
# Daily Dynamics of Gas Exchange and Photosynthetic Pigments in Green Algae. Chlamydomonas parientaria

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ABSTRACT

Algological studies include the study of physiological processes of promising algae from the point of view of productivity. In order to achieve high productivity, algae are grown in intensive laboratory conditions, which are accompanied by changes in the amount of gas exchange processes and photosynthetic pigments.

The study of this nature is necessary to determine the processes of adaptation to changes in external conditions, as well as to determine the dependence of the photosynthesis apparatus on light. Productive strains are characterized by high photosynthesis and lability of photosynthetic apparatus capable of ensuring high productivity of microalgae. The ratio of photosynthetic pigments characterizes the physiological state of cell culture and is related to the operation of photosystems I and II of photosynthesis (I).

**Keywords:** daily dynamics of microalgae photosynthesis, gas exchange, pigments, biological rhythms, activity, photosynthesis intensity, light, cultivation, nutrient medium, optimal factors, bilmass, chlorophyll a, chlorophyll b, cells.

Physiological properties of some green algae and cyanobacteria have been studied by many authors both in laboratory conditions (2, 3, 4, 5) and in natural water bodies (6).

It is known that the greatest biomass growth and photosynthetic activity in microalgae cultivation are observed under day and night light conditions (2). In nature, there are biological rhythms of the light and dark phases of photosynthesis, which are subject to the length of daylight hours and the themes of the new period.However, it remains to be determined how the processes of gas exchange and the amount of pigments change during the day in algae belonging to productive strains. In this regard, the purpose of this work is to study the daily dynamics of the intensity of photosynthesis and dark respiration, the amount of pigments (chl.a, chl.b and total carotenoids) of the intensive culture of green algae Chlamydomonas parientaria in the phase of active cell growth (exponential phase).The object under study is Chlamydomonas parentaria - a new species isolated by us from wastewater of Namangan region. Strain UA-5-22 is grown intensively under laboratory conditions in glass containers by mixing air and SO2 (1-1.5%) with foam. Hydrogen is grown in the famous Tamiya mineral medium. Day and night lighting with DR L-400 lamp (1-70 W/m2FAR). The strain belongs to productive algae, and its productivity is 6.4 g/l s.b. for 7-8 days in the optimal cultivation mode.Photosynthetic production and uptake of oxygen was determined by the Winkler titrimetric method (7). Photosynthetic productivity was calculated by calculating changes in dry weight (g l), cell growth - in a Goryaev chamber. Pigments were determined and calculated according to the formula in Method 8. Experiments were repeated three times.Tables 1 and 2 present data on the daily dynamics of photosynthesis intensity and dark respiration of the culture at different stages of active growth (4 and 6 days). Experiments have shown that at the beginning of the exponential phase, the highest activity of gas exchange processes is observed, as well as the highest rate of biomass growth. Green algae cells are known to divide mainly at night (3). As shown in Table 1, the number of cells almost doubled during the night hours.Proliferation of cells by simple division also indicates favorable conditions for cultivation in a short period of time. However, by the end of the next two days and the transition to the stationary phase (day 6), cell division slows down significantly and becomes independent of constant light during this period. Such information allows to reduce the growth time of the studied culture to 5-6 days or to use this strain in continuous proton culture.On the 4th day, the maximum intensity of visible photosynthesis was observed at 6 hours (12-15 hours) during the day (271.5 mgO2 g.s.b.h). At night, it decreased more than 2 times. However, due to the absence of sharp dynamics of dark respiration, the actual photosynthesis values did not fall below 100 units, which indicates high activity of photosynthetic apparatus during the day.During the transition to the stationary phase, the maximum intensity of photosynthesis was observed in the morning hours (900-1200 hours), and a further decrease in visible and true photosynthesis indicates a reduction in the number of active hours for absorbing light energy (from 6 to 15 hours). At the same time, the level of the maximum intensity of photosynthesis decreased by 2.5 times (103.2 mgO2/g s.b.h). During the observed period, weak dark respiration indicates low energy expenditure of cells for this process.

But if on the 4th day weak respiratory activity and high photosynthesis were accompanied by an active accumulation of biomass, on the 6th day a decrease in gas exchange processes was observed in general, which further affects the biological state of the cells. Thus, despite constant illumination, the main absorption of light energy by pigments occurs during the day, and there is no violation of biological rhythms, which means that this mechanism is genetically based and does not undergo rapid changes in external conditions.

Observations of the intensity of respiration showed that during the day its level is significantly lower than the intensity of photosynthesis. The greatest activation of respiration is observed in the evening hours (1800-2100), that is, the F/D ratio remains above 1. At night, a general decrease in physiological processes occurs, and the values of photosynthesis and respiration depend on the following. is subject to the physiological state of algae cells and the biological rhythm of plant organisms.

Table 1

4. Some physiological indicators of Chlamydomonas parientaria during the day. (4 days)

| Time, hour | t°C | P,g/l | N, million cells/ml | mg O2/g s.b.h | | | mg O2/g s.b.h | | | | a/v | ΣXl Σkar |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Iovp | Iotp | Bi | Chl.a. | Chl.b. | Σкар | $Xl_{a+b}$ | | |
| $9^{00}$ | 23 | 0,29 | 4.0 | 220.7 | 264.8 | 44.1 | 24.2 | 8.75 | 15.3 | 32.9 | 2.76 | 1,58 |
| $12^{00}$ | 24 | 0,31 | 4.2 | 261.9 | 306.5 | 44.6 | 41.6 | 90,9 | 25.6 | 132,5 | 0,46 | 1.62 |
| $15^{00}$ | 24,5 | 0,33 | 4.4 | 271.5 | 326.7 | 55.2 | 33,5 | 61.1 | 16.8 | 94.6 | 0,54 | 5.63 |
| $18^{00}$ | 24,5 | 0,35 | 4.7 | 111,8 | 201.2 | 82.9 | 25.9 | 14.5 | 14.3 | 40.4 | 1.78 | 1.81 |
| $21^{00}$ | 25 | 0,40 | 5.4 | 116.0 | 188.0 | 72.0 | 29.9 | 20.0 | 13.9 | 49.9 | 1.50 | 2.15 |
| $24^{00}$ | 26 | 0,64 | 8.7 | 110.0 | 160.2 | 50.2 | 20.3 | 17.3 | 9,5 | 37.6 | 1.17 | 2.13 |
| $3^{00}$ | 26 | 0,68 | 9,2 | 60,6 | 118.2 | 57.6 | 10,4 | 13.5 | 8.76 | 23.9 | 0,77 | 1.18 |
| $6^{00}$ | 26 | 0,72 | 9,7 | 67,8 | 103,4 | 35.6 | 5.43 | 9.2 | 2.52 | 13.6 | 0,59 | 2.15 |

Iovp- intensity of visible photosynthesis
Iotp - intensity of true photosynthesis
Bi- breathing intensity

Table 2

Daily dynamics of photosynthesis intensity and
breathing Chlamydomonas parientaria (6 days)

| Time, hour | t°C | mg O2/g s.b.h | | |
|---|---|---|---|---|
| | | Iovp | Iotp | Bi |
| $9^{00}$ | 21.5 | 70.3 | 101.2 | 30.9 |
| $12^{00}$ | 21,5 | 103.2 | 113.6 | 10.3 |
| $15^{00}$ | 22,5 | 61.6 | 71.9 | 10.3 |
| $18^{00}$ | 23 | 51.6 | 61.9 | 10.3 |
| $21^{00}$ | 23 | 36.7 | 52,2 | 15.5 |
| $24^{00}$ | 23 | 51.6 | 72,2 | 20.6 |
| $3^{00}$ | 23 | 46.5 | 82.6 | 36.1 |
| $6^{00}$ | 23 | 30.9 | 46.4 | 15.5 |

almost level off (60.6 and 57.6 mgO2/g s.b.h, respectively). On the 6th day, the regularity of the dynamics of photosynthesis and respiration does not change, but the activity of both processes decreases significantly. The lowest activity of respiration was 10.3, and of photosynthesis - 30.9 mgO2/g s.b.h. Apparently, such a level of gas exchange for cells during this period is sufficient to maintain vital processes, i.e., we observe a period of “rest” of cells after active reproduction.Despite the inhibition of gas exchange processes at night, the expediency of using round-the-clock lighting along with the optimization of other factors (temperature, nutrition, CO2 supply) lies in the fact that photosynthesis does not stop at night. The intensity of photosynthesis is at a low level, but continues to function, which is ultimately accompanied by greater productivity.The daily dynamics of pigment content in Chlamydomonas parietaria, as in other algae, is closely related to photosynthetic activity and is very sensitive to changes in cultivation conditions. The experiments showed that the optimal content of pigments undergoing active photosynthesis was observed at 12.00 (chl. ha - 41.6, chl. r - 90.9, car. - 25.6 mg / g w. b (Table 1 ).In this case, the amount of chl.r exceeds chl.a, because the culture is under conditions of moderate light intensity and is not subject to photoinhibition. In the evening and at night, despite the light, there is a decrease in all considered pigments. The lowest value of the indicators was obtained at 6 o'clock in the morning. At the same time, the ratio of pigments (chl. a/chl. $ and chl./car.) remains at a fairly stable level in relation to their composition during the day.

The results showed that Chl. (Table 1.3). In the period from 09:00 to 12:00, the biggest jump in the growth of chl.b (10 times) is observed. At the same time, the composition of chl.a changes gradually. Perhaps this is due to the main photosensitizing role of chl.a along with additional functions of chl.b and carotenoids. Table 3 shows that changes in the amount of pigments during the day can be divided into gradual or mild changes and spasmodic periods. As you can see, despite the fact that the light regime does not change during the day, "jumps" to the side with an increase in the number of pigments occur in the morning. This also confirms that the activity of physiological processes of cells depends on biological rhythms.

It should be noted the observed cycle of the number of pigments during the day. That is, in the morning hours, for example, how many times the amount of chl.a increased, how many times it decreases during the rest of the day.

The obtained results allow us to draw conclusions about the daily dynamics of gas exchange and the composition of pigments under the conditions of day and night light and optimal nutrition and temperature.

Table 3

Daily dynamics of photosynthetic pigments Chlamydomonas parientaria (4 days)

| Time,hour / Number of pigments | $9^{00}$-$12^{00}$ | $12^{00}$-$15^{00}$ | $15^{00}$-$18^{00}$ | $18^{00}$-$21^{00}$ | $21^{00}$-$24^{00}$ | $24^{00}$-$3^{00}$ | $3^{00}$-$6^{00}$ | $6^{00}$-$9^{00}$ |
|---|---|---|---|---|---|---|---|---|
| Chl.a | Increases 2 times | Decreases by 1.5 times | | Decreases by 1.5 times | | Decreases by 2 times | Decreases by 2 times | Increases 4.5 times |
| Chl.b | Increases 10 times | Decreases by 1.5 times | Decreases by 4 times | Slight decrease | | | Decreases by 2 times | Increases 2times |
| Σkar | Increases 1.5 times | Decreases by 2 times | Slight decrease | | | | Decreases by 4 times | Increases 5.5 times |

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