REGULATIVE-ADAPTATION TO TEMPERATURE AND ITS INFLUENCE THROUGH LIGHT ON THE CELLULAR AUTOTROPHY *

Part II, 4. Cellular Reactions of Two Algal Strains Upon Shifts to Limit-Temperatures Under 20-Kilolux

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I. Low Temperature Reactions : *Chlorella* 211/8K.

INTRODUCTION.—The photosynthetic-"Reaction norm" in 20-Kilolux light intensity under the regulative-adaptation to temperature of two algal strains has been established (Part-I)*. In order to understand further responses to active metabolism, the so-called *high-temperature* strain *Chlorella* 211/8K. has been allowed to react at low temperature shift.

Experimental.—The selected strain prefers to grow at higher temperature (reported to be at 39° or higher up) having a tendency towards refusal of cell-division and growth at 15° in 20-Kilolux. Consequently, harvested at 25°/20 K-lux by 12/12 hours, light/dark, after 6 hours light, the cells are allowed to the shifting-reaction at 15°/20-Kilolux. The cells are synchronised *at* 25° affording a unique experimental approach towards accurate determination of the cell-substances to explain the temperature-shift mechanism.

Results.—As represented in (Fig. 1 *a*, *b*, *c*) a 30-hours' observation gives a slight increase in dry-matter and the negligible yield in cell-number by counts. Significantly, a strong production of RNA is observed but the amount of DNA remains practically unchanged. The RNA-production corresponding to the increase of total-protein in turn, is presumably synthesised at the cost of decrease in the reserve-carbohydrate, $C(H_2O)$ or the carbohydrates produced at the initial active and gradual passive photosynthetic reactions of the cells. The residual dry-matter for the increasing slight change as such may be explained from the total-$C(H_2O)$-balance so far as the present experimental evidences are in support.

Parallel to cellular analysis, the photosynthetic rate sinks down in response to the regulatory stay at 15°-shifting. The rate measured at 30°, however, shows a positive value towards photosynthetic-O_2 evolution even after 30 hours' shifting-regulation. It is therefore inferred that the effect of low-temperature reaction under sufficient light energy from 20-Kilolux, the cellular-RNA continues its synthesis correspondingly to protein level increase which in turn continues its production at the cost of cellular carbohydrate reserve showing the $C(H_2O)$-level decrease.

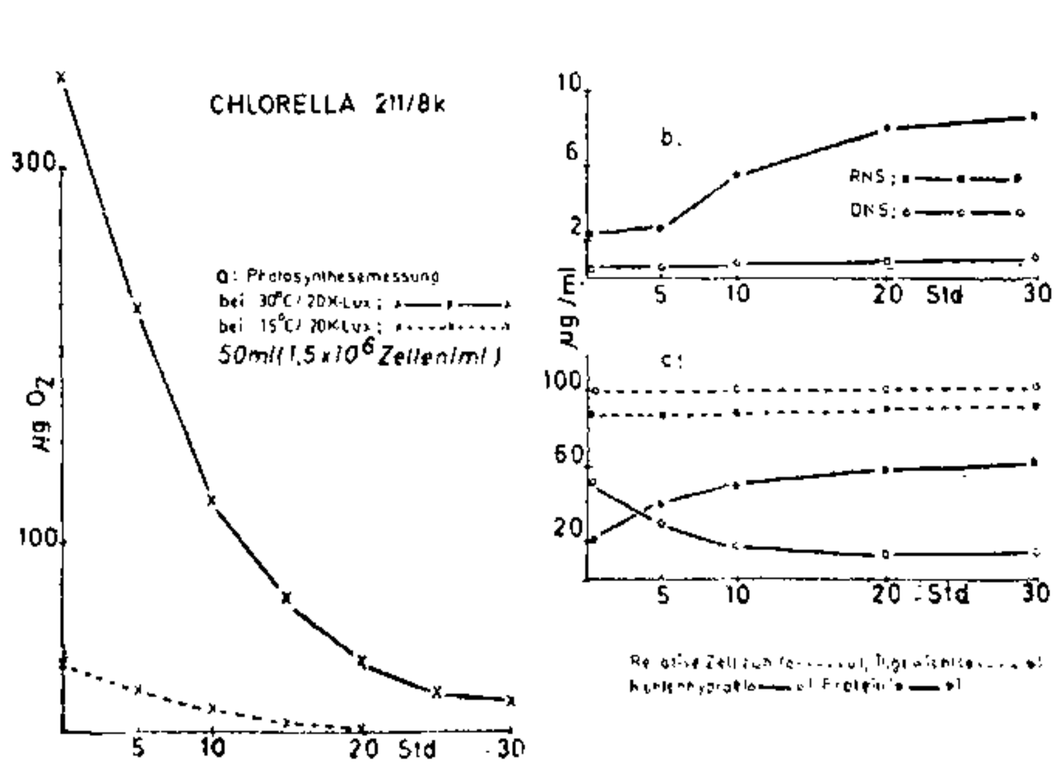

FIG. 1. *Chlorella* 211/8K Reactions to lower temperature (15°)-shifting. (*a*) Photosynthesis 50 ml. ($1{\cdot}5 \times 10^6$ cells/ml.), (*b*) RNA (RNS), DNA (DNS). (*c*) Relative cell-count (O— — —O), Dry-weight (●— — —●), Carbohydrate (O——O), and Protein ●——●. Hour (Std.).—Dr. Das.

II. Experiments with Pseudochlorella

It is a low-temperature strain selected to compare the cellular behaviour with that of the previous 211/8K-strain so that the reaction-mechanism of the cellular-dynamics can be more accurately established. A modified procedure has been followed: the cells are allowed to react first at 20/30° (72-hr.) in periodic 12/12-hours' shifts instead of light/

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dark, by continuous 20-Kilolux. This procedure regulates the arrest of cell-division for the low-temperature strain at lower temperature but allows only at 30°/20 K-lux. The cells are then set to the shifting regulation at 10°/20 K-lux.

Results.—Fig. 2 *a*, *b*, *c* represents similar behaviour of the cellular constituents in establishing the mechanism.

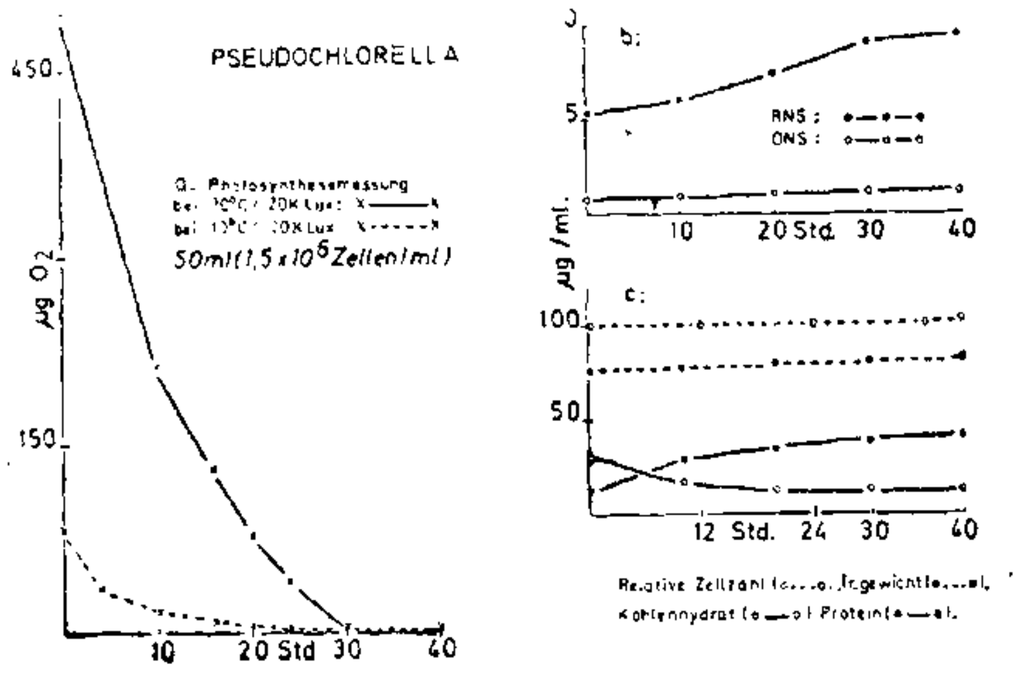

FIG. 2. *Pseudochlorella* (*a*), (*b*) and (*c*) : descriptions same as in Fig. 1 and also text.

III. Shifting-Reactions at Higher Temperature

The strain *Pseudochlorella* offers itself on genetical ground to respond to the higher temperature regulations. It is not easy to control the strain-211/8K at higher-temperature for analytical purposes. Therefore, *Pseudochlorella* has been selected to show more clearly the cellular reactions with regard to upper level of temperature shift. The results have been represented in (Fig. 3 *a*, *b*) to direct that the increase in cell-count at 25°/20 K-lux, is optimum. The cells are raised from solid agar-mineral medium at room-temperature (18–22°) and allowed to react for 30 hours in standard liquid mineral media. At 30° it is clearly observed that a strong depreciation towards increase in cell-number is counted. Negligible count increase is observed at 15° and at 10° complete arrest in cell-division by 20 K-lux, can be observed.

It is to be noted here that, upper-temperature shift brings about the nucleic acids-level *not* similar to that at the lower-temperature shift for *Pseudochlorella* under 20 K-lux. The difference is surely considerable to observe that at 25° the synthesis of DNA and RNA is co-ordinated. Although a slight increase in DNA-content at 30° can be seen, a strong decrease in RNA-amount follows like a pattern of *middle-hill decline* of total-RNA and consequent to it is also the arrest of cell-division at this upper-temperature of cellular regulatory mechanism.

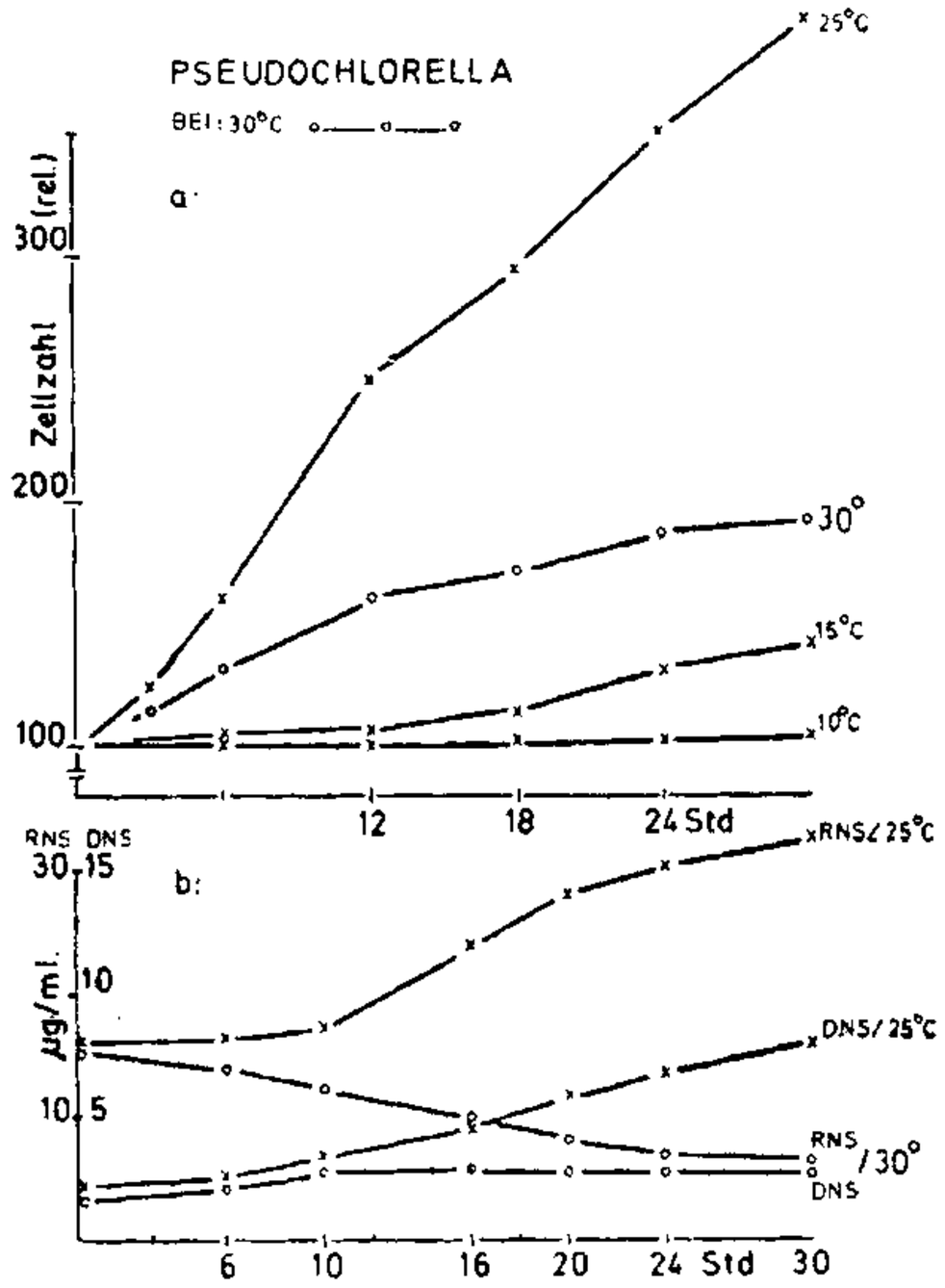

FIG. 3. *Pseudochlorella* at 30° (O——O——O) (*a*) Shifting to (30°) higher temperature. To compare (×) at 10, 15 & 25°. (*b*) RNA (RNS), DNA (DNS). 25° (×), 30° (°). Cell-counts (Zellzahl rel.), Hour (Std.).—Dr. Das.

IV. Concluding Remarks

It has been communicated by Johnson and James (1960) that there is an increase of cell-volume without any change in dry-matters when the cells of *Chilomonas paramœcium* are incubated at lower temperature-shift, the increase of volume has been shown only due to accumulation of water. The present observations on the two algal-strains communicate that RNA-accumulation in the cell allows to volume increase where the total dry-matters may remain practically unchanged due to the effect of lower temperature shift. The photosynthetic carbohydrates in reserve, as synthesised from the saturated light energy supplied at lower temperature-shift induces protein-synthesis in stimulation to RNA-increase over DNA,—it certainly follows at the

cost of total-carbohydrate conversion to protein in *Pseudochlorella* under the cellular volume-increase process. *Chlorella* 211/8K. gives more doubtless experimental support on this shift-reaction at low temperature by virtue of the authoritative responses vested upon the strain in fuller details.

Contrasting at *the upper* temperature-shift, a weak synthesis of DNA without cell-division is observed. The accompanying nuclear-mitosis is evidenced by Feulgen-nuclear reactions (-communicated elsewhere) showing many colour-centres per cell, which are yet seldom observed at *the lower* temperature-shift. The block of cell-division under such nuclear-mitotic condition may therefore be explained that at higher temperature the process stands not only on the sufficient DNA-production, but upon another factor that lowers RNA-level associated with plasma-divisions also. Gross and Jahn (1962), however, have given an hypothesis on the possibility of the formation of some thermo-stable or, under certain condition, thermo-labile proteins responsible for *Chlamydomonas*-reactions to thermal-stresses.

But, based upon the major photosynthetic process of the autotropic cells, subsequent experiments with promoter substances as co-factors or co-substrates (-communicated elsewhere) have developed the present idea on the nucleic acids-level of the cellular metabolism to give satisfactory explanation to this modern issue on the regulatory temperature reactions.

1. Johnson. B. F. and James, T., *Expt. Cell Res.*, 1960, **20**, 66.
2. Gross, J. A. and Jahn, T. L., *J. Protozoo.*, 1962, **9**, 340.

USE OF RADON MEASUREMENTS TO DETERMINE SOURCE OF THE SOUTH-WEST MONSOON CURRENT OVER THE ARABIAN SEA

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RAMA[1] has suggested that radon (half-life 91 hours) measurements over the Arabian Sea can be used to determine whether the south-west monsoon current is primarily of northern hemisphere origin—from north-east Africa and Arabia or of southern hemisphere origin—south-east trades which have crossed the equator. The basis of this suggestion is that the air from across the equator would be poor in radon, while the air from north-east Africa and Arabia would be rich in radon. In a paper on "Radon in monsoon current" Rama[2] presented results of radon measurements at the deck-level of ships and showed that in the region of the south-east trades, the radon concentration ranged between 2 and 4 dpm/m^3, while that over the Arabian Sea was often ten times as much. The following questions are relevant regarding Rama's suggestion :

(*a*) Is the air mass over the Arabian Sea not adulterated ?

During the monsoon months (*i*) there is presence in the surface layers of a belt of moderate to strong south-westerly winds 200–500 km. wide off the Somalia-Arabian coast between about 6° and 18° N and (*ii*) a trough of low pressure extends from inland Somalia across south-east Arabia to the main heat—low over West Pakistan. The International Indian Ocean Expedition (IIOE) results have shown that the south-westerly to westerly air over the Arabian Sea is moist and has unstable lapse upto about 1·0 to 1·5 km. and that there is above it drier air with nearly dry adiabatic lapse on some occasions with an inversion between the two air masses and less moist air with nearly saturation adiabatic lapse and with or without an inversion between the two air masses on other occasions.[3,4] To the west of the axis of the trough there will be relatively dry continental air with high radon concentration ; to the east of the axis the drier radon-rich continental air would be drawn along with the south-westerly to westerly moist air with relatively much less radon or which is poor in radon.