anatomy and Dr. I. H. Goldberger, has been appointed special lecturer of child hygiene in the school for oral hygiene.

MR. ARTHUR C. WALTON, M.A. (Northwestern '15), M.A. (Harvard '16) has been made acting professor of biology in the chair made vacant by the death of Professor Umbach. Mr. Walton holds a Harvard traveling fellowship and had planned work in Sweden but was prevented by the war.

FRED G. ALLEN, of Erie, Pa., a graduate of the University of Toronto, has been appointed assistant professor in electrical engineering at Lafayette College to take the place left vacant by the resignation of E. D. Tanzer, who has become assistant professor of electrical engineering at the Georgia Institute of Technology.

EARLY in January Miss Margaret Heatley, instructor in botany at Wellesley College, sailed for South Africa to take charge of the botanical department in Huguenot College of Cape Colony during the absence on sabbatical grant of Dr. Bertha Stoneman. Miss Alice M. Ottley, who was absent on leave, has returned to Wellesley College to fill the vacancy in the botany department caused by Miss Heatley's absence.

## DISCUSSION AND CORRESPONDENCE

### NOTE ON THE GEOMETRICAL MEAN AS A B. COLI INDEX

IT is always a beneficial means of grace for a scientist to wander into paths outside his own domain; such excursions often reveal too the lack of coordination between the various sciences, although happily there has been great progress within the past two decades in this respect. These remarks are evoked by a reading of the note by William Firth Wells: "The Geometrical Mean as a *B. Coli* Index" in SCIENCE for January 11.

The first impression gained is the lack of a clear presentation of the method. The notion of a geometric mean is purely mathematical, but it must be said that to a mathematician, even to one fairly conversant with the theory and methods of bacteriological analysis, the theory on which this method rests is not at all in evidence, save only perhaps in the remark that "the ordinary bacteriological dilution scale is in reality a logarithmic scale." It does not, however, follow necessarily that the most probable number of *B. coli* is the geometric mean as obtained by Mr. Wells. In support of this contention, see a thoroughly mathematical treatment of the whole question by M. H. McCrady,[1] of the laboratories of the board of health of the Province of Quebec; the formulas there derived show that the logarithmic function is more complicated than Mr. Wells perhaps has in mind. His experimental data may, on the other hand, show that his proposed method will serve well as a "first approximation."

The second impression coming from a study of the article is the feeling that this method merits a mathematical treatment. It seems to be essentially as follows: Five sets of twenty tubes each, containing portions of the sample in powers (not "multiples") of ten, are tested for the presence of gas, indicating the presence of *B. coli*. For the dilutions 10 c.c., 1 c.c., .1 c.c., .01 c.c., .001 c.c., graded with the scale numbers 0, 1, 2, 3, 4, respectively, the number of tubes showing presence of *B. coli* was 20 18, 8, 1, 0, respectively, the experiment having been extended from a dilution at which all tubes gave positive results to one in which no tube gave such a result. In going from the weakest dilution to the next higher there was a *gain* of one tube, next a gain of 7, then of 10, then of 2. The scale numbers, which appear to correspond to the logarithms of certain hypothetical most probable numbers of *B. coli* for the separate dilutions, are averaged with the foregoing gains used as weights, *i. e.*, 2, 10, 7, 1, 0; and the weighted mean thus found corresponds to the logarithm of the desired most probable average number of *B. coli*. In other words, the weighted geometric mean of the above-mentioned hypothetical numbers of *B. coli* is taken as the desired average.

An immediate consequence of the mathematics involved is that the same result is

[1] M. H. McCrady, "The Numerical Interpretation of Fermentation-Tube Results," *Journal of Infectious Diseases*, Vol. 17, No. 1, January, 1915, pp. 183–212.

always obtained by dividing the sum of all the positives except the highest by the highest, *e. g.*, 1/20 (18 + 8 + 1 + 0) = 1.35. That a mathematical treatment would improve and standardize the computation can be seen from the remark that a hasty study gives the following simpler result (subject to the doubt already expressed as to the validity of the theory): The aggregate per cent. of "positive" tubes gives the logarithm of the most probable average number of *B. coli* per 100 c.c., *e. g.*, 1/20 (20 + 18 + 8 + 1 + 0) = 2.35, and this is the logarithm of 224. This rule will explain, for example, why Mr. Wells's "reversion method" works, for it is the mathematical equivalent of the foregoing. A further implication is that the author would seem to be wrong in saying that the "percentage positive" (the aggregate percentage) gives the desired result for a test using a single dilution; to use a concrete example, 18 positives out of 20 at 1 c.c. together with 0 positives out of 20 at .1 c.c. should by any test be regarded as indicating a smaller number of *B. coli* than the 18 positives alone, yet the rule here commented on yields the same results for both.

It will be of undoubted value to have Mr. Wells's more complete presentation particularly of the experimental data which he mentions.

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## SOME DEFECTS IN OUR AGRICULTURAL INSTRUCTION

In the preface to the text-book on agricultural botany ("Traité de Botanique Agricole et Industrielle") by J. Vesque, professor of agricultural botany in the National Institute of Agronomy of France, the following criticism on the agricultural instruction then (1885) given in France occurs:

> In France the agricultural instruction attaches itself more and more to rearing of livestock. It is too much forgotten that the animals are nourished by the plants, or, if it is not forgotten, it is taken for granted that the culture of plants consists merely in the production of a maximum mass of vegetables. The nature of the plants, the species which populate our fields, the seeds confined to the soil are far from preoccupying the cultivator as much as the nature of the soil and the fertilizers employed. All the agricultural instruction may at this point be summed up in three words: Zootechny, agricultural chemistry and rural engineering. The plant, the initiative in all agricultural pursuits, is almost excluded. How many cultivators know the herbs of their farms, how many are capable of distinguishing the good from the bad? Liebig was certainly not wrong in accusing the students of the agricultural schools of knowing neither the seeds of the grasses nor the grasses themselves.

These remarks, describing the character of the agricultural instruction in France in 1885, fit the condition prevailing in many of our American agricultural colleges at the present day to a strange degree of exactness. The same neglect of the scientific knowledge of plants is present, not only in courses in which animal industry is the major subject, but even in such courses as agronomy and horticulture, which from their very nature should deal largely with plants. We find the botanical equipment of the average graduate very meager indeed. He has not infrequently been the recipient of long lecture courses on forage plants without possessing definite knowledge of the distinction between grasses and legumes; or he has studied ornamentals in his horticultural courses without enough training in botany to appreciate either the meaning of the description of a plant or the importance of its scientific name; or he may have spent considerable time in judging corn without having clearly in his mind to which family of plants the Indian corn belongs, or what characteristics distinguish it from the other members of its family. Such vague knowledge of plants is not uncommonly met with among graduates from agricultural colleges claiming thoroughness for their preparation.

No one will deny the right of agriculture to the title of a generous place in the higher education, based as it is on those natural sciences, in which our country claims its proudest distinction in its progress. It is also undoubtedly the intention of all these agricultural colleges,