**CERCOZOA** Cavalier-Smith, 1998, emend. Adl et al., 2005

**CERCOMONADIDA** (Poche, 1913), emend. Vickerman, 1983, emend. Myl'nikov, 1986

Family **CERCOMONADIDAE** Kent, 1880, emend. Myl'nikov & Karpov, 2004

Genus ***Cercomonas*** Dujardin, 1841

***Cercomonas angustus*** (Skuja, 1948) (Figs 1–3)

*Cercobodo angustus* Skuja, 1948

*Cercomonas angustus*: Myl'nikov & Karpov, 2004

**Description.** Cell cylindrical, usually straight or slightly curved, 10–14 µm long and 3–4 µm wide. Anterior end obtuse, posterior end thinning and roundish. Two flagella arising from the ventral depression on the anterior part of the cell. Anterior flagellum about the cell length or shorter, posterior flagellum 1.5–2 times the cell length. Pseudopodia not numerous, simple and short, originate from the any part of the cell. Median nucleus in the anterior end of the cell. One or two contractile vacuoles usually situated in the anterior half of the cell body, rarely – in the posterior half. Food vacuoles in the posterior part of the cell. Moves rather quickly, at that cell strongly twists. Front flagellum is a little deflected sideways during the swimming.

The species was originally described from fresh waters of Sweden (Skuja, 1948).

**Comparative Remarks.** Zhukov (1971) reported a larger cell, 19–26 µm long, but relatively narrower, 2.5–4 µm wide.

***Cercomonas ovatus*** Klebs, 1892, **new combination** (Figs 4–6)

*Dimorpha ovata* Klebs, 1892

*Cercobodo ovatus*: Lemmermann, 1910

**Description.** Cell almost round or ovate, 7–11 µm long and 6–10 µm wide. Equal flagella two times the cell length. Amoeboid stage with a broad obtuse pseudopodia. Contractile vacuole and median nucleus in the anterior end of the cell. Food vacuoles situated in the posterior part of the cell body. Nutrition animal and saprophytic.

The species was observed in stagnant waters of Europe within epibioses and detritus (Lemmermann, 1910, 1914)

**Comparative Remarks.** Other authors reported a noticeably larger cell of this species: 19–26 µm long and 18–21 µm wide (Lemmermann, 1910; Zhukov, 1993).

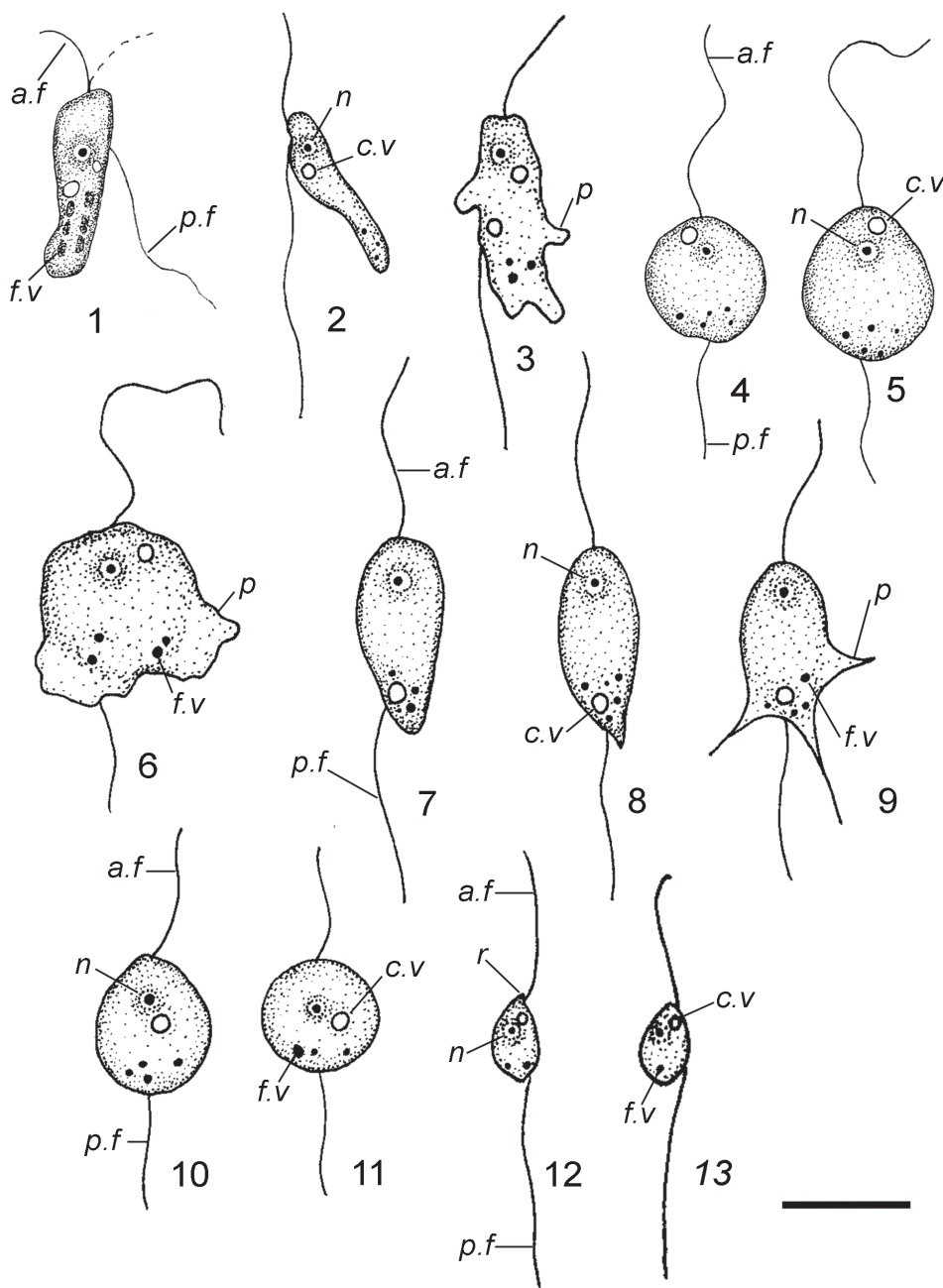
At present, the name *Cercomonas* is considered as the senior synonym of the following generic name: *Reptomonas* Kent, 1880, *Cercobodo* Krassiltschik, 1886, *Dimorpha* Klebs, 1892, *Dimastigamoeba* Blochmann, 1894, *Cercomastix* Lemmermann, 1913, and *Prismatomonas* Massart, 1920 (Mignot & Brugerolle, 1975; Schuster & Pollack, 1978; Patterson & Zölffel, 1991; Myl'nikov & Karpov, 2004).

***Cercomonas radiatus*** (Klebs, 1892) (Figs 7–9)

*Dimorpha radiata* Klebs, 1892

*Cercomonas radiatus*: Myl'nikov & Karpov, 2004

**Description.** Cell oval or egg-shaped, sometimes with a pointed posterior end, 8–12 µm long and 3.5–7 µm wide. Anterior flagellum about the cell length, trailing posterior flagellum two times the cell length. Amoeboid stage with a long, thin, radial pseudopodia.



**Figs 1–13.** Morphology of the species. 1–3, *Cercomonas angustus* (1, type view, 2, cell variability, 3, amoeboid stage); 4–6, *C. ovatus* (4, type view, 5, cell variability, 6, amoeboid stage); 7–9, *C. radiatus* (7, type view, 8, cell variability, 9, amoeboid stage); 10–11, *Bodo globosus* (10, type view, 11, cell variability); 12–13, *B. spora* (12, type view, 13, cell variability). Scale bar: 10  $\mu\text{m}$  (1–11), 5  $\mu\text{m}$  (12, 13).

**a.f** – anterior flagellum, **c.v** – contractile vacuole, **n** – nucleus, **f.v** – food vacuole, **p.f** – posterior flagellum, **p** – pseudopodium, **r** – rostrum.

Median nucleus in the anterior end of the cell. Contractile vacuole in the posterior half of the cell body. Food vacuoles in the posterior part of the cell. Nutrition animal and saprophytic.

It is a polysaprobic species, which occurs in miry water bodies within over rotten plant residues (Lemmermann, 1910, 1914). The species is also known from sod-podzol soil of Azerbaijan (Nikolyuk, 1956; Lepinis et al., 1973).

*Comparative Remarks.* Other authors reported the inflation of the posterior end of the cell with a large, apparently food vacuole (Lepinis et al., 1973).

**EXCAVATA** Cavalier-Smith, 2002, emend. Simpson, 2003

**EUGLENOZOA** Cavalier-Smith, 1981, emend. Simpson, 1997

**KINETOPLASTEA** Honigberg, 1963

**METAKINETOPLASTINA** Vickerman, in Moreira, Lopez-Garcia & Vickerman, 2004

Order **EUBODONIDA** Vickerman, in Moreira, Lopez-Garcia & Vickerman, 2004

Genus **Bodo** Ehrenberg, 1830

**Bodo globosus** Stein, 1878  
(Figs 10, 11)

*Description.* Cell broadly oviform or spherical, without distinct rostrum, 5–10  $\mu\text{m}$  long and 3–8  $\mu\text{m}$  wide. Anterior flagellum about the cell length, posterior flagellum two times the cell length. Median nucleus and contractile vacuole situated in the central part of the cell. Kinetoplast not seen. The most typical movement is quaky, without rotation concerning a longitudinal axis of a cell, with a frequent change of a direction.

Known to occur in mesosaprobic waters (Zhukov, 1993) on the planktonic algae (Skuja, 1956). It is widely distributed in sod-podzol soils (Lepinis et al., 1973) and, at the same time, a representative of coprozoon protistofauna (Sandon, 1927; Skuja, 1948; Nikolyuk, 1956).

*Comparative Remarks.* Calkins (1926) reported cells with a very long posterior flagellum (about 5 times the cell length).

**Bodo spora** Skuja, 1956  
(Figs 12, 13)

*Description.* Cell oval or spherical, slightly metabolic, 2–4  $\mu\text{m}$  long and 1.5–3  $\mu\text{m}$  wide. The dorsal side of the cell is more prominent than ventral one. Visible only half face small pointed rostrum situated on the anterior end of the cell. Two flagella arising from the ventral depression under the rostrum. Anterior flagellum 2–3 times longer than cell, posterior flagellum 3–4 times the cell length. Kinetoplast not seen. Contractile vacuole situated in the anterior or posterior part of the cell.

It was originally described from freshwaters of Sweden (Skuja, 1956), and is commonly observed in mesosaprobic waters (Zhukov, 1993).

*Comparative Remarks.* The species is the smallest one among other representatives of the genus.

## DISCUSSION

The examined species of heterotrophic flagellates are extremely rarely identified in protistological studies, although they are typical inhabitants of soils and small-size stagnant water bodies of high trophic status (Zhukov, 1971, 1993; Lepinis et al., 1973). These species are bacterivorous and play important role in the control of abundance, production and structure of the bacteriocenoses (Berninger et al. 1991).

The cell morphology of examined heterotrophic flagellates corresponds to that described earlier (Lemmermann 1910, 1914; Skuja, 1956; Zhukov, 1971, 1993). However, they are generally distinguished by a smaller size of the cell, but the ratios of the flagellum length and the cell length are similar.

*Bodo globosus* and *Bodo spora* are characterised by some features which are not

typical for bodonids. In particular, there was found the cell body metaboly, and the kinetoplast was not seen. Besides, the contractile vacuole is not always situated in the anterior end of the cell and can migrate. The latter feature is different from what is known for bodonids, which are characterised by the contractile vacuole always located in the anterior end of cell because its content belongs to the cavity of the flagellum pocket (Myl'nikov, 1992). On the contrary, the contractile vacuole of cercomonads does not usually occupy a strictly determined place in the cell and can migrate due to cyclosis (Myl'nikov, 1992).

Owing to the rare occurrence and low abundance, *B. globosus* and *B. spora* were not isolated as clonal cultures, this is why their ultrastructure was not studied. However, that could indicate an authentic taxonomic position of the species. Formally, I left the two species in the genus *Bodo* but their relations with bodonids seems only superficial while affinities to Cercomonadida is evident.

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