ings and in public schools under the auspices of the museum and a 50 per cent. curtailment of lectures for school children in the museum. All of these measures are designed to cut down expenses for fuel, light, and service, as the minimum appropriation of $240,000 asked for by the museum, figured to cover regular expenses only without provision for further development, has been cut down to $200,00 in the city budget.

By the will of the late Major S. Field Thorn, who died recently in San Francisco, the California Academy of Sciences is to receive "Cragthorn Park," near Santa Cruz, California. The place consists of 242 acres and was Major horn's country home. After the various specific bequests have been paid the academy is to receive the balance of the estate, which it is thought will be considerable. Major Thorn was at one time manager of the Palace Hotel in San Francisco and was for many years interested in the Academy of Sciences.

In connection with the spring meeting of the American Physical Society at the Bureau of Standards, Washington, on April 25 and 26, there will be an exhibit of physical apparatus illustrative of war developments in physics. The exhibit was opened on the afternoon of the 24, all day on the 25 and 26, the evening of the 25 and the afternoon of the 28.

UNIVERSITY AND EDUCATIONAL NEWS

Harvard University and the Smithsonian Institution receive $50,000 each by the will of Mrs. Virginia Purdy Bacon. Columbia University receives $25,000 for scholarships.

By the will of Alexander Cochrane, late of Boston, and head of the Cochrane Chemical Company, Peter Bent Brigham Hospital will receive $10,000 for the establishment of a free bed, and at the termination of a trust fund created for benefit of the members of Mr. Cochrane's family the principal of the trust is to go to Harvard College.

The University of California receives by the will of Mrs. Phoebe Hearst, $60,000, to continue scholarships and a valuable collection of paintings, tapestries and objects of art.

Professor William A. Noyes, head of the department of chemistry of the University of Illinois; Professor Frank Morley, of the Johns Hopkins University, and Professor William T. Sedgwick, of the Massachusetts Institute of Technology, will be included in the faculty of the summer session of the University of California, giving respectively courses in chemistry, mathematics and public health.

At the agricultural college of the University of Idaho, Herbert P. Davis, dairy husbandman, Dairy Division, U. S. Department of Agriculture has been appointed dairyman of the Agricultural Experiment Station, and vice director of the station, and J. E. Nordby, lately first lieutenant in the Motor Section of the Aviation Service, has been appointed associate animal husbandman of the Agricultural Experiment Station, and will have charge of experimental work in animal husbandry.

Captain James Riddick Partington, has been appointed to the newly established university chair of chemistry, tenable at East London College.

Nature states that Professor Ludwig Jost, of Strasburg, succeeds at Heidelberg Professor G. Klebs, who died last October in his sixty-first year, and Dr. W. Ruhland, of Halle, succeeds Professor von Vöchting at Tübingen.

DISCUSSION AND CORRESPONDENCE

BASIS OF THE GEOMETRICAL MEAN AS A B. COLI INDEX

Could I have realized that Professor Cairns would honor by mathematical consideration the "Geometrical Mean" (Science, March 8, 1918) method of obtaining a bacteriological index, I should have hesitated to "wander into paths outside my own domain." However, no elaborate discussion of the mathematical relation between the theory of chance variation and the geometrical mean can be expected to induce the empirical bacteriologist to use it as a *B. coli* index. The simplicity of application and practical utility in daily routine will in the end be its recommendation. Still a brief mention of the grounds on which it seemed to

be based may help to establish it until fuller treatment is possible.

Professor Phelps has thrown light on the problem by distinguishing between the distribution of *B. coli* in space and its distribution in time. The former alone is discussed by McCrady[1] in treating of fermentation tubes made from a single sample. The latter furnished the data for suggesting the "geometrical mean," which was based on a large number of samples taken at different times from single sources, as, for example, given points on a river. Both methods accomplish the same practical purpose by obtaining a weighted mean which eliminates the undue influence of positive high dilutions and the results differ from each other only by a factor which is nearly constant. Whether we wish to base the method à priori on the theory of probability or upon the actual form of the data, becomes an academic problem, but in practise the simpler is naturally to be preferred.

The arbitrary application of the conventional theory of chance to physical data can always be questioned. Bertrand in his "Calcul des Probabilités" calls attention to the fact that if a quantity varies as the law of chance, any observed function of that quantity does not, whereas the choice of the quantity is arbitrary. This distinguishes the mathematical theory of probability from the theory of chance variations of observed quantities. The number and magnitude of the forces acting to change a physical quantity may vary according to the law of chance, whereas the observed change is some function of those forces. Generally those forces combine as a product instead of a sum and so it is believed more fundamental that proportional variations instead of absolute variations follow the conventional law. In physics the variations are very small compared to the arithmetic mean value of the observed quantity and the effect may be commonly negligible because the proportional and absolute variations approach each other. The average is in such cases a very good index of the measurement. In biology, and especially bacteriology, the variations, as in the number of bacteria, are many times as great as the mean value and the geometrical effect becomes so pronounced as to require a logarithmic average or a geometrical mean. Francis Galton[2] discovered the wide practical application of this law and McAllister[3] fully discussed it mathematically.

In the end, therefore, we are thrown back upon the data themselves to determine the most fitting method of reduction and, as the Pearson School of statistics teaches, the sole purpose of such methods is to obtain some representative value of the data. Fortunately, Allen Hazen has given us in probability paper, a simple and sufficiently accurate graphical method of analyzing such rough data. Professor Whipple[4] has summarized and plotted a large mass of bacteriological results and shows that they follow a logarithmic probability curve closely enough. The results obtained in the Investigation of the Potomac River[5] show also that the logarithmic summation curves are strikingly symmetrical about the median line. In the results obtained at the Washington Filtration Plant[6] over a five-year period, the distribution of turbidity readings were found to agree with this form of curve, and the bacteriological results are almost parallel. It is further believed that the practical evolution of the geometrical scale of dilutions indicates that where variations are great the arithmetical scale is but an approximation over short portions of the more natural and fundamental geometrical scale.

[1] *Jour. Infect. Dis.*, 1915, 17, p. 183.

[2] Galton, Francis, "Geometric Mean in Vital and Social Statistics," *Proc. Roy. Soc.*, 29, p. 365, 1879.

[3] McAllister, Donald, "The Law of the Geometric Mean," *ibid.*, p. 367.

[4] Whipple, Geo. C., "The Elements of Chance in Sanitation," *Jour. Franklin Institute*, Philadelphia, CLXXXII., 37, 205, 1916.

[5] Hygienic Laboratory Bulletin No. 104. Table 13, pp. 87–94, and Charts E–H bet. pp. 128–129.

[6] Wells, Wm. Firth, "Some Notes on the Use of Alum in Slow Sand Filteration," *Proc. Am. Water Works Assn.*, 1913.

In conclusion, I suggest a simple rule for obtaining the "score" as an approximation to the "geometrical mean," namely *Revert dilutions*[7] *and apply Phelps Method.*[8] The process of reversion gives the benefit of geometrically reducing the data, and by applying Phelps' Method one obtains an approximate "Geometrical Mean." This is the principle successfully applied in "scoring" oysters.

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CARDIUM CORBIS A MONŒCIOUS BIVALVE

In the work entitled "Tertiary Fauna of Florida," *Transactions of The Wagner Free Institute of Science of Philadelphia,* Vol. 3, part 5, 1900, p. 1071, William H. Dall makes the following observation with reference to *Cardia:* "Nearly all *Cardia* have two forms, one more equilateral and globose, the other more oblique and elongated, but whether these differences can be correlated with sex is at present unknown."

If attention has been called to the fact that certain species of *Cardia* are monœcious, since Dall made the above statement, the writer of this note is not aware of it.

Variation as mentioned in the above quotation is very noticeable in the common *Cardium corbis* Martyn of the northwest coast. On preparing sections of the visceral region of individuals of this species in recent studies, their hermaphroditic character was clearly shown, masses of ova being interspersed with and sometimes completely surrounded by the spermaries.

I have not had the opportunity of examining other species of *Cardia.* They may or may not be monœcious, but it is evident, from the above observation on *Cardium corbis* Martyn, that variations in this genus must be based upon something other than sexual differences.

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[7] Standard Methods of Water Analyses, Report Committee Am. Public Health Ass'n, 1912.

[8] Phelps, Professor Earle B., *Am. Jour. Pub. Hyg.,* 18, 1908, p. 141.

THE PASSENGER PIGEON

To the Editor of Science: In 1902, 1904 and 1905 I rented a house at Devon, about sixteen miles west of Philadelphia, and on several occasions a single passenger pigeon visited my garden there. Doves came frequently. I was near enough to the passenger pigeon to make mistake impossible. Its color and size would easily distinguish it from the dove, as well as its method of flight and the use of its tail in rising from the ground, which is so much freer than that of the dove, while the shape of its tail would make it impossible to mistake its spread tail for that of a domestic pigeon. I was at Devon again during the summers of 1907 to 1913 inclusive and four or five times saw a single passenger pigeon. The last time was while motoring in 1913. I was running swiftly along a road not far from the woods and a bird got up by the side of the road and after rising from the ground about fifteen feet started off towards the woods. When its flight changed from semi-perpendicular to horizontal I was not twenty yards from it and could clearly see its breast and the under side of its tail and just afterwards the upper side of its tail still spread as the bird changed its course. I could see where it got up on the road and had an excellent idea of my distance, so that I could judge of its size, as well as its color and the shape of the tail.

I have always felt very skeptical about the "scientific" killing off of the last bird of a species which was so broadly distributed and most of whose haunts were so far from the abode of any one who would be likely to write for the papers. It may be what professional scientists would call scientific, but to me, as a business man, it has seemed pretty much like jumping at conclusions and trading on one's ignorance.

F. R. Welsh

QUOTATIONS

THE BRITISH BIRTH RATE

It is very difficult to bring home to people the meaning of a tendency so long as that tendency can only be expressed in figures. Yet