drop at a time. Still another source of error—and the main reason why these comparison tests are so useful to any one of the blood-group workers—is the limited choice of animals and especially breeds, which is available to most of the workers for production and standardization of reagents.

These results indicate the accuracy with which blood types are regularly determined in cattle when the tests are made by experienced persons. They also indicate that these trials are helpful in solving the problems of standardization. Comparison of new reagents, developed independently in different laboratories, often indicates that some are detecting the same antigenic factor and leads to an agreement on nomenclature. The trials will be continued on an annual basis.

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2. Thanks are due to the following blood-group workers and their associates who have participated in this program and contributed to its success: J. Bouw, Holland; M. Braend, Norway; R. J. Humble, Canada; E. J. Lazear, Ohio; Miss C. Lindstrom, Finland; D. R. Osterhoff, South Africa; J. Moustgaard and A. Neimann-Sørensen, Denmark; J. Rendel, Sweden; A. Meyn and D. Schmid, Munich; W. H. Stone and M. R. Irwin, Wisconsin; C. Stormont and W. J. Miller, California; C. P. Stroble, Wyoming; E. Mitscherlich and A. Tolle, Göttingen, Germany.
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Some Characteristics of a Thermophilic Blue-Green Alga

Abstract. An alga identified as *Synechococcus lividus* has an exponential growth rate of nine doublings per day at 52°C with illumination of 1500 foot-candles. It uses nitrate or urea as a nitrogen source and does not use acetate or glucose. It seems a promising organism for atmospheric regeneration in sealed cabins.

Photosynthesis by algae is one of the most promising methods for atmospheric regeneration in sealed space cabins. In order for such a system to be practical, the algae used must be capable of achieving high growth and photosynthetic rates. We wish to present some data on a thermophilic blue-green alga that appears to have value in this respect.

The organism was originally obtained by the USAF School of Aviation Medicine in a collection of mixed specimens from the hot springs in Yellowstone National Park. It was received in our laboratory in a mixed culture of algae and bacteria and was isolated in unialgal culture by serial transfer in liquid cultures maintained at a temperature between 50° and 55°C. The cells are about 1.4 μ in diameter and 4 to 9 μ long, the most common length being about 6 μ. They are straight or slightly curved. Some occur in pairs joined at the ends. Polar granules are occasionally observed. From the description given by Copeland (see *1*) this species has been tentatively identified as *Synechococcus lividus*.

A nitrate medium described by Gafford and Craft (*2*) gives good growth and was used for all experiments reported here. Best growth occurs when the *p*H of the medium is adjusted to about 7.5. We have recently found that a urea medium (*3*) recommended for the culture of the thermophilic strain of *Chlorella pyrenoidosa* will also provide maximum growth at *p*H 7. There is no growth in the dark when acetate or glucose is provided as the carbon source.

Growth was measured by determining the optical density of the suspension at 500 mμ with a Beckmann model DU spectrophotometer, using 1-cm cells. Agreement between optical density and packed cell volume was best when the suspension was diluted to keep the measured optical density below 0.25. Thus the measurements were all made in much the same density range. The measured density was multiplied by the dilution factor to express the cell concentration of the culture.

Cultures of 100 ml were grown in test tubes suspended in thermostatted water baths. The bath containers were glass jars 12 in. in diameter, each supported over a grid of ten 15-watt fluorescent lamps. The bottoms of the tubes were about 12 cm above the lamps. Carbon dioxide was provided by bubbling 2 percent carbon dioxide through small polyethylene tubes. We have estimated the effective light intensity, by measurements with a Weston model 614 footcandle meter, to be about 400 ft-ca. Other cultures were grown in the same tubes at higher light intensity. These tubes were placed in a narrow water bath sandwiched between two vertical panels, each of which held eight 107-watt Powergroove fluorescent lamps. Here the effective light intensity is about 1500 ft-ca.

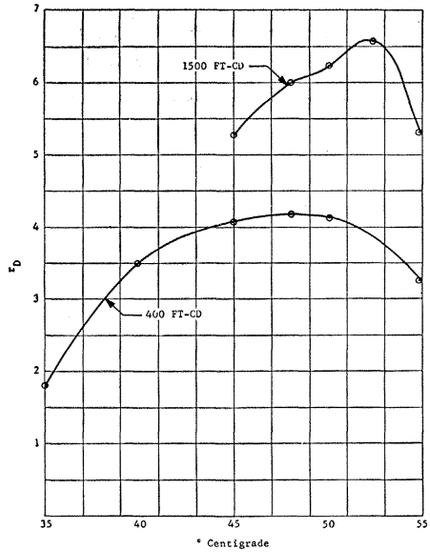

Fig. 1. Growth rate of *S. lividus* in doublings per day (r_D) with respect to temperature at 400 and 1500 ft-ca illumination.

Figure 1 shows the growth rate at various temperatures for both light intensities. The general shape of the curves is rather similar to those shown for *Chlorella pyrenoidosa* TX 71105 (*4*). With the higher intensity light the cells did not tolerate temperatures below 40°C as well as with less light. The optimum temperature is higher with more light. Growth occurs even at 60°C, but at a lower rate.

The curves of Fig. 1 were determined by measuring growth over periods of 21 to 23 hours. Since it appeared that the cultures were light-limited at the end of that time, we measured density at shorter intervals. Exponential growth rates determined in this manner fell in the range of 6 to 7 doublings per day at 400 ft-ca and 8 to 9 doublings per day at 1500 ft-ca for periods of 7 hours or more. The shift to linear growth occurred after 12 to 14 hours. At this time the calculated cell density is 0.4 and 1.8 ml of cells per liter at low and high intensity light. Thereafter growth continued at about 0.09 and 0.3 ml of cells per liter per hour. As expected, the linear growth rates are in approximately the same ratio as the light intensities.

We find this alga of particular inter-

est for atmospheric regeneration systems. It has practically no tendency to cause foaming or to stick to the surface of culture vessels, even in old or mismanaged cultures. The higher culture temperature results in more efficient cooling systems, while discouraging fungal and bacterial contamination (*5*).

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5. We wish to acknowledge, with gratitude, the technical assistance of Patricia Korty and Seymour Wildman.

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Localization Effects with Steady Thermal Noise in One Ear and Pulsed Thermal Noise in the Other

Abstract. When the duration or repetition rate of pulses in the left ear is increased, while steady, in-phase, thermal noise sounds in the right ear, the pulses are heard to move toward the median plane. At still longer durations (for a given repetition rate) the loudness of noise on the right diminishes, until finally all sound is localized at the median plane.

In these experiments thermal noise was led through a mixing circuit such that part went through an electronic switch and interval timer (Grason-Stadler) to the left ear, and the other part went to the right ear. Thus pulses were presented to the left ear, and steady, in-phase noise to the right ear. Over-all presentation time of stimuli to both ears for a given judgment was set at 10 sec by a Hunter interval timer. Signals in each channel went through an attenuator and transformer before arriving at the earphone (Telephonic TDH-39).

Perception corresponding to left ear pulses. The left ear attenuator was set at 40 db above threshold for each subject. (Thresholds were obtained for 200 msec, 1 per sec bursts of noise.) The right ear attenuator was then set to give voltage into the right phone equal to that in the left phone. Repetition rates of pulses used were 1.4, 4.7, 13.9, 58.8, and 105.3 per second. For a given pulse repetition rate, the duration of the pulse could be increased until the subject heard the pulses at the median plane. (The median plane is defined as the plane passing between the cerebral hemispheres.) Thresholds for such centering were obtained by the Method of Limits, using four crossings.

Figure 1, curve *A*, shows data (medians) for the ten subjects used. The duration required to center the pulses decreases as pulse repetition rate is raised. Individual differences in required duration are more marked at low pulse rates, but all subjects tended to require increasingly smaller durations with increasing repetition rates. (A Friedman rank order test shows significance beyond the .001 level.)

The greatest interaction occurs when the noise in the two ears is in phase (perfectly correlated); for in another experiment with an additional ten subjects, we found that reversing the phase of noise coming to the two ears significantly raised the duration required to center the pulses. It should be noted that Pollack (*1*) did not obtain significant localization effects by using partially correlated noise.

The present results can be said to show summation effects, since increasing pulse duration increases center localization effects. Tobias and Schubert (*2*) also found summation effects in overcoming an initial binaural transient disparity. They suggest that the power of the initial transient disparity on localization may be related to neural onset responses. It is possible that in the present experiment the localization "power" of the neural onset response in the left ear must be overcome by increasing pulse duration and thus increasing duration of interaction with the right ear stimulus.

Right ear perception. The duration of the *gap* in the left ear noise was increased until the subject could first detect noise at the right ear position. Thresholds for this detection were determined by the Method of Limits, with four crossings. Half of the subjects obtained these thresholds before those described previously. Order of conditions, as in the preceding experiment, was determined for each subject from a set of randomly drawn numbers.

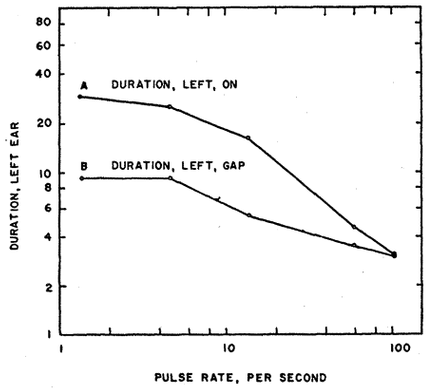

Fig. 1. (Curve *A*) Median duration (left ear) required by subjects to center the pulses, decreasing as the pulse repetition rate is raised. (Curve *B*) Median duration of gap (left ear) required by subjects for the detection of noise in the right ear, decreasing as the pulse repetition rate is raised.

Figure 1, curve *B*, shows that the median duration of gap required for the detection of noise in the right ear falls for the higher repetition rates used. (A Friedman rank test shows significance beyond the .001 level.)

Our tentative interpretation of these results is as follows: Conduction through the neural channel corresponding to right ear localization perception is suppressed when the stimulation occurs in the left ear. When the left ear stimulus ceases, nerve impulses can pass through this channel; but beyond this point is a summation process, because of which detection depends on repetition rate and duration.

Questioning of the subjects revealed that the right-ear signal was heard to increase in *loudness* as gap duration was increased. Furthermore, at low repetition rates (1.4 and 4.7), the right-ear signal was heard typically as pulsing; at higher rates the signal heard at the right ear location was heard as *continuous*. These latter continuity effects (see *3*) may occur over such long periods of time because of the facilitating effect of the continuous input to the right ear. A possible mechanism might be an additional neural "facilitation" circuit from a region prior to a localization gating mechanism to a region beyond (*4*).

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