Acclimatization of Euglena in the optimum pH for photosynthesis

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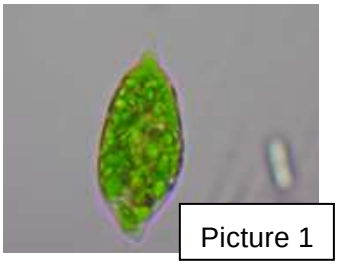
Abstract

According to the precedent research in our school, the optimum pH of Euglena for photosynthesis is around 8.0. However, Eugulena live in an environment with weak or neutral acid. In addition, some prior research show that they grow well in the environment of pH 6.5. We focused on this difference and hypothesized that they have the ability of “Acclimatization” which they change their optimum pH depending on the environment around them. As a result, we concluded that they do not have the acclimatization ability in photosynthesis but they can acclimate their optimum pH for multiplication.

1. Background・Purpose



Picture 1

Euglena is a microbe that has features of both animals and plants. They can move on their own and photosynthesize. According to some research, Euglena was proved to grow well in an environment with weak or neutral acid. However, our senior’s research about Euglena’s relationship between pH levels and photosynthesis shows Euglena’s optimum pH for photosynthesis is about pH8.0, a weak base. The purpose of our research is to explain why the optimum pH for Euglena cultured in our school to photosyntesize is about pH 8.0. For our research we used Euglena gracilis (picture 1, Euglena) which our senior had cultured.

2. Hypothesis

Our hypothesis is that Euglena has the ability of acclimatization in the optimum pH for photosynthesis. Acclimatization is the ability to adjust to the environment. In this case, we hypothesize that Euglena adjusted to the pH of the culture fluid and changed its optimum pH from neutral to 8.0.

3. Experiment Ⅰ

Procedure

① We made culture fluid (phosphoric acid buffer) of pH5.0, 6.0, 7.0, and 8.0. For each acclimatization period we cultured Euglena in the fluid for a week. .

② After a week, we added 0.5g of sodium hydrogen carbonate to 200 ml of the fluid and density of dissolving carbon dioxide is enough for Euglena to photosynthesis.

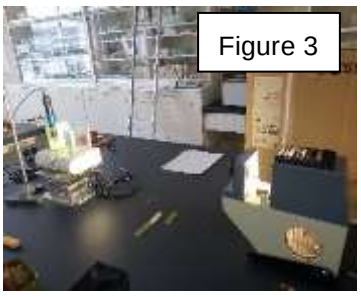


Figure 3

③ We lit each culture fluids with 6300lx incandescent lamps (Figure 3) and measured the density of dissolving oxygen (DO) in these fluids with fluorescent dissolved oxygen meter (figure 4)

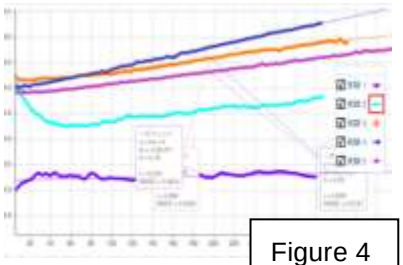


Figure 4

④ Photosynthetic speed (mg/min.)/the amount of chlorophyllWe calculated the inclination of the DO graph, which represents the photosynthetic speed.

⑤ We had to take the difference of individual density between each culture fluid into consideration. Therefore, we conducted the following operations;

(ⅰ)Measure the absorbance of each culture fluids in 590nm light

(ⅱ)Divide photosynthetic speed by the absorbance

(ⅲ)Plot the graph of revised data

Ⅱ. Results and consideration

Photosynthetic speed in pH 8.0 was higher than that in any other pH levels. (figure 5)

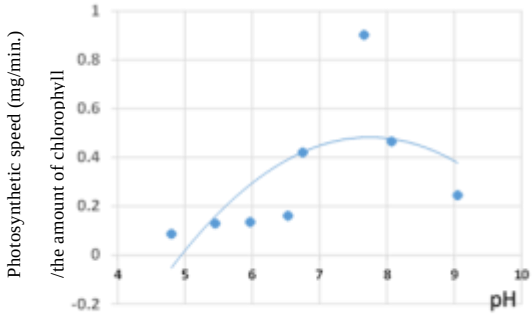


Figure 5
Relationships between pH levels and photosynthetic speed

Consideration 1

Acclimatization exists, however the value of the pH5, 6, 7 is so low that a period of acclimatization is not enough for Euglena to adjust to the pH.

Consideration 2

Acclimatization does not exist, and the optimum pH for the photosynthesis of Euglena is around pH8 as originally observed. The optimum activity pH for RubisCO is around pH 8.

Therefore, we cultured Euglena based on the considerations for a longer term and we conducted the following experiments Ⅱ and Ⅲ.

4. Experiment Ⅱ

Procedure

① We cultured Euglena in culture fluid of pH levels 6,7,8 for one week and moved them to each culture fluid of pH levels 6,7,8.(We made 9 culture fluids)

② We measured light absorbance in 390nm in order to calculate the number of Euglena per 1 liter of each culture fluid.

② We dissolved sodium hydrogen carbonate in each culture fluid to add enough carbon dioxide which Euglena needs for photosynthesis.

③ We measured pH of each culture fluid and made sure that the pH of each culture fluid is not moved by phosphoric acid buffer.

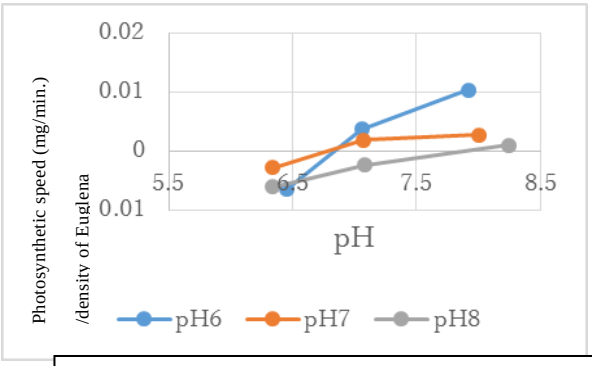
⑤ We put each culture fluid in a dark room for thirty minutes.

⑥ We irradiated each culture fluid with 6300lx light to let Euglena photosynthesize and measured changes dissolved oxygen density.

⑦ We did this experiment four times and took the average measured value.

Result

Graph 6 illustrates the experiment's results.



Graph 6
pH-dependent photosynthesis speed of long-term cultivated Euglena at each pH

5.Experiment Ⅲ

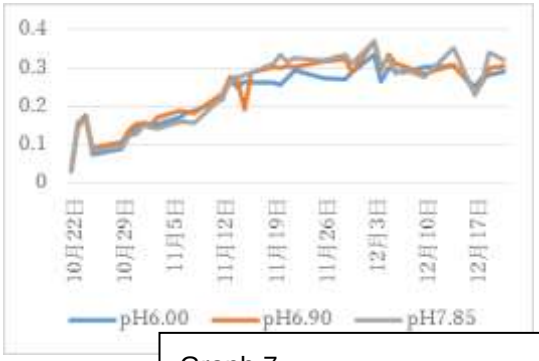
Procedure

② We cultured Euglena in culture fluid with pH levels 6,7,8.

③ We measured light absorbance in 590nm every few days and measured the changes in the number of Euglena per 1 liter.

Result

The situation of multiplication about each Euglena is the same.



Graph 7
Change of individual density overtime

6. Consideration

We conducted Experiment Ⅱ and Ⅲ in order to analyze the photosynthetic activity in terms of physiological aspects, and density in terms of survival rate.

Experiment Ⅱ suggests that, Euglena's optimum pH was observed to be around 8 despite the long term cultivation in each pH levels therefore RubisCO's optimum pH is around pH 8.0. In particular, the fact that photosynthetic rate under pH6 was the highest suggests that, as Kitaoka[2)] demonstrates , weak acid is optimum circumstance for Euglena to be cultivated. However, we weren't able to observe the acclimatization in this experiment. On the other hand, we didn't observe any difference of rate between all pH levels in Experiment Ⅲ, which can mean Euglena has the ability of acclimatization in its growth rate. Therefore, it can be said that, in nature even under pH 8 in summer due to the increase of photosynthetic rate, Euglena can maintain its multiplication rate, and that Euglena can adjust

to broad length of pH levels in terms of multiplication and have the ability of acclimatization. However the optimum pH is originally around 6, which should also be the physiologically optimum pH while the photosynthetic ability, which is influenced by the optimum pH of RubisCO is most activated around pH 8.0. This means our expectation was wrong that, in the optimum pH for photosynthesis, Euglena changed its optimum pH since our senior's research showed the optimum pH for photosynthesis of Euglena changed which was cultivated in the culture fluid of pH8.0 for long term. Therefore we conclude that Euglena has the ability of acclimatization in its multiplication but not in the optimum pH for photosynthesis.

7. Prospect

We would like to identify the reason why the graph in which Euglena which had been cultivated in pH8.0 was below the two others in Experiment Ⅱ, which can imply that the amount of RubisCO of that is smaller than the others.

8. References

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「達古武沼における植物プランクトンの季節変化と水平分布」

9. Key words

Euglena, acclimatization, optimum pH, photosynthesis