NOTES ON OOMETRY

WITH ONE ILLUSTRATION

By GRIFFING BANCROFT

The purpose of this paper is to show how average egg sizes may be measured and how the resulting figures may be interpreted. Obviously if, in a restricted area, all the eggs of a given race of birds were to be measured an average size for that district could be determined. This absolute average, even though impossible of getting, can be approximated closely. How many eggs must be measured to do so depends on how greatly those of one set vary from those of another and also on what degree of accuracy is desired. In general I find that about seventy-five eggs give a figure correct to one-tenth of a millimeter, but often a smaller number is sufficient. If two places of decimals are carried the hundredths of a millimeter serves only to qualify the tenth.

There is individual variation in the sizes of eggs. Those of one set of Song Sparrow's eggs, for instance, may be twice as large as those of another. So we must apply mathematical laws of chance and make use of a large enough number of specimens to offset accidental selection. That will have been accomplished when an increase in the number already measured will not materially change the average sizes. I give, as an example, a table of measurements of Song Sparrow's eggs from El Rosario, Lower California, Mexico. The selection was made partly because this is the largest series I have measured and partly because it is the least satisfactory. The individual variations of the eggs of these sparrows are the greatest within my experience. Therefore we can safely conclude that almost any other series of measurements would be well within the range of error here obtained. In making the table I measured twenty-four eggs at a time so as to have a check. I have copied the figures just as I jotted them down in my notebook:

24	eggs	averaged	20.35	by	15.19
48	eggs	averaged	19.94	by	15.08
72	eggs	averaged	20.04	by	15.09
96	eggs	averaged	19.98	by	15.10
120	eggs	averaged	19.97	by	15.09
144	eggs	averaged	20.09	by	15.12
168	eggs	averaged	20.10	by	15.15
192	eggs	averaged	20.06	by	15.15
216	eggs	averaged	20.03	by	15.14
240	eggs	averaged	20.04	by	15.14
250	eggs	averaged	20.06	by	15.15

I carried this series to unusual length in order to be sure of the closest tenth of a millimeter. It is quite obvious that if I record the average of these eggs as 20.05 by 15.15, I have not been more than one-twelfth of a millimeter wrong at any time after the first three measurements. So even with this knotty problem I can safely draw deductions that are based on accuracy to within a tenth of a millimeter.

Such accuracy is necessary because the value of the work lies in comparative rather than in actual dimensions. It is perhaps of not great moment to science whether the average width of Song Sparrows' eggs is 15.1 or 15.6 millimeters. But it is of great importance to know whether those of one district are or are not greater than those of another, that is, if we really do know. Constant differences are pregnant with meaning even though they be but fractions of a millimeter.

To make the necessary measurements there is needed an instrument of precision. One that should prove satisfactory is illustrated in the accompanying drawing (fig. 57). It is of wood with a steel rod sunk flush in one side. For its proper use there is first required a determination of the zero point. No matter with how much care the meter rod be put in place or perfect right angles be attempted a small error is to be expected when one deals with tenths of millimeters. The zero point can be determined by measuring twenty small eggs at one time. If the same eggs are remeasured in two batches of ten each, and in four of five each, simple mathematics will give the constant error.

In measuring the length of eggs they should be so placed in the trough that small ends are always in contact with small ends, and, conversely, large ends with large ends. If the eggs are held parallel to the trough and perfect contacts are established the sum of the lengths of any number of eggs, not exceeding a half a

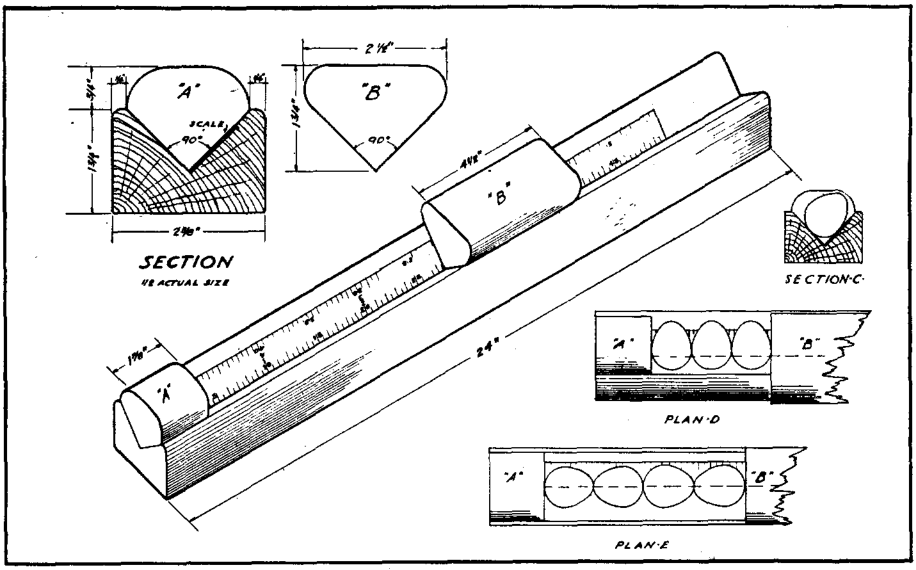

Fig. 57. OOMETER DESIGNED AND USED BY THE AUTHOR OF THE ACCOMPANYING ARTICLE.

meter in the aggregate, may be determined in one reading. This reading should be made to the nearest tenth of a millimeter and the net result, when divided by any considerable number of eggs, is accurate beyond the requirements of this work. When proper care is used this method should eliminate the personal equation and a number of different workers should be able to obtain identical results. The use of calipers or of any other devices on the market shows far too much individual variation.

To measure the width of eggs they simply have to be placed upright on their large ends and allowed to lean against one side of the trough in contact with each other. The sliding plug is shoved against them and an accuracy is obtained that cannot be approached by any other process. It is decidedly greater with minor than with the major axes.

If minimum and maximum figures are desired they can be obtained separately. Personally I consider them meaningless. I have runts and abnormally large eggs in nearly every extensive series in my collection, but I fail to see the value of keeping any record of them. Of course I disregard the obvious runts, but where sports end and natural but extreme sizes begin, is, at best, a matter of opinion.

The value of oometry lies in the determination of delicate variations in the sizes of the eggs of birds of the same species. Comparative skin measurements often show little or nothing regarding the actual size of the living specimen. One subspecies may have shorter wings, tail, tarsi, or claws than another and still be as large or larger. Furthermore, comparative skin measurements are not susceptible to great accuracy. Their value is weakened by personal factors, and they cannot be or are not used in sufficient numbers.

The proper interpretation of egg measurements follows as a corollary upon their determination. For instance, under ordinary circumstances little value can be attached to tables which show longer eggs in one group and wider eggs in another. That would mean an average difference in shape, a difference which exists freely enough between species but has not as yet been found in subspecies to a sufficient degree of certainty. The student can readily tell when his figures have become stable. When that has been accomplished he can make comparisons and analyses founded on definitely scientific data. I do not feel that I am exaggerating by claiming that the comparative factors disclosed rank equally in importance with chromatic and skeletal differentiations.

As an illustration see my article in THE CONDOR (XXIX, 1927, p. 31). There I published the following figures on the Western Gull, *Larus occidentalis*. From Todos Santos and Los Coronados Islands, 50 eggs average 2.78 x 1.95 inches; from Scammons Lagoon, 50 eggs average 2.89 x 1.98 inches; from San Luis Island, 30 eggs average 2.89 x 1.99 inches.

Let us see what can safely be deduced from figures. It is clear that the eggs of *livens* are not only much larger but are also more elongated than those of *wymani*. I argued at the time of publication that the dimensions prove that *Larus occidentalis livens* is really *Larus livens*. If there were intergradation it would appear in the figures, for yellow legs and pink legs do not account for the table above. In 1928, I found downy young of the Western Gull in the Gulf of California. Their ground color is almost white, as contrasted with the rich brown of baby *wymani*. So the inclusion of both forms in one species is not tenable. It is also clear that the birds of Scammons, though they have pink legs, are also *livens*, and that they and the birds of the Gulf are subspecies of each other. Is there not justification for naming a new gull, with characteristics of larger eggs than in *L. o. wymani* and with a range of at least the west-central shores of Vizcaino Bay? The birds differ from *L. o. livens* in having pink legs instead of yellow ones.

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