Laboratory experiments with plankton algae as a means to understand primary production

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Laboratoriumsexperimente mit Planktonalgen als ein Mittel, um die Primärproduktion zu verstehen. Editorial Note: Professor STEEMANN NIELSEN has asked that his symposium contribution be presented here only in form of an abstract since investigations, carried out after the Symposium, appeared to make it necessary to alter the last part of the paper. Further experiments have shown, however, that the originally presented theory was entirely correct. (See also text of abstract.)

If we want to obtain adequate knowledge concerning the biological behaviour of a species of plankton algae in nature by means of laboratory experiments, it is necessary to make detailed investigations. Experiments with the diatom *Skeletonema costatum* are presented. This species is able to grow abundantly during both summer and winter in Danish waters; it is even found at negative temperatures. However, the species is not found in arctic waters.

Skeletonema costatum is able to adapt to all temperatures found in Danish waters. However, if the temperature is very low, it is necessary that the day is short, thus explaining the absence of the species in the Arctic.

The growth rate of the species decreases with decreasing temperature, although the rates of photosynthesis and respiration do not change. This fact was originally explained as being due to the increase in the concentration of enzymes at lower temperatures. As the enzymes represent a substantial part of the organic matter (more or less equal to the concentration of proteins), according to this theory, more organic matter has to be produced at low temperatures in order to double the number of cells. Investigations made after the symposium seemed to indicate at first that this is not true. In a series of growth experiments at 20° C and 7° C the amount of protein per cell was practically the same. However, further experiments have now fully corroborated the original theory. An examination of the diatoms used in the first experiment has further shown that auxospore formation had taken place in the diatoms grown at 20° C but not at 7° C. The two populations could therefore not be compared.

Discussion following the paper by STEEMANN NIELSEN

WEBB: In measuring the growth of *Chlorella* do you find loss of organic material from the cell into the water, and if so, do you allow for this?

STEEMANN NIELSEN: During normal conditions the loss of organic matter is very low. By introducing poison or by giving the algae a shock by increasing the light intensity very much, considerable amounts of organic matter may be given off by the algae.

BARNES: Have you considered the possibility that the enzymes remain the same with the substrates made more readily available?

STEEMANN NIELSEN: This is a very likely possibility.

CRISP: Is the adaptation of algal cells sufficiently rapid to take place in a single generation? If many generations were necessary, selection rather than true adaptation might be taking place.

STEEMANN NIELSEN: One generation is necessary for adapting the algae to new conditions.

CRISP: Have you observed in your experiments on different photoperiods any tendency for endogenous rhythms of reproduction or photosynthesis to be developed as a result of adaptation?

STEEMANN NIELSEN: We have not investigated this question.

CRISP: Do you find light adaptation occurs in circumstances in nature where the algae are frequently carried below the euphotic zone by turbulent water movement?

STEEMANN NIELSEN: No adaptation differences between different depths are seen in nature when the water masses are not vertically stabilized.

DILLARD: Are the pigments for photosynthesis assumed to be present at all times in excess? If not, have you seen a parallel increase in chlorophyll and the enzymes of photosynthesis?

STEEMANN NIELSEN: In plankton algae the pigments are never in excess at low light intensities, but always at high light intensities.