THE UNIVERSITY OF TEXAS
AUSTIN 12

DEPARTMENT OF ZOOLOGY

February 8, 1951

Huntington Hotel
Pasadena

Dr. Leo Szilard
Institute of Radiobiology and Biophysics
University of Chicago
Chicago, Illinois

Dear Dr. Szilard:

We are very much interested in your development of the Chemostat. May I have reprints of your description of the apparatus in Science and the subsequent paper on its use in the Proceedings of the National Academy of Science. May I also make some comments on the comparative operation of your instrument and our continuous-culture apparatus.

Our two instruments appear to have inherent stability under two different kinds of conditions, each of usefulness for physiological work. Our continuous-culture apparatus is inherently stable under conditions in which a microorganism is growing freely with no limitation imposed in the diluting culture medium. Dilution is geared automatically to the rate of growth. On the other hand, this apparatus is unstable when there is a nutrient deficiency in the culture medium. Then the organisms remove the limiting nutrient until it is completely absent in the culture where upon growth gradually comes to a halt and the culture ceases to continuously dilute itself.

In contrast, your system in the Chemostat is inherently unstable unless some factor in the media is, or may become, limiting for rate of growth. Unless rate of growth and rate of dilution are perfectly matched this system will either continually dilute the culture to infinite dilution or continuously concentrate the culture until some factor perhaps does become limiting from the medium. However, if there is a limitation imposed by the medium, then your system becomes inherently stable since rate of growth is now forced to adjust itself to rate of dilution.

In other words, your system operates by allowing rate of growth to adjust itself to rate of dilution; while in our system we adjust rate of dilution to rate of growth. Very likely this comparison has already suggested itself to you. To me the principle illustrating by the opposing direction of the controls is particularly interesting. I feel pretty silly in not having thought of your arrangement before as an outgrowth of our own device. Your arrangement should prove

particularly useful in a number of our deficiency problems in algal physiology.

My congratulations on your invention of an exceedingly useful device.

Sincerely yours

Jack Myers

Jack Myers
Professor of Zoology

JM:lr

1155 East 57th Street
Chicago 37, Illinois
February 13, 1951

Dr. Jack Myers
Department of Zoology
The University of Texas
Austin 12, Texas

Dear Dr. Myers:

Many thanks for your very interesting letter of February 8. Enclosed you will find the reprints for which you asked. They are advance prints made by the Institute for the convenience of its sponsors; the regular reprints are not yet in our possession.

I wonder if you could let me have a spare copy of your paper describing the continuous-culture apparatus to which your letter refers or else if you could let me have the exact reference.

I would also much appreciate your letting me have reprints of your other papers relating to studies of the growth-requirements of algal cultures.

We have just moved to our new building and we plan to set up one or two Chemostats growing chlorella and play around with nutritional studies for a little while. In the meantime we have developed another model of the Chemostat more adapted for use in experiments where the flow rate w of the nutrient is very low (such as would be the case for small-scale experiments on the growth of alga cultures) and this new model has completely replaced in our laboratory the one described in Science. I expect to have a description of the new model ready before the end of next month, and shall then send you a copy of the manuscript.

Our main interest will remain for the time being with bacteria and bacterial viruses.

I wish to thank you for the kind words which you had in your letter about our device.

Sincerely yours,

Leo Szilard

wv

CARNEGIE INSTITUTION OF WASHINGTON
DEPARTMENT DIVISION OF PLANT BIOLOGY

P. O. ADDRESS:
CARNEGIE INSTITUTION OF WASHINGTON
STANFORD, CALIFORNIA

July 12, 1951

Dr. Leo Szilard
Institute of Radiobiology and Biophysics
The University of Chicago
Chicago, Ill.

Dear Dr. Szilard:

In planning a set-up of a chemostat arrangement for Chlorella here I am faced with the following difficulty. The maximum growth rate of Chlorella of $\alpha = 1.96$ per day at 25^0 corresponds to an increase of about 8% per hour. For a growth tube of V=100 ml. there will be required a flow rate, w, of 1 to 8 ml./hour.

Dr. L. O. Morgan, who has been working on development of a chemostat in our program at the University of Texas, tells me that he has had difficulty in achieving constancy of such flow rates with the constant-pressure device described in your original paper in Science. I am, therefore, looking for a better metering device for these very low flow rates. I have one advantage in that for many kinds of experiments aseptic technique does not have to be maintained.

It occurs to me that you already may have met and solved this problem. I should greatly appreciate your advice.

It would be helpful also to have reprints of your work on the chemostat for reference in our work here.

Sincerely yours,

Jack Myers

Jack Myers

July 23, 1951

Dr. Jack Myers
Department of Plant Biology
Carnegie Institution of Washington
Stanford, California

Dear Dr. Myers:

Your letter of July 12th has been forwarded to me to Denver. The chemostat arrangement which we have been using during the past year should work satisfactorily under the conditions which you describe. You will find a description of this gadget in a manuscript which I enclose. This paper is in print and will appear in the Cold Spring Harbor Symposium.

If you drop a line to Dr. Novick in Chicago, he could let you know where we buy the valves which we found to be satisfactory over several months' operation.

The device described in the manuscript is the only one which we are using nowadays, and we have about 18 of them, though we rarely run more than 12 at any one time. It requires practically no supervision and the flow rate is constant.

Sincerely yours,

Leo Szilard

LS:hw

P.S. I might visit California rather soon, though perhaps not before October, and I am wondering whether you will be there, in which case, I should like to drop in, if I may at the Stanford Laboratory

CARNEGIE INSTITUTION OF WASHINGTON
DEPARTMENT DIVISION OF PLANT BIOLOGY

P. O. ADDRESS:
CARNEGIE INSTITUTION OF WASHINGTON
STANFORD, CALIFORNIA

August 1, 1951

Dr. Leo Szilard
Dept. of Biophysics
University of Colorado Medical Center
Denver 7, Colo.

DearDr. Szilard:

Thank you for your letter of July 23 and the enclosed reprints.

I have set up several chemostat devices based on your original design. We are studying growth of algae and I have the following thought in mind. Even when the medium is complete, illumination becomes growth limiting for an algal culture diluted at a washing-out time of less than its maximum growth rate. In sunlight, or at very high densities of population, it is difficult to use photometric control of our original apparatus. In that system one varied some external condition and determined the growth rate, holding the density constant. With your chemostat arrangement I am reversing the procedure, i.e., fixing the growth rate by the rate of dilution and determining the density in the steady state for a given illumination.

I shall not be here later than about September 1, but I know that Dr. C. S. French and the group here would welcome a visit from you at any time.

Sincerely yours,

Jack Myers

Jack Myers