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MORPHOLOGY OF SINGLE-CELLED ALGAE AND OBTAINING BIOLOGICALLY ACTIVE SUBSTANCES FROM THEM

Abstract
Aquarius – aquaculture, in its productivity significantly exceeds trees and grasses, synthesizes significant amounts of biomass and various biologically active substances that perform certain physiological functions. Algae tissue cells are rich sources of valuable biopolymers and biologically active substances. An additional morphological criterion is presented to distinguish vegetative samples of the genera Yendonia and Mikamiella (Delesseriaceae, Rhodophyta). The undescribed earlier feature of Y. crassifolia is the presence of abundant lightrefracting cells in the tissues of the blades of both fertile and vegetative plants. This feature was never observed in Mikamiella, namely, in M. ruprechtiana. Additional data amending the description of the genus Yendonia are presented.
Key words: Aquarius, biologically active substances, Ankistrodesmus, Yendonia.

МОРФОЛОГИЯ ОДНОКЛЕТОЧНЫХ ВОДОРОСЛЕЙ И ПОЛУЧЕНИЕ ИЗ НИХ БИОЛОГИЧЕСКИ АКТИВНЫХ ВЕЩЕСТВ

Аннотация
Водоросли – аквакультура, по своей продуктивности значительно превосходит деревья и травы, синтезирует значительные количества биомассы и различных биологически активных веществ, выполняющих определенные физиологические функции. Клетки тканей водорослей являются богатыми источниками ценных биополимеров и биологически активных веществ. Представлен дополнительный морфологический критерий для выделения вегетативных образцов родов Yendonia и Mikamiella (Delesseriaceae, Rhodophyta). Неописанной ранее особенностью Y. crassifolia является наличие большого количества светопреломляющих клеток в тканях пластинок как фертильных, так и вегетативных растений. Эта особенность никогда не наблюдалась у Mikamiella, а именно у M. ruprechtiana. Приведены дополнительные данные, изменяющие описание рода Yendonia.
Ключевые слова: Водоросли, биологически активные вещества, анкистродесмус, Yendonia.

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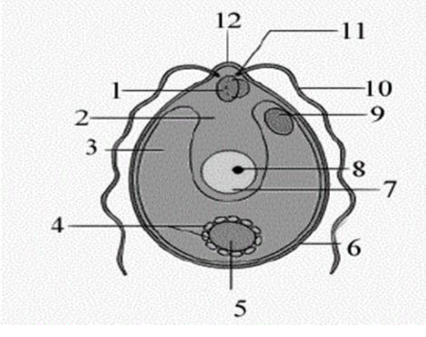
Annotatsiya
Suv o‘tlari – akvakultura, o‘z mahsuldorligi bo‘yicha daraxtlar va o‘tlardan sezilarli darajada oshadi, ma’lum fiziologik funksiyalarni bajaradigan muhim miqdordagi biomassa va turli xil biologik faol moddalarni sintez qiladi. Yosunlar to'qimalarining hujayralari qimmatli biopolimerlar va biologik faol moddalarning boy manbalari hisoblanadi. Yendonia va Mikamiella (Delesseriaceae, Rhodophyta) avlodlarining vegetativ namunalarini farqlash uchun qo'shimcha morfologik mezon taqdim etiladi. Y. crassifolia ning ilgari tavsiflanmagan xususiyati ham unumdor, ham vegetativ o‘simliklarning ustunligi to‘qimalarida yorug‘likni sindiruvchi hujayralarning ko‘p bo‘lishidir. Bu xususiyat Mikamiellada, ya'ni M. ruprechtianada hech qachon kuzatilmagan. Yendonia jinsining tavsifini o'zgartiruvchi qo'shimcha ma'lumotlar keltirilgan.
Kalit so‘zlar: Suv o‘tlari, biologik faol moddalar, Ankistrodesmus, Yendonia.



Enter. The morphological diversity of algae is very large, but almost all species found in the soil are distinguished by their microscopic size and single-celled. It can also occur in the form of threads or colonies. Algae cells are surrounded by a cell wall composed of cellulose with a mixture of pectin. In some algae, the cell walls are covered with a thick layer of organic matter, while others are impregnated with silicon. The cell contains the cytoplasm, one or more nuclei, vacuoles, and chloroplasts - the organs of photosynthesis. In algae, chloroplasts come in a variety of shapes and colors, but they always contain the pigment chlorophyll. The color of algae also depends on other pigments. In many species of algae, chloroplasts contain special protein bodies - pyrenoids, around which starch accumulates. It can also accumulate directly in chloroplasts. In addition to starch, algae cells can synthesize other polysaccharides, as well as monosaccharides and fats. Three methods of reproduction are known in this group of microorganisms: vegetative, asexual, and sexual [1].

Literature review. The cell is the main structural unit of the algae body. It is represented by single-celled or multicellular forms. The specificity of single-celled forms is determined by the fact that their organisms consist of only one cell, so the characteristics of the cell and the organism are combined in its structure and physiology. Small, simple invisible, single-celled algae take raw materials from the environment, mineral salts and carbon dioxide from them: produce proteins, carbohydrates and fats.

In addition, the cell uses water and carbon dioxide as nutrients and, due to solar energy, forms organics from inorganic compounds based on them. The algae cell is an integral living system. It consists of three closely spaced parts: the cortex, the cytoplasm, and the nucleus (Figure 1) [4].

Figure 1. Appearance of the algae cell:

1 - contractile vacuoles;
2 - cytoplasm;
3 - bowl-shaped chromatophore;
4 - starch grains;
5 - pyrenoid;
6 - cell wall;
7 - nucleus;
8 - nucleus;
9 - eye socket;
10 - flagellum;
11 - basal body;
12 – papilla

Cell shell. In microvilli, the cell surface has a dense shell or cell wall. The cell membrane provides direct interaction with the external environment and interaction with neighboring cells (in multicellular organisms). The cell membrane has a complex structure. It consists of an outer layer and a plasma membrane beneath it. The main skeletal substance of algae cell membranes is cellulose. Filamentous cellulose molecules are assembled in the shells into structural units - microfibrils that form the shell frame.

There are several morphologies of thallus formation in single-celled algae:

Amoeboid (rhizopodial) - such single-celled algae do not have a rigid cell membrane and as a result cannot maintain a permanent body shape. Due to the absence of a cell wall and the presence of special intracellular structures, the cell has a creeping motion through pseudopodia or rhizopods. Some species are characterized by the formation of syncytia as a result of the fusion of several ameboid cells. The amoeboid structure may have some secondary monadic shape by throwing or pulling back the flagella.

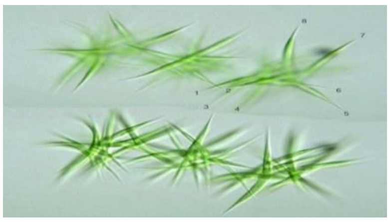
Monadic - single-celled algae with a permanent body shape, flagellums, often stigma, while freshwater algae have a shrinking vacuole. Cells are actively moving in the vegetative state. Often there is a fusion of several monadic cells into a colony surrounded by a common mucus, in some cases they are even connected to each other by plasmodesmata.

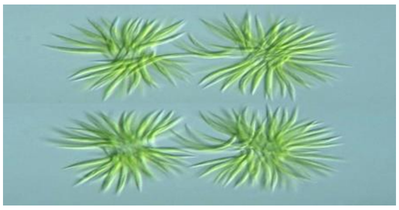
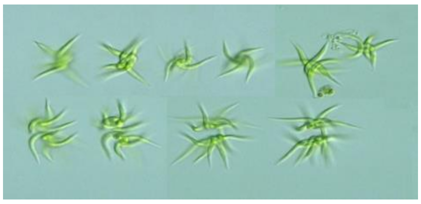
Coccoid - Single-celled, devoid of moving organelles and maintains a constant body shape in the vegetative state of the cell. Often there is a thickened cell wall or shell, which is moved using various tumors, holes, etc. to facilitate the ascent of the water column. Many algae with such a structure form colonies. Some diatoms and desmids are able to move actively by separating mucus [3].

Many species of green algae (eg, Chlorella sp., D. salina, Ankistrodesmus angustus, and B. braunii) can produce EPS, which contains large amounts of exopolysaccharides. The monosaccharide components of exopolysaccharides are hexose, pentose, uronic acid, methylpentose, methylhexose, and / or sulfate. The most common monosaccharides were glucose, galactose, arabinose, fucose, xylose, mannose, glucuronic acid, and galacturonic acid . Of all the five green algae studied, no more than four major monosaccharide components are present in a single exopolysaccharide (Moore and Tischer, 1964). S. acuminatus contains all simple sugars except glucose. Mannose has been found to be a typical and important monosaccharide in exopolysaccharides of Chlorophyceae, including S. acuminatus, Ankistrodesmus densus, and Kirchneriella aperta (Lombardi and Vieira, 1999; Lombardi et al., 2005; Paulsen et al., 1998). Mannose appears to be one of the major sugars (between mannose, ramnose, and uronic acid) responsible for complexes with heavy metals such as copper and lead.

There are many known species of unicellular algae, but among them we have studied in depth many species whose morphology and physiology have not been fully studied, such as ankystrodesmus, scenedesmus, chlorococcum, botrycococcus.

If we look at the morphology of the species Ankistrodesmus from the single-celled sub-algae, this species belongs to the group of green algae. It is found in plankton of water bodies and lakes, in mud, in contaminated areas of high aquatic plants. The shape of the cell varies depending on the living conditions: arc-shaped, spiral-shaped, crescent-shaped, as shown in Figure 2 [5].



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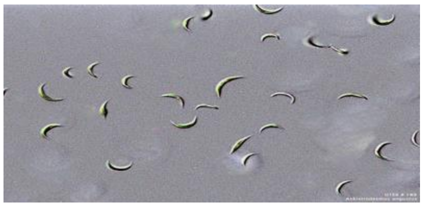

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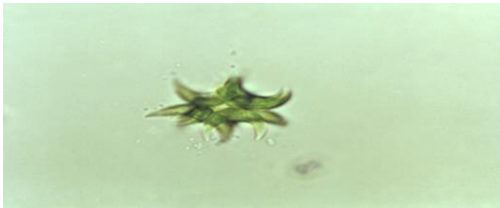

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Figure 2. Cell forms of ankistrodesmus species are: a) Ankistrodesmus falcatus (cell length up to 60 microns), b) Ankistrodesmus falcatus. stipitatus, c) Ankistrodesmus densus, d) Ankistrodesmus spiralis, f) Ankistrodesmus gracilis, e) Ankistrodesmus angustus, g) Ankistrodesmus bibraianus

The current state of industrial biotechnology of microalgae and scientific research in this area.

Research Methodology. Although the hopes for the replenishment of the world's food protein reserves at the expense of microalgae did not materialize, in the course of fundamental and applied research carried out in the 70-90s of the 20th century, it was found that many species can synthesize and accumulate in commercially significant quantities a wide range of unique biologically active substances (BAS), which have a pronounced positive effect on the human body and animals. The high plasticity of microalgae metabolism, regulated by environmental conditions, was shown, which means that it is possible to control the biosynthesis of biotechnologically valuable compounds under conditions of intensive culture [8,6,7]. From this point of view, microalgae are no longer considered as a reserve food in case of global famine, but as the most valuable renewable raw material resource for the production of biologically active substances (carotenoids, vitamins, ω-3.6 polyunsaturated fatty acids, phycobiliproteins, polyglucans, antibiotics, cytostatics, etc.), feed for aquaculture, animal husbandry and poultry farming, agrochemicals (herbicides, fungicides, fertilizers, growth stimulants), energy carriers (biodiesel, hydrogen, methane, ethanol), plastics and other technical products [1,7,8,9].

Analysis and results. The undoubted successes of the last decade include the expansion of the range of cultivated species and the geography of their mass production (Table 1). World production of microalgae in 2008 – 2012.

Object of cultivation	**t•year-1**	**Main manufacturers**
Chlorella	2000	Japan, Korea, China, Germany
Dunaliella	1200	Australia, Israel,
Haematococcus	300	China, India
Crypthecodinium	240*	USA, China, India Japan, Israel
Schizochytrium	10*	USA
Live aquaculture:	1000	USA

*algal oil (for the production of 1 ton of oil, at least 5 tons of biomass are needed [8]).

Microalgae cultures generally present biomass concentrations that range from $0.5\ g{\cdot}L^{-1}$ and $5\ g{\cdot}L^{-1}$ when they reach the stationary phase of growth in open tanks and photobioreactors, respectively (Vandamme, Foubert, and Muylaert 2013). The microalgal biomass should be preferably harvested in order to reduce storage and processing costs. The current harvesting strategies allow to concentrate the biomass up to 100 times, reaching concentrations close to $50\ g{\cdot}L^{-1}$ (Vandamme, Foubert, and Muylaert 2013)[6].

Chemical flocculation is commonly performed with cationic polyelectrolytes, such as metallic salts and polyacrylamide based-polymers, that interact and neutralize the negative surface of microalgae cells (Pugazhendhi et al 2019; Vandamme, Foubert, and Muylaert 2013). Despite the high efficiency of the cationic polyelectrolytes, these compounds are difficult to remove, and they contaminate the water and biomass. Thus, the use of cationic polyelectrolytes should be carefully evaluated in microalgae farms that produce biomass for food and feed (Vandamme, Foubert, and Muylaert 2013). There are safer alternatives, such as chitosan and cationic starch, that might be better alternatives to harvest microalgal biomass for food and feed (Vandamme, Foubert, and Muylaert 2013)[6,7.].

Conclusion and Recommendations. The relevance and necessity of the research carried out in the study of the growth conditions of unicellular algae, its goals and objectives are justified, the object of research classified, research Republic science and technology compliance with the priority directions of development is shown. The scientific novelty and practical results of the research were discussed and obtained scientific and practical significance of the results, research that the results have been put into practice, published works and information about the composition of the dissertation is presented.

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