opinion which has ever been expressed upon any activity of the survey.

The repercussions of the control policies of the survey are many and varied. The mouse plague of Kern County, California, 1926–7, has been attributed, with reason, to the poisoning of predatory mammals, a natural control over the numbers of mice. The fur trade is concerned over the fur-bearers needlessly killed by survey poison squads. A strong argument against extermination or near-extermination campaigns can be advanced on esthetic grounds for surely a young, faunally rich country like the United States does not wish the great open spaces swept clear of all wild life in order to make the West a sheep man's paradise. The American public should love its wild life and want it preserved in its original entirety as far as is reasonably possible.

But unless nature lovers throughout the length and breadth of the country assert themselves and demand a pause in this organized slaughter, the Biological Survey will continue to develop the technique of destruction and to expand along the lines which have proved to be such a bureaucratic success. The survey is subjected to great pressure by the forces working for specialized control; it is placed in an exceedingly awkward position. The conservationists must exert an even greater pressure against the control policies of the survey in order to accomplish any useful end. For awkward as is the plight of the survey, the lot of our wild life is even more precarious.

H. E. ANTHONY

AMERICAN MUSEUM OF NATURAL HISTORY

FITTING THE CURVE OF THE DIMINISHING INCREMENT TO FEED CONSUMPTION-LIVE WEIGHT GROWTH CURVES

IN a recent paper,[1] Hendricks, Jull and Titus suggested a method of interpreting the results of feeding experiments by means of the curve of the diminishing increment. The senior author felt that the method might be more useful to workers in animal nutrition if the curve of the diminishing increment could be accurately fitted by some rapid method.

The most rapid method of determining the constants in the equation:

$$W = A - Be^{-kF} \qquad (1)$$

proposed up to the present time, is, perhaps, the method of arithlog plotting used by Brody.[2] However, it has been the experience of investigators at the U. S. Animal Husbandry Experiment Farm, Beltsville, Md., that, in many instances, it is difficult to judge accurately which value of the constant, A, makes the values of log $(A - W)$ lie most nearly along a straight line, when plotted against the corresponding values of F as abscissae.

The writer has tried a method of approximating the values of the constants which appears to give much more accurate results than the method of arithlog plotting.

The differential form of equation (1) may be written:

$$\frac{dW}{dF} = C - mW \qquad (2)$$

in which, $C = kA$, and, $m = k$. If finite increments are substituted for the infinitesimals of the Calculus, equation (2) becomes:

$$\frac{\triangle W}{\triangle F} = C - mW \qquad (3)$$

in which the ratio, $\frac{\triangle W}{\triangle F}$, represents the gain in live weight, per unit feed eaten, over a short interval of time, and W represents the average live weight of the animal during that interval of time, calculated by taking one half of the sum of the live weights at the beginning and at the end of the interval.

The values of the ratio, $\frac{\triangle W}{\triangle F}$, for consecutive intervals of time, lie along a straight line, when plotted against the corresponding values of W as abscissae. A simple linear equation of the form, $Y = aX + b$, may be easily fitted to such a set of data by the method of least squares.

It is readily apparent that the slope of the fitted straight line is $-m$. The intercept of the line on the axis of ordinates is C, since when $W = 0$, $\frac{\triangle W}{\triangle F} = C$. The intercept of the line on the axis of abscissae gives the mature weight of the animal, since when $\frac{\triangle W}{\triangle F} = 0$, $mW = C$, and $W = \frac{C}{m}$, or A. The value of the constant, B, in equation (1) may be calculated by subtracting the initial weight of the animal from the mature weight, A.

The writer fitted equation (3) to data obtained from two lots of chickens which had been weighed each week up to the age of one year. The values of C, which Hendricks, Jull and Titus (*loc. cit.*) have interpreted to represent the true efficiency of the feed for growth, were found to be 0.343 and 0.355, respectively. The corresponding values, calculated after carefully "adjusting" the constants of the integrated

[1] Walter A. Hendricks, Morley A. Jull and Harry W. Titus, "A Possible Physiological Interpretation of the Law of the Diminishing Increment," SCIENCE, 73: 427–429, 1931.

[2] Samuel Brody, "Growth and Development with Special Reference to Domestic Animals. III. Growth Rates, Their Evaluation and Significance," *Mo. Agr. Expt. Sta. Bull.* 97, 1927.

equations by the method of least squares, are, respectively, 0.340 and 0.356. The error, due to the use of the rapid method of fitting the curves, was less than one per cent. in each case, which is undoubtedly well within the limits of the experimental error involved.

The chief source of inaccuracy in the rapid method of fitting the curves probably lies in using the gains in live weight, per unit feed eaten, over finite intervals of time as approximations to the values of the derivative, $\frac{dW}{dF}$. If the chickens used in the writer's study had been weighed at less frequent intervals, the rapid method probably would not have yielded quite such accurate results.

The advantages of this method over the method of arithlog plotting are the elimination of the errors of judgment, which are inherent in the latter, and the fact that the value of the constant, C, which is of particular interest if the curve is used to interpret the results of a feeding experiment, can be determined directly.

WALTER A. HENDRICKS

BUREAU OF ANIMAL INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

THE EFFECT OF THE APPLICATION OF A FIELD OF ATTRACTION TO A GAS

CONSIDER a gas of molecules, or electrons, in a shallow vessel having two of its plane walls parallel to each other. The vessel is placed in a field of attraction with these walls at right angles to it. Let us suppose that the conditions are such that a molecule on moving from one of these plane walls to the other has little chance of undergoing a collision with another molecule. Hence when a molecule moves from one of the plane walls to the other against the field, it undergoes a decrease in velocity, while when it moves in the opposite direction its velocity undergoes an increase. Hence the molecules impinge and rebound from one of the walls with a greater velocity than is the case at the other wall. Now the velocity of rebound[1] is an index of the temperature of the gas close to the wall; and hence under these conditions there will be a continual transference of heat from one wall to the other. But this is thermodynamically impossible. It follows therefore that the molecules must undergo certain changes compensating for this effect of the field. The occurrence of inelastic collisions of the molecules with the walls can not, it will be found, by themselves explain the effect. If, however, we suppose that the molecules possess certain properties previously deduced in other ways,[2] this effect can be compensated for. These properties are: (a) A molecule, or electric charge, slows down when moving freely, and absorbs radiant energy in the process which is stored up as internal energy; (b) potential energy of attraction, or repulsion, may become internal energy, and *vice versa;* (c) internal energy may also be directly converted into radiation.

We may now suppose that the internal energy accumulated by a molecule during its motion according to (a) and (b), is mainly converted into potential energy of repulsion according to (b), and this into kinetic energy, at the wall where the molecules arrive with a decrease in velocity. This is to take place in such a manner that the average velocity of collision is reduced at one of the walls and increased at the other, so that the temperature is the same at both walls.

If a different explanation of the difficulty is possible, I shall be glad to hear about it.

R. D. KLEEMAN

SCHENECTADY, N. Y.

[1] Apart from the increase caused by the attraction of the wall. R. D. Kleeman, *A Kinetic Theory of Gases and Liquids*, John Wiley & Sons, New York.

[2] R. D. Kleeman, *Phil. Mag.*, 7: 493, 1929; *Nature*, 124: 728, 1929; SCIENCE, 70: 478, 1929; 71: 340, 1930; 72: 224, 1930; *Z. anorg. u algem. Chemie*, 196: 284, 1931; *Z. Electro-chemie*, 37: 77, 1931; 37: 371, 1931.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE IOWA EYE-MOVEMENT CAMERA

MANY efficient cameras for photographing eye movements have been built since the inauguration of the corneal reflection method of eye photography by Dodge in 1901. The first cameras obtaining a continuous record of eye movement recorded only the horizontal movements of one eye. Dearborn made an advance by recording the vertical movements of one eye on a horizontally moving film and the horizontal movements of the other eye on a vertically moving film. The camera herein described obtains simultaneous binocular records of both vertical and horizontal movements.

The light used to produce the corneal reflection for photographing is a direct current Bausch and Lomb automatic carbon arc. This light, screened from the view of the reader, is placed at right angles to the eyes as is illustrated in Fig. 1. The light is focussed by a large condensing lens on a diaphragm which allows only the center of the light from the positive carbon to pass on. Between the light and the diaphragm is a chopping disc operated by a synchronous motor which interrupts the beam of light fifty times