Ohio, under the auspices of the University of Cincinnati. The retiring president, Dr. W. C. Mendenhall, will deliver his address at the Netherland Plaza Hotel in the evening of December 26.

THE winter meeting of the American Society of Agricultural Engineers will be held in the Stevens Hotel, Chicago, from November 30 to December 4. The society will meet in four technical divisions on farm power and machinery, farm structures, rural electrification and soil and water conservation. Between 300 and 400 agricultural engineers and others interested in agricultural engineering are expected to attend.

IT is reported in *Museum News* that at a conference of museum representatives held at Melbourne in May, 1936, a resolution was passed that a museum association be formed in Australia and New Zealand and that the first meeting be held in New Zealand in January, 1937. The conference at Melbourne was arranged and financed by the Carnegie Corporation of New York. It was attended by delegates from twelve museums and art galleries in Australia, four in New Zealand and one in Tasmania.

BY the will of the late Mrs. M. B. Graham the income from her estate of approximately $350,000 is left in trust to be divided between her husband, Samuel Jordan Graham, of Washington, and Laurence Stokes Fuller, of Paris. Upon their deaths the principal, will be given to the Johns Hopkins University to be used in seeking a cure for infantile paralysis.

THE *Journal* of the American Medical Association reports that an estate estimated at more than $200,000 has been bequeathed to the University of Pennsylvania by the late Frances T. Kinsey to support and develop the Gastro-Intestinal Clinic at the University Hospital under the direction of Dr. Thomas Grier Miller, or for such other activities in this field as he may desire. After Dr. Miller severs his connection with the university hospital the income is to be used for such similar activities as the professor of medicine may desire. The fund will be known as "The Kinsey-Thomas Foundation for the Study and Treatment of Diseases of the Digestive System." It is to be a memorial to two sisters and a brother-in-law of Miss Kinsey.

DR. OWEN H. WANGENSTEEN, professor and head of the department of surgery at the University of Minnesota, and Dr. Alton Ochsner, professor and head of the department of surgery at Tulane University, will edit, with Dr. Alfred Blalock and Dr. William F. Rienhoff, Jr., as associate editors, a new surgical journal beginning on January 1, entitled "Surgery, A Monthly Journal Devoted to the Art and Science of Surgery." This journal is not to be the official organ of any group or organization, but will essay to give early publication to new and original material written up in concise form.

DISCUSSION

SIGNIFICANT FIGURES IN STATISTICAL CONSTANTS

IT is to be hoped that the rule for retaining significant figures in statistical constants proposed by E. B. Roessler in a recent issue of SCIENCE[1] will not be adopted very widely by those "workers in social and biological sciences" who "are not mathematicians and use statistical analysis only as a necessary tool." The rule proposed is as follows: *"In a final published constant retain no figures beyond the position of the first significant figure in the standard error; keep one more place in all computations."*

There are two parts to the rule, and the arguments against it apply to the parts separately.

The arguments in favor of rounding off a reported statistic have been given by the proponent of the above rule: not only is much time wasted on computations, due to the retention of more figures than the precision of the data warrants, but results expressed to many decimal places without regard to their precision give a very misleading impression of the accuracy of the result. Of these two arguments, the first is the more important, since the existence of any number of decimal places in a statistic accompanied by its probable error will not give any misleading impression of accuracy to a competent reader.

Since results are not generally presented to an indefinite number of decimal places, the question is not *whether* to round off, but *how far* to carry the rounding-off process. If more figures are retained in the published result than are warranted by the precision of the data, then the only real harm seems to be in the waste of time devoted to computation. The reader can do his own rounding off. If, on the other hand, the rounding-off process is carried too far, then the published result does not give all the information contained in the data and the reader is unable to supply the lack. It would therefore seem reasonable to advo-

[1] SCIENCE, 84: 289–90, September 25, 1936.

cate caution in the rounding off of such numbers. This applies especially to the reports of such statistics as may be used by a reader in further calculations for some special purpose of his own. If correlation coefficients and reliability coefficients are reported, for example, the reader may wish to employ these in estimating the value of the correlation coefficient corrected for attenuation. For this purpose, he will want values sufficiently accurate so that his final estimate of the correlation coefficient corrected for attenuation will be in error only through the unreliability of the original data and not through the rounding-off errors in the published numbers.

These considerations apply to biological, economic and social statistics as much as to any other. In this connection, Dr. Roessler argues that, "since the errors of measurement are ordinarily tremendously greater in biological, economic and social investigations than in physical observations, the retention of more than one doubtful figure in a constant is unjustified." A consideration of the standard error concept would lead us to believe that the relatively larger errors of measurement in social investigations would result in obtaining relatively larger estimates of the standard errors of the statistics from them, and that any sound procedure for rounding off a statistic in the light of its standard error should therefore apply as well to social as to physical data.

In the light of these various considerations it seems desirable to urge Kelley's suggestion[2] rather than Dr. Roessler's. That is, keep the figures in the reported result to the place indicated by the first figure of one half the probable error.[3]

The number of places which must be kept in the computations in order to guarantee the accuracy of the last figure in the reported result will depend, of course, on the nature of the computations.[4] If any single rule is to be followed, it should be one which would guarantee the accuracy of the last retained figure from any of the more ordinary types of computation. Walker and Sanford have shown[5] that if the less accurate of two approximate numbers contains n significant digits, their product and their quotient each contains n or $n-1$ significant digits. And about once in four times the error will affect one more place than this rule states.

[2] SCIENCE, 60: 524, 1924.

[3] This amounts to the insertion of "one third of" in front of "the standard error" in Roessler's rule. Thus the two rules often result in keeping the same number of places.

[4] Incidentally it is to this problem that Scarborough addressed his treatment in *Numerical Mathematical Analysis*, p. 11, quoted by Roessler.

[5] Helen M. Walker and Vera Sanford, "The Accuracy of Computation with Approximate Numbers," *The Annals of Mathematical Statistics*, vol. 5, no. 1, pp. 1–12, 1934.

It would therefore seem desirable to keep two more places in computation than the number of places to be reported.

The following rule should therefore be urged instead of the one proposed by Dr. Roessler: *In a final published constant, retain no figures beyond the position of the first significant figure in one half the probable error; keep two more places in all computations.*

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SELENIUM BEARING VEGETATION DURING LATE CRETACEOUS TIME[1]

DURING the past year evidence has been obtained that points clearly to the fact that at the time the continental portion of the Medicine Bow formation was being deposited certain plants were present that absorbed selenium in large quantities. The preservation of selenium in these plant-bearing rocks is all the more striking because of the fact that the samples taken for analysis were from weathered surfaces and from beds tilted at steep angles. Leafy carbonaceous shale has been collected from a type section in southern Albany County, Wyoming, that has given upon analysis over 150 parts per million selenium. Sandstones contacting these seleniferous carbonaceous veins have yielded as high as 157 parts per million selenium. Sandstones in this formation not subjected to this influence are only moderately seleniferous if at all. The concentration of selenium in the carbonaceous material is confined to the top part of a vein where skeletal leaves and other vegetable characters are still recognizable. The coal and lignitic matter in the Medicine Bow formation has been found to be only sparingly seleniferous. This fact correlates with current observations in that selenium absorption in quantity is a highly specialized phenomenon and therefore not common to all native plant genera.

This is the first evidence that has been found in the Rocky Mountain region showing an unusual enrichment of selenium in vegetative remains during Cretaceous time. While it is true that one may find seleniferous carbonaceous matter, for example, in the basal Dakota (Lower Cretaceous) that yields more selenium than is found in the associated conglomerates, yet the selenium content of the Medicine Bow material reported on is in a class by itself when compared with any other carbonaceous beds that have been examined thus far.

These data, brought out in the study of the nonmarine portion of the Medicine Bow formation, confirms the theory advanced by the Wyoming investiga-

[1] Contribution from the Research Chemistry Department of the University of Wyoming.