THE GROWTH PHASE IN NEUROSPORA CORRESPONDING TO THE LOGARITHMIC PHASE IN UNICELLULAR ORGANISMS

STERLING EMERSON

Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena, California

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In such organisms as yeast, bacteria, and unicellular algae and protozoa, the logarithmic phase of growth serves to indicate that none of the conditions essential to growth have been significantly altered during that period. Throughout the logarithmic phase of growth, the time elapsing from one cell generation to the next remains constant, and the number of cells doubles in each generation. A falling off in growth rate may indicate the exhaustion of a substrate or the accumulation of inhibitory products.

The structural basis for growth is very different in freely branching filamentous organisms such as the ascomycetous fungus *Neurospora*. In such forms growth is restricted to the tips of the branches (hyphae), and the bulk of the tissue formed does not continue to grow (Smith, 1923).

Growth in the length of individual branches soon develops a constant rate (cf. Smith, 1924). In growth tubes that restrict growth to a single direction, the mycelial frontier progresses along the surface of the agar at a constant rate once this rate has been attained (Ryan, Beadle, and Tatum, 1943). In petri dish cultures, in which growth is confined to a plane rather than a straight line, circular colonies result that increase in size by growth at their circumferences. The radii of such colonies increase at a constant rate over a considerable period (Fawcett, 1921); hence the square roots of their areas increase linearly with time.

In liquid culture, on the other hand, the direction of growth is not at all confined. The form of the growth may be thought of as a sphere that grows only at its surface. As long as conditions supporting unlimited growth are maintained, it would be expected that the radii of these "spheres" should increase at a constant rate, and consequently the cube roots of their volumes (mass) should increase linearly with time.

Increase in dry weight with time is plotted in figure 1 on three scales, linear, logarithmic, and cube root. The data are from cultures of wild type *Neurospora crassa* (strain E-5256) grown in sucrose-minimal medium at 25 C. The volume of culture medium was 20 ml in each culture. Three sizes of flasks (50, 125, and 500 ml) giving relative surface areas of 1:2:4 were used to vary the availability of oxygen. The linear plots show increasing growth with time throughout most of the period studied. In the logarithmic plots, fits to straight lines are approximated only in the earliest stages of growth, not persisting beyond 4 to 8 mg dry weight. In the cube root plots, on the other hand, straight lines are approximated over a much longer period, until 20 to 50 mg dry weight of mycelium has been

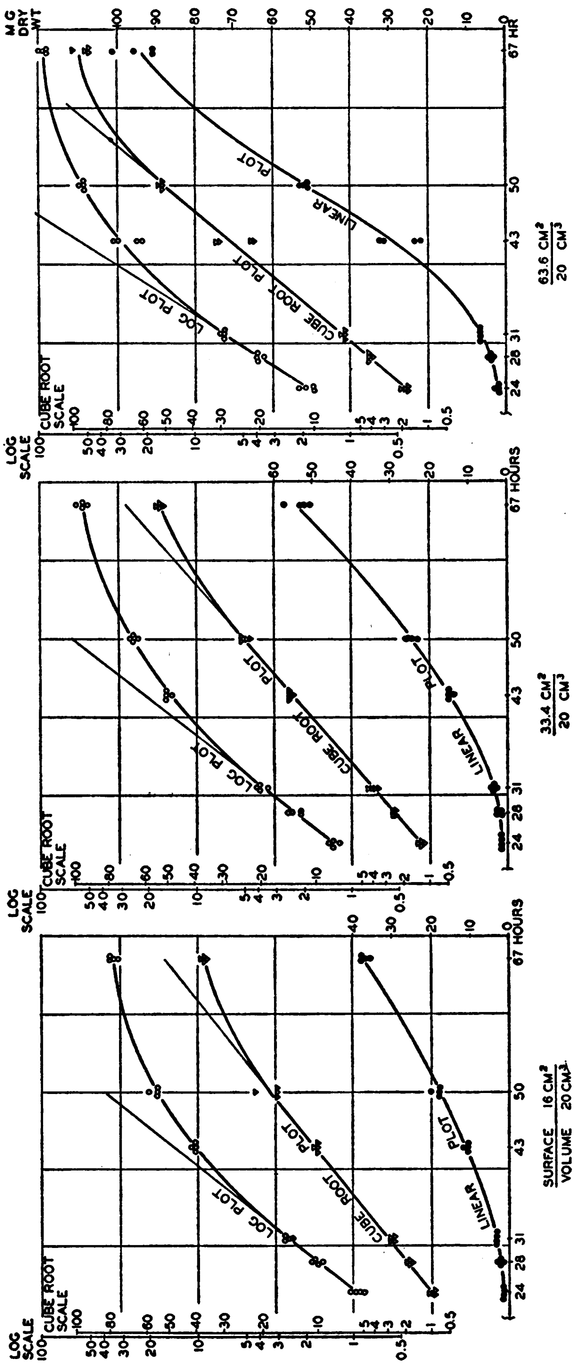

Figure 1. Plots of increase in dry weight with time.

produced. Data from a large number of other experiments show the same relationship to the three methods of plotting.

It appears, then, that there is a "cube root" phase in the growth of *Neurospora* in liquid culture that corresponds to the logarithmic phase in the growth of unicellular organisms. As long as the cube root of the mass of a culture increases at a constant rate, conditions favoring unlimited growth may be assumed to prevail. The same conclusions presumably hold for other organisms of similar growth habit.

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