0.05 gram. The scale and plunger are of such dimensions that 10 grams is indicated on the scale. The loads on the pans have to be balanced to within 10 grams and then the excess in weight is indicated on the scale. However, the scale and plunger can be changed to increase or decrease the portion of the weight which is automatically indicated on the scale. It is rather simple to calculate the diameter of the plunger necessary to give an even multiple or an aliquot part of the scale, and the plungers may be interchanged readily. Since the length of the scale can be changed by adjusting the weight k, the calculation of the diameter of the plunger does not have to be exact. We have replaced and used the plunger shown in the sketch with a smaller one so that the entire length of the scale indicates 2 grams only, instead of 10 grams.

The scale divisions are equally spaced throughout the entire length of the scale. The total movement of the beam of the balance is through a relatively small angle, about 5° 55′, and for such an angle the error introduced by equally spacing the scale division is negligible. The scale a may be made flat instead of being shaped in the form of an arc, but it is necessary to arc the scale in the balance shown to keep the image of the lamp filament sharply focused throughout the entire range of the scale. On the analytical balance mentioned below we use a flat scale. Another change in the construction of this balance is in the adjustment for the change in rest point due to the contraction or expansion of the displacement liquid which is made by shifting the scale.

Our device has been installed also on an analytical balance of 200-gram capacity. A difference in loads on the weighing pans of 1,000 milligrams or less is indicated on the scale, and the scale can be read easily to 5 milligrams, but it is possible to make the balance more sensitive than this.

The balance has been proven to be simple to construct and operate. It is accurate, and since the movement of the indicating beam of light may be altered at will and the plunger may be interchanged to give different values to the scale divisions, it is extremely flexible and may be employed for a wide variety of weighings. We have found the balance to be very useful in preparing samples of definite weight, since the amount of material to add after the approximate quantity has been placed in the weighing cup is indicated on the scale. The fatigue of weighing is reduced with our balance, and the speed of weighing is greatly increased.

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SECTIONING ORBITOID FORAMINIFERA[1]

THIS fall, wanting to make some careful studies of several different Orbitoids, of which there was only one specimen each available, it was necessary to develop a new technique in order to get both equatorial and vertical sections from the same specimen, the ordinary technique requiring more than one individual.

The technique developed is applicable to all Orbitoids ranging in size above 3 mm in equatorial diameter. The method is as follows:

The specimens were first freed of matrix. Then a common cork about 25 mm in diameter (Fig. 2) was

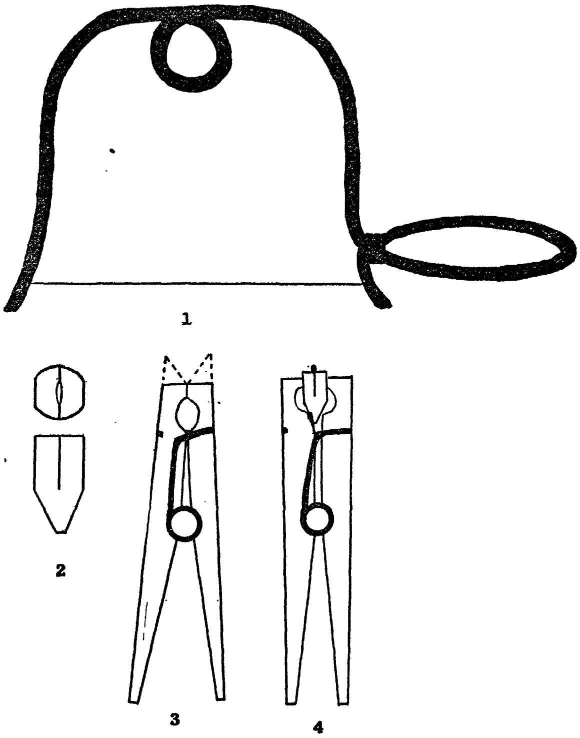

FIG. 1. Fret saw strung with wire. 2, Cork cut to hold specimen. 3, Spring clothes pin with ends cut off as shown by dotted line. 4, Clothes pin, cork with specimen in place to cut.

slit with a sharp blade about two thirds of the way down the center and the sides cut off parallel to the center cut. The lower part was then beveled off to allow it to be grasped in a common spring clothes pin. It is necessary to select a good cork and to cut it parallel with the grain.

The specimen was placed in the cut in the cork for about one half its diameter, the rest sticking out. Then an ordinary spring clothes pin with the ends cut off, as in Fig. 3, was used to hold the cork plus the specimen. I found it best to force a slight depression in the sides of the cork against the specimen so

[1] Method developed during some work done under a grant from the National Research Council.

as to hold it better. Care must be exercised in placing the Orbitoid in the cork so that when the specimen is cut the embryonic apparatus is not damaged. For cutting, a common fret saw frame (Fig. 1) was strung with a piece of No. 10 B & S gauge copper wire under slight tension. This with F.F.F. carborundum and plenty of water was used to cut off a portion of the test. The cut was made as close to the center as possible without damaging the embryonic apparatus. This cutting can be judged only from experience in handling specimens. The wire cuts the test quickly and easily and if due care is exercised in handling the saw, the sawed surface is relatively plane and smooth. The portion cut off is used for a vertical section.

The larger part containing the embryonic apparatus was then mounted in Canada Balsam, as is usually done in making equatorial sections. This part was then ground down on a fine hone; stopping every few strokes to make a Camera Lucida tracing. When the equatorial plane was reached a final tracing was made and measurements of the various parts taken. The Orbitoid was reorientated in additional Canada Balsam as for a vertical section and another series of tracings made, until the embryonic apparatus is again bisected. The cut-off part is then used to make a vertical section in the usual way. There is left a complete vertical section and a piece of the specimen with two polished surfaces; an equatorial and a vertical plane.

The series of Camera Lucida tracings were then drawn on separate sheets of celophane by means of India ink and studied. I have found this method of great use in the study of deformed Orbitoids, especially one that had a twin growing up from one surface. This method is rapid and sure, and it gives a convenient way to study the various chambers of the "larger foraminifera."

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SPECIAL ARTICLES

A POSSIBLE PHYSIOLOGICAL INTERPRETATION OF THE LAW OF THE DIMINISHING INCREMENT

WORKERS in animal nutrition have long felt the need for some satisfactory means of expressing mathematically the relation between growth and feed consumption. The interpretation of the results obtained in many feeding experiments is often complicated by differences in the amounts of feed consumed by the lots which are being compared. Obviously, it would be very desirable to have some means of calculating the true efficiency of any given feed for growth, regardless of the amounts of feed consumed by the experimental animals.

The applicability of the law of the diminishing increment to the problem of describing the relation between feed consumption and live-weight of growing animals was demonstrated by Spillman.[1] More recently Jull and Titus[2] have shown that the equation as given by Spillman is a fairly accurate means of expressing the live-weight of growing chickens as a function of feed consumption. Titus[3] showed that the growth of ducklings can be described by the equation equally well. Beyond pointing out the fact that each successive gain in live-weight for an equal increment of feed intake tends to bear a constant ratio to the gain immediately preceding, neither of the abovementioned investigators offered any explanation to account for the relationship.

The differential form of the equation of the curve of the diminishing increment is:

$$\frac{dW}{dF} = k(A - W) \qquad (1)$$

which merely states that the gain in live-weight per unit of feed intake is directly proportional to the difference between some constant and the live-weight already attained. The constant A has been interpreted to represent the mature weight of the animal, since when growth ceases,

$$\frac{dW}{dF} = 0, \text{ and } W = A.$$

No matter how accurately this equation may describe the relation between feed consumption and growth, it throws very little light upon the physiological processes involved unless some rational explanation is presented to show why the equation fits the facts.

It is common knowledge among workers in animal nutrition that the feed intake of a growing animal is utilized essentially in two different ways. One portion is used to supply the fuel required to carry on the metabolic activities of the animal and may be designated as the maintenance requirement.* The other portion is used for growth and part of it is retained and incorporated into the body tissues, pro-

[1] W. J. Spillman and Emil Lang, "The Law of Diminishing Returns," World Book Co., Chicago, 1924.

[2] Morley A. Jull and Harry W. Titus, "Growth of Chickens in Relation to Feed Consumption," *Jour. Agr. Res.*, 36 (6): 541–550 (1928).

[3] Harry W. Titus, "Growth and the Relation between Live-weight and Feed Consumption in the Case of White Pekin Ducklings," *Poultry Sci.*, 7 (6): 254–262 (1928).

* This, of course, includes the energy requirements for all voluntary muscular activity.