important respect the major theoretical features of both weight and metabolism curves of human fasting subjects upon which we have laid special emphasis in this and in the succeeding paper. The experiments show clearly (1) that oversized rats also pass into a period of almost purely logarithmic loss in weight (optimal stage where $\left(\frac{dq}{dt}\right) = \text{constant}$; (2) that basal metabolism in terms of Cal./Kg./Day recedes *below* the equilibrium level and remains *constant* during this phase; and (3) as we must expect from equation (7) a subsequent *increase* in U when $\left(\frac{dq}{dt}\right)$ rises at a later stage of the process, in virtue of the absence of the original source of energy S in equation (1).[6] The latter increase in the velocity of starvation will be discussed more extensively in another paper;[7] but, the rise of basal heat production, U, under such conditions is a direct outcome of the energetics of metabolism set forth in equation (7).

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On the Motion of Growth. V. Rate of Loss in Weight for Minimum Metabolism.

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From theoretical considerations in conjunction with data on heat production during prolonged fasting it has been shown[1] that the optimal relative rate of starvation at which a human individual would conserve his body reserves to the utmost ought to be closely in the neighborhood of 0.0064 Kg./Kg./Day. It is now proposed to examine this result in the light of several observations on the point.

By far the most accurate of the data at hand are those reported by Benedict,[2] but in Figure 1 we have also included the curves of Succi for several fasts, as well as that for Beauté. The ordinates are in $\log_{10}$ (Weight) $= .4343q$, the abscissae in days. There is,

[6] Wetzel, N. C., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 224.

[7] Wetzel, N. C., to be published.

[1] Wetzel, N. C., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 354.

[2] Benedict, F. G., A Study of Prolonged Fasting, Carnegie Institution Publication No. 203, Washington, 1915.

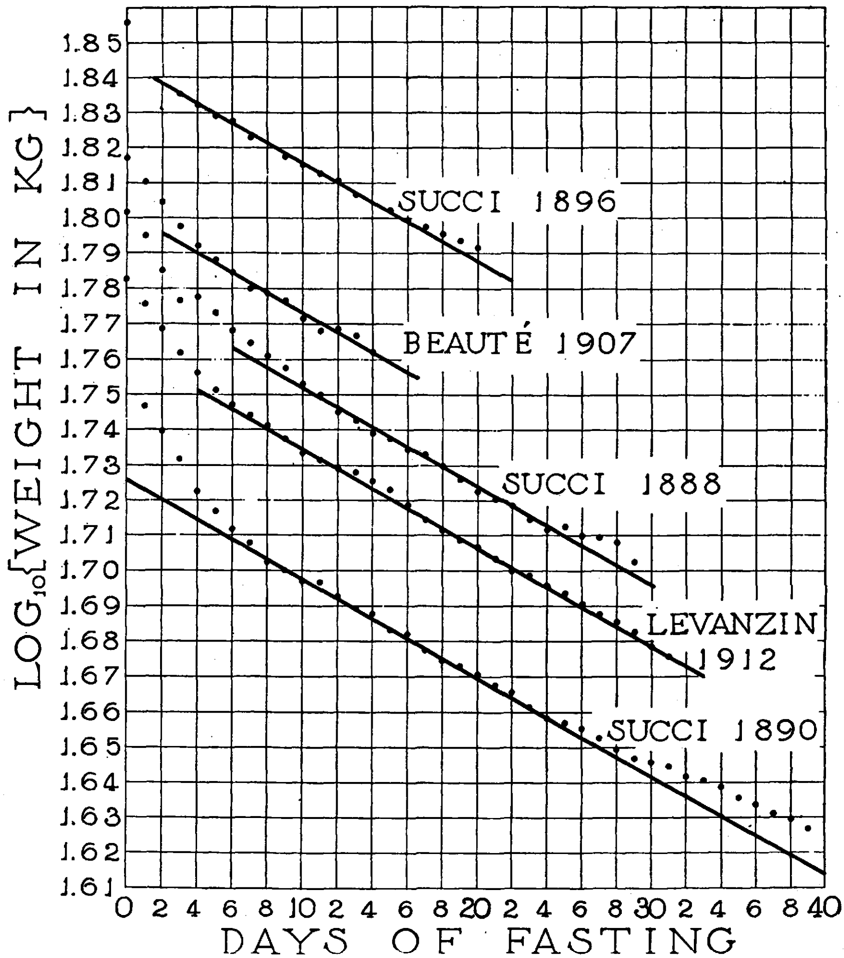

FIG. 1.

The parallel lines drawn through the several sets of observations indicate the expected slope of 0.0064 Kg./Kg./Day during the apparently linear phase of loss in weight.

here, a striking similarity not only in the almost identical shape of these curves, but also in their slope, especially after the 4th or 5th day of fasting. This slope appears so decidedly linear that purely graphical analysis could hardly detect any significant curvature. We shall call this the "apparently linear" phase.

Taking the data on Levanzin by Benedict for each day from the 8th to the 30th inclusively and analyzing this apparently linear phase by least squares, we find that the slope is 0.00645 Kg./Kg./Day, a numerical result completely confirming that given above and already reached by an independent method previously described.[1]

Straight lines have also been drawn through the other examples and indicate the expected slope, 0.0064. These likewise pass excellently through their respective points in every case, notwithstanding the diverse conditions and times of observation.

But, even though the foregoing value for an "optimal" rate of starvation is actually witnessed in practice—we must avoid the conclusion that starvation would necessarily continue indefinitely in this way. Indeed, as it will appear in a subsequent paper, the "linear" phase in such experiments discloses merely a temporary, though an admirably close approach to what are fundamentally "ideal" conditions of starvation for the individual subject and for the kinetic system his organism represents. The true nature of the starvation curve is decidedly more complex, and will be described elsewhere.

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On the Motion of Growth. VI. Energetics of Bacterial Growth and Heat Production.

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In several previous communications[1-5] we have outlined a concept in which the phenomena of growth and metabolism are viewed as separate forms of a single underlying mode of motion. A scaffolding is thus provided by which each of these major processes may be studied more directively. But our descriptions up to this point have been restricted to the special case of human growth and metabolism, and it is therefore proposed, since the methods and the theory are sufficiently general, to consider an example of the cognate phenomena in a population of unicellular organisms. In order, however, to apply the present theory, it is essential that we possess simultaneous information upon the two chief processes in action, namely, growth and coincidental heat production. Such data, for our purposes, need to be more than ordinarily accurate, else analysis is labor in vain. Considering the difficulties at hand, there is small wonder that suitable observations are few; indeed, in the bacteriological field there are no data which are more worthy of attention and study than those reported within the past few years by

1-5 Wetzel, N. C., PROC. SOC. EXP. BIOL. AND MED., 1932, **30**, 224, 227, 233, 354, 358.