Population age structure control when unicellular algae are cultivated

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It is well known that changes of functional activity during a life cycle are conforming to the biological law. Cultivating the highest plants and animals, a man has to take into consideration this law, has to use a synchronous cultivation for annual plants or has to form an optimal age structure for perennial plants and animals. Moreover, as a rule, it becomes to be the aim to optimize the final product when the process is continuous.

Considerable changes of chloroplast functional activity and metabolism in the life cycle of cell give the opportunity to increase cultures productivity and to control microalgal biomass chemical composition as well.

In view of the said, we felt that it would be of definite interest to analyze the parameters of populations on the basis of age distribution. Any culture parameter named F may be represented in the mathematic formula [1, 2]:

$$F = N\int_{0}^{T} f(t)\, n(t)\, dt$$

where:

N - a general number of cells in population;
T - duration of life cycle of cell;
n - density of age distribution of cells;
f(t) - dependence of f parameter of cell on its age;
t - age of cell.

This formula indicates that controlling the value n(t) the culture parameters may be changed and, consequently, a content of product, energy using efficiency, etc. may be also changed.

For the purpose of this control realization it is necessary to know any specialities of life cycle of cell, the value f(t). There are many data of different scientists and for different cultures in this direction [3 - 5], beginning with well-known works by H. Tamiya that allow to transform the theoretical problem of microalgae photobiosynthesis control into the practical one.

For example, operating with *Chlorella* sp. K., there is indicated that in synchronous culture with optimal combination of cultivating parameters (light intensity = 350 W m^{-2}, temperature = 37°C, CO_2 concentration in gas mixture = 1.7 %) the general parameters of cell are changing in the following way [6, 7].

The comparison of curves (fig. 1) shows that the average value of specific rate of chlorophyll content increase on the light stage of cell development is higher than specific rate of biomass growth. After 5.5 hours of development cycle, the biomass growth is slowed down. The same slowing-down process concerning the rate of chlorophyll synthesis is indicated by 1.5 hours before.

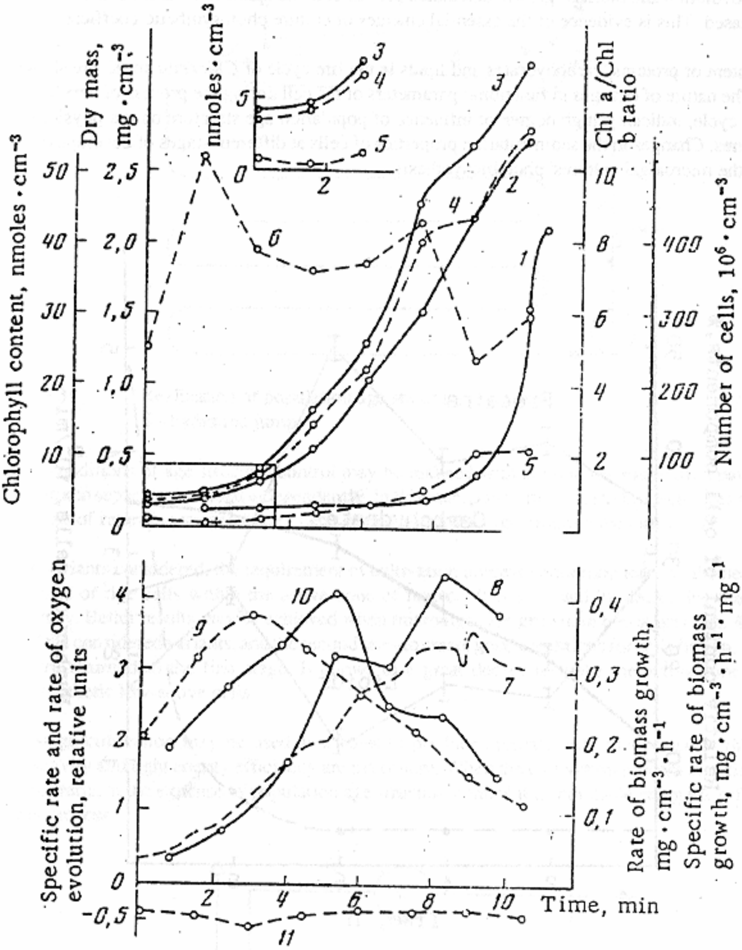

Figure 1: Changes in parameters of a synchronous culture of *Chlorella* sp. K. during ontogenesis at optimal CO_2 concentration.

1 - number of cells; 2 - cell biomass; 3 - chlorophyll content;
4 - content of Chl a; 5 - content of Chl b; 6 - ratio of content of Chl a to content of Chl b;
7 - rate of oxygen evolution ($\Delta O_2/\Delta t$); 8 - rate of biomass increase ($\Delta P/\Delta t$);
9 - specific rate of oxygen evolution ($\Delta O_2/\Delta tP$); 10 - specific rate of biomass increase ($\Delta P/\Delta tP$);
11- specific rate of respiration ($-\Delta O_2/\Delta tP$). The scale of chlorophyll content is enlarged two times on the insert.

It is especially interesting to compare the rates dynamics of oxygen evolution and biomass growth. These processes are to be done step by step with strongly pronounced points of slowing down correspponding to 1.5, 4.5, 6.0 and 7.5 hours from the beginning of the development cycle. The same interesting points have been observed by other scientists operating with different cultures [8 - 10]. Owing to the different natures of rate

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