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New species of green snow algae *Chloromonas* (Volvocales, Chlorophyta) from Bulgaria

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Abstract
We describe a new cryophilic species of Chlamydomonadaceae, *Chloromonas andrei* sp. Nov. From Bulgaria. The cells are susceptible from 5 °C to subfreezing temperatures. The local distribution of the species, description and comparison with related taxa is given. The species is characterised by a little papillum, two apical contractile vacuoles, chloroplasts around the wall plate covering a large part of the interior of the cell.

Keywords: *Chloromonas*, new taxa, snow algae, morphology, Chlorophyta

1. Introduction
Cryophilic algae are well adapted to living in snow or in extreme conditions of low temperature high irradiance level, high acidity and low nutrient concentrations [1, 2]. Snow algae are cold-tolerant freshwater organisms which growing on the surface of snow and ice for one to two weeks per year during the early spring snowmelt [3, 4].
The growth temperature range for this algae are 3-10 °C [5]. The snow algae are adapt to this harsh environment, throught adaptive features like motile stages and spore formation.The spores have large amounts of lipid reserves, polyols and sugars, which protective role allows to withstand subzero temperatures in winter and also high soil temperatures and desiccation in summer [6]. The protective role of polyunsaturated fatty acids (PUFAs) against the damaging effect of high light intensity and UV radiation, especially at low temperature, obviously helps the organism to survive and adapt in extreme environments [6]. Many of the snow algal species are colored green, red, orange and based on the colour they are divided into main groups [7, 8].
The present study describes the morphological characteristic of a new found snow algae species of genus *Chloromonas* from Bulgaria.

2. Materials and methods
The material from new founded species is collected from ephemeral basin in the marble cup in the Ancient Theatre of Plovdiv, Bulgaria (42°08'490"N 24°45'039"E). The cup with a diameter of about 50 cm and depth of 15 cm was fulfilled with snow. The locality was visited three times in 2014. During the first visit on 24 February the water was in bloom, with deep green grass color and the temperature was + 5 °C during the day. In the second visit on 28 February the water was completely frozen as ice was green grass. During the third visit on 8 March the cup was filled with colored green snow melting on the periphery. The measured temperatures at midday were: + 6 °C air, + 1 °C water near melt snow, + 0.3 °C the melting of snow. The water froze completely during the night. Samples were collected and analyzed during three separate visits. The study of the material collected was performed with a microscope Olympus CX31 in the Department of Biology and Aquaculture in Trakia University.

3. Results and discussion
A microscope analysis showed that the blooming is mainly due to three types of green flagellates. In the three visits (24-28 February and 8 March 2014) dominated two species belonging to the biggest genus *Chlamydomonas*: - *Chl. Pumiliformis* Peterfii and *Chlamydomonas* sp, and less described new species *Chloromonas andrei* sp. nov.
The chloroplast of a new found species showed similarity to chloroplast from other species *Chl. infirma* (Gerloff) Silva, *Chl. lacustris* L.S. Petrfi, *Chl. ferrophila* Ettl [9], but differed by them in the form of cells and papillum.

The new found species has most similarity with *Chloromonas modesta* (Pascher) Gerloff et Ettl [9], but clearly differs from it in the following important taxonomic features such as:

1. Shape of chloroplast - in new found species around wall, and in *Chloromonas modesta* top forming;
2. Size and location of eyespot – in new found species is small in the front of the cell, and in *Chloromonas modesta* is large in the rear part of the cell;
3. Differences exist in the form of the cell, papillum, etc. (Table 1).

Table 1: A comparison between Chloromonas *andrei* sp. nov. and Chloromonas modesta (Pascher) Gerloff et Ettl

Features	*Chloromonas andrei* sp.nov.	*Chloromonas modesta*
Cell shape	Dorsoventral with a slightly flattened ventral side	ovoid to spherical
Cell size	length – 7.5 - (9.2) – 11.3 µm width – 5.5 - (7.2) – 10.0 µm	to 9.0 µm
Flagella	8.7 – 11.3 µm	= length of cell
Papillum	little	big
Contractile vacuole	two, apical	-
Chloroplast	around the wall plate covering a large part of the interior of the cell	top forming
Eyespot	small in the front of the cell	large in the rear part of the cell

4. Description

Cell shape is spherical to ovoid, dorsoventral - a slightly flattened in a plane parallel to the flagellum; envelope thin, tightly to the chloroplast with distinct papilla; flagella = length of cell; chloroplast - around the wall plate covering a large part of the interior of the cell, as from the flattened side remains free longitudinal narrow strip between the front and rear ends of the cell; eyespot - bright orange, elliptical, in the front of the cell; the core in the middle of the cell; two contractile vacuole in the front end (Figure 1); the cell 7.5 - (9.2) – 13.0 µm length and 5.5 - (7.2) – 10.0 µm width; the ratio length / width 1.0 - (1.3) – 1.6; flagella length 7.5 – 13.0 µm - equal to the length of the cell. Reproduction is unknown.

Iconotypus: Plovdiv, Bulgaria - marble cup (diameter 50 cm and depth 15 cm) with water from melting snow (24.02. – 08.03. 2014).

***** The species name is dedicated to the son of prof. dbs Ivan Kirjakov – Andrei.

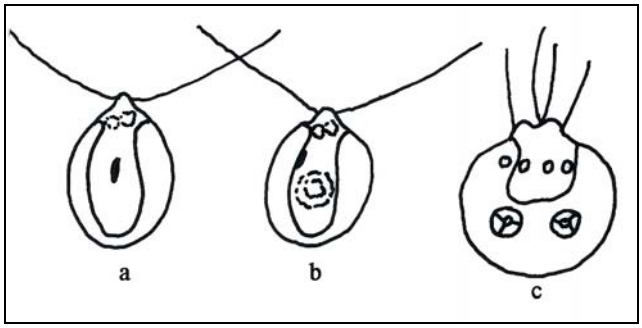

Fig 1: Chloromonas andrei sp. nov.: a – vegetative cell with two contractile vacuole and eyespot; b – vegetative cell with nucleus; c – dividing cell.

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