A new species of soil predatory flagellate, *Colponema edaphicum* sp. n., from Vorontsovskaya Cave, North Caucasus (Protista, Alveolata: Colponemidae)

A.P. Mylnikov & D.V. Tikhonenkov

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A new species of soil predatory flagellate, *Colponema edaphicum* sp. n., is described from Vorontsovskaya Cave (Krasnodar Terr.). This species is characterized by the small-sized flattened oval cell with small rostrum and pointed distal part as well as by amphora-shaped toxicysts. Morphological diagnoses of other known *Colponema* species are given. Intrageneric distinctions are discussed.

A.P. Mylnikov, D.V. Tikhonenkov, Institute for Biology of Inland Waters, Russian Academy of Sciences, Borok, Yaroslavl Prov. 152742, Russia. E-mail: mylnikov@ibiw.yaroslavl.ru, tikhon@ibiw.yaroslavl.ru

Introduction

The genus *Colponema* was established by Stein (1878) for predatory flagellates with two heterodynamic flagella and one longitudinal groove. Up to now, this genus is composed of 3 species, which differ from each other in the length of the flagella, cell sizes and cell shape. The representatives of the genus occur in fresh and marine waters and soils (Lemmermann, 1914; Sandon, 1927; Bovee, 1979; Zhukov & Mylnikov, 1987). Predation of colponemids was clearly recognized, because these flagellates could capture small colourless flagellates from the orders Kinetoplastida and Chrysomonadida (Zhukov & Mylnikov, 1987). *Colponema loxodes* Stein, 1878, a species often cited in faunal lists (Lemmerman, 1914), was investigated using light and electron microscopy (Mignot & Brugerolle, 1975; Zhukov & Mylnikov, 1987). Other two species have never been found and studied after the original description.

The new species was isolated as culture from the soil samples taken in the Vorontsovskaya cavernae system near Sochi on 29 January 2005. The temperature of the air and soil was 12 °C. The predator was cultivated in Petri dishes with addition of flagellates *Bodo saltans* Ehrenberg, 1832 as food.

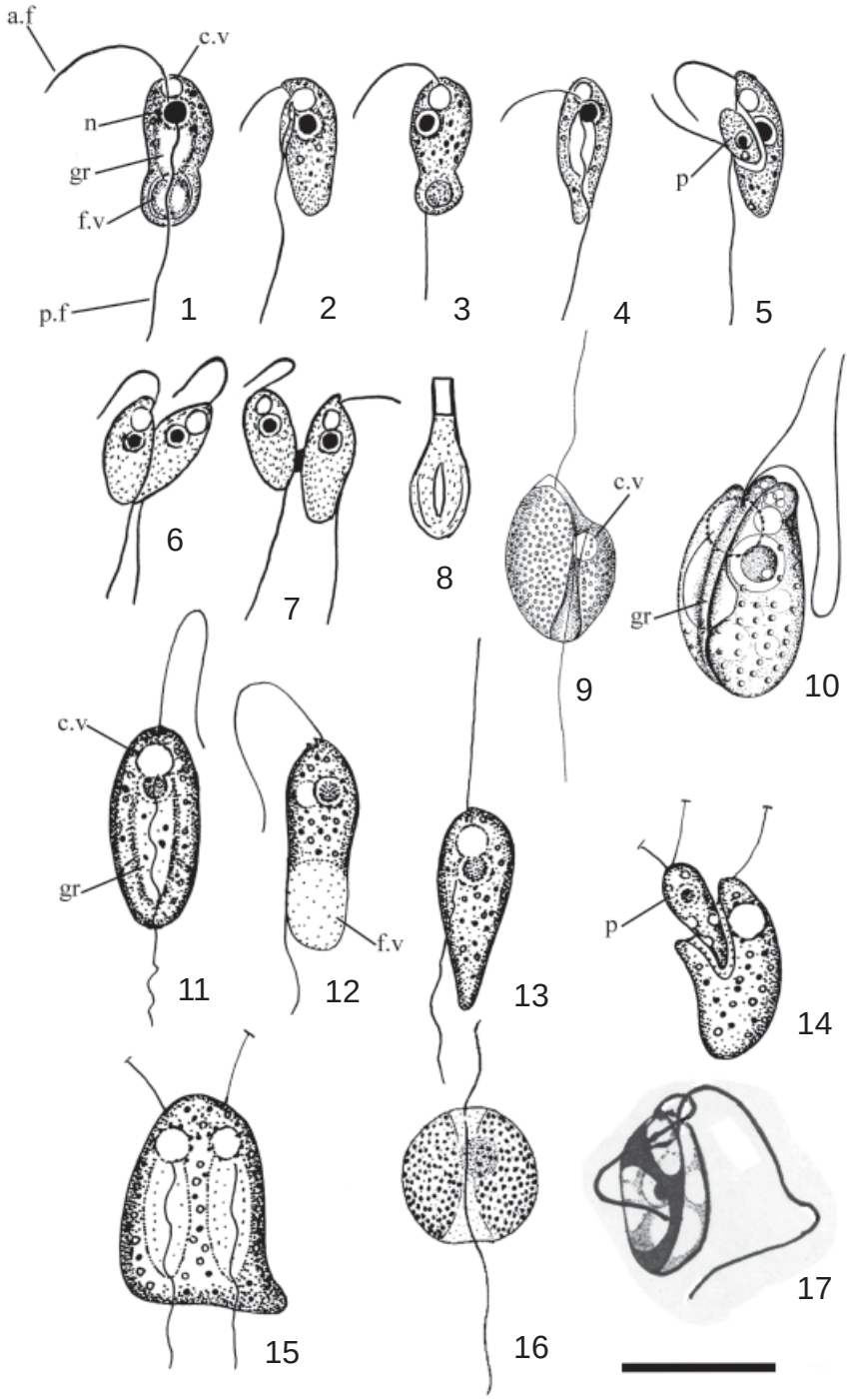
The taxonomic position of the genus *Colponema*, according to Cavalier-Smith & Chao (2004), is as follows: infrakingdom Alveolata, phylum Myzozoa, subphylum Dinozoa, infraphylum Protalveolata, class Colponemea, order Colponemida, family Colponemidae.

Colponema edaphicum sp. n.
(Figs 1-8)

Holotype (Fig. 1). **Russia**, *Krasnodar Terr.*, Vorontsovskaya cavernae system (43°36'66"N, 39°55'96"E) near Sochi, soil, 29.I.2005, slide no. 536 (A. Mylnikov), deposited at the Institute for Biology of Inland Waters.

Description. Cell flattened, oval, 8-12 μm long, 2.5-4.5 μm wide, with small rostrum and pointed distal part. Flagellar bases situated in anterior part of cell subapically. Anterior flagellum about as long as cell or slightly longer, often curved to dorsal cell surface. Very thin posterior flagellum about twice as long as cell, situated in ventral groove and making undulating movements there. Large contractile vacuole situated in anterior part of cell (Figs 1-3); median nucleus in anterior or central cell part (Figs 1-6). Young specimens with small rostral anterior end of cell and rounded posterior end (Fig. 2). Longitudinal groove of starveling specimens appreciable, posterior ends of their cells pointed and not containing food vacuoles (Fig. 4). Sometimes posterior end skew and displaced to the left of vertical axis of cell.

Cell swims rapidly, direct or zigzag. The organism is an obligate predator; it uptakes small bodonids and quickly perishes in the absence of prey. The prey is captured as a whole in the lon-



Figs 1-17. *Colponema*. **1-8**, *C. edaphicum* sp. n. (**1**, holotype; **2-4**, cell variability; **5**, capture of a prey; **6**,**7**, cell division; **8**, toxicyst); **9-15**, *C. loxodes* (**9**, from Lemmermann, 1914; **10**, from Chadefaud, 1944; **11-15**, from Zhukov & Mylnikov, 1987); **16**, *C. globosum* (from De Faria et al., 1922); **17**, *C. symmetricum* (from Sandon, 1927). *a.f*, anterior flagellum; *c.v,* contractile vacuole; *n*, nucleus; *gr*, longitudinal groove; *f.v*, food vacuole; *p.f*, posterior flagellum; *p*, prey. Scales: 10 μm (1-7), 1 μm (8), 20 μm (9-15), 15 μm (16, 17).

gitudinal groove zone (Fig. 5). The cell, which captured a prey, forms a large food vacuole at the posterior end of cell-body, which becomes to roundish (Fig. 1). Reproduction or rest cysts not found in culture. Cells multiply by binary longitudinal division (Figs 6, 7). The flagellate has extrusomes (Fig. 8) of the toxicyst type, according to Hausmann (1978). Their length is about 1 μm and they are visible only at high magnifications of an electronic microscope. These extrusive organellae keep the amphora-shaped form after discharge.

Comparison. The new species is similar to the type species, *Colponema loxodes* Stein, 1878. Both species are obligate predators, which capture the prey as a whole (Mignot & Brugerolle, 1975). *C. edaphicum* differs from *C. loxodes* in the twice smaller and elongate cell body and shorter anterior flagellum (Chadefaud, 1944; Zhukov & Mylnikov, 1987). From other described colponemid species, *C. globosum* De Faria et al., 1922 and *C. symmetricum* Sandon, 1927, the new species is distinguished by the narrower and smaller cell (De Faria et al., 1922; Sandon, 1927).

Etymology. The species name means "soil-dwelling".

Discussion

All species of the genus *Colponema* are obligatory predators capturing their prey as a whole, have large food vacuoles, an anterior contractile vacuole and swim rapidly (Stein, 1878; Lemmermann, 1914; Chadefaud, 1944). The main distinctive feature of the genus is the longitudinal ventral groove with undulating posterior flagellum. Species within this genus are mainly differing in the cell and flagellar sizes, as well as cell shape. Belonging of *C. edaphicum* to the genus *Colponema* is undoubtful.

Colponema edaphicum and *C. loxodes* are similar in the presence of a large contractile vacuole and ventral groove (Figs 1, 9-11). Satiated cells of these two species contain a large food vacuole (Figs 1-3, 12), whereas starveling or young specimens have pointed posterior end of the cell (Figs 4, 13). The prey is captured in a longitudinal groove zone, and the cells multiply by binary longitudinal division (Figs 6, 7, 15). Extrusomes of similar structure (toxicysts) were revealed in the cells of these predators (Mignot & Brugerolle, 1975; Hausmann, 1978).

Diagnoses of the previously known species of *Colponema* are given below.

Colponema loxodes Stein, 1878 (Fig. 9). Cell ovoid or bean-shaped, 17-30 μm long and 8-15 μm wide, with well-marked rostrum. Anterior flagellum about as long as cell, makes flapping movements; posterior flagellum about 1.5 times as long as cell, undulates in the longitudinal ventral groove. Large spherical nucleus and contractile vacuole situated in anterior part of cell. Large food vacuole in posterior cell part. Cytoplasm contains light-refracting granules. Amphora-shaped toxicysts about 0.9-1.5 μm long. Cells multiply by longitudinal division. Cysts not found. Inhabit fresh-waters, including benthos of ponds, reservoirs, sewage waters as well as soils rich in humus.

One of the main features of the species is obligate predation. Predator moves on spiral, after contact to prey stops and within 1-2 minutes captures it. Any paralyzing effects on prey not revealed. Pattern of absorption of food was described by Zhukov & Mylnikov (1987). Predators become small and perish in the absence of food. Posterior cell end of starving individuals pointed, cytoplasm becomes more homogeneous. Flagellates start division after consumption of several prey cells. The species was observed in the coastal zone of the Rybinsk reservoir and in greenhouse soil of Borok settlement (Zhukov & Mylnikov, 1987).

Colponema globosum De Faria, Cunha & Pinto, 1922 (Fig. 16). Cell oval, wide and flattened, anterior part wider than posterior one. Longitudinal ventral groove deep, with wide curvilinear margins. Ventral groove narrowed in middle part of cell and widened at the cell ends (especially near the posterior end). Cell about 15 μm long and 13-14 μm wide. Flagella originating from ventral groove near the anterior cell end. Anterior flagellum slightly shorter than cell; posterior flagellum about twice as long as cell. Median contractile vacuole situated at the anterior end of the cell. Cytoplasm contains light-refracting granules. Cysts not found. Observed rarely, in the marine waters of the Rio de Janeiro gulf, Brazil (De Faria et al., 1922).

Colponema symmetricum Sandon, 1927 (Fig. 17). Cell rigid, flattened, elliptical, with widely rounded ends. Well-visible median longitudinal ventral groove divides the cell into two equal parts. Cell length about 9-15 μm. Subapical anterior flagellum about 1.5-2.0 times as long as cell; subapical posterior flagellum about 3-4 times as long as cell. Spherical nucleus situated slightly below the cell center, near dorsal side and distinguishable only after fixation. Organism always attach to the substratum by the distal end of posterior flagellum and jerking constantly backwards and forwards. Data about feeding absent. Cysts not found. Rare species, observed in soils of England (Sandon, 1927). The attachment of the cell to the substratum is unusual for representatives of the genus.

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