It is believed that the forms here described and interpreted are unique in inorganic nature.

ALAN W. C. MENZIES
RALPH BEEBE

PRINCETON, N. J.

UNLIKE INTERPRETATIONS OF FULLER'S SCALE IN DETERMINING DEGREE OF ACIDITY

In following directions for making up bacteriological culture media the writer has been impressed by the marked differences in acidity as recommended by different bacteriologists. For example, "The Standard Methods of Water Analysis," adopted by the American Public Health Association, 1917, and commonly used by bacteriologists, recommends the use of culture media of a +1.0 acidty.[1] Smith (4, p. 69), however, apparently recommends a +15.0 agar and a +10.0 gelatin, and these figures are frequently used by plant pathologists in designating the acidity of culture media.

The question which naturally arises is, do bacterial pathogens of plants require in general a much higher degree of acidity than bacteria of milk, sewage, water, animal pathogens, etc., or is it possible to explain this difference by assuming unlike interpretations of Fuller's scale. The writer with the hope of clarifying the situation has compared the descriptions of Fuller's method as given by Smith, whose texts are universally used by plant pathologists, with the description usually presented by bacteriologists, particularly animal pathologists, and also with the description originally presented by Fuller. He finds that Fuller's scale is interpreted differently.

Smith's (l. c.) description follows: "The plus and minus on Fuller's scale denotes, respectively, acid and alkaline media. The +10, for example, means that exactly 10 cubic centimeters of normal alkali must be added to a *liter* (writer's italics) of the culture medium to render it exactly neutral to phenolphthalein, and, correspondingly —10 means that the fluid is alkaline to phenolphthalein and that 10 cc. of normal acid would need to be added to bring 1 *liter* back to the neutral point." He follows this interpretation of Fuller's scale, as amount per liter, in his very recent work (5, p. 106): "Our standard agar is +15 and our standard gelatin +10 on Fuller's scale, or 1.5 per cent. and 1 per cent. respectively, if reckoned on 100 c. c. portions. It is best to keep to Fuller's scale since we make up media in liters, not in 100 c. c. portions."

The following description of Fuller's scale, taken from Park and Williams' (3, p. 102), is typical of the interpretations placed upon this scale by various texts on animal pathogens: "Calculation—Five c. c. of medium require 2.4 c. c. of N/20 NaOH, therefore *100 c. c.* (writer's italics)—would require 2.4 c. c. of N/1 NaOH—; in other words, the medium is 2.4 per cent. acid to phenolphthalein or +2.4 if expressed according to *Fuller's method* or *scale.*" It will be noted that in this interpretation Fuller's scale is used as degree of acidity in *100 c. c.* of medium in contrast to those interpretations in which the scale denotes degree of acidity in *1,000 c. c.* of medium.

Fuller's (1, p. 388) own description reads as follows: "For accuracy and convenience, the expression of acidity or alkalinity of culture media in numbers of cubic centimeters of a normal solution *per liter* (writer's italics) is by far the best, and I recommend its universal adoption as a standard method." Concerning degree of acidity with reference to optimum growth, he says (p. 391): "Speaking in general terms the available data appear to warrant the placement of the optimum degree of reaction within narrower limits, between 10 and 20 of our scale," and (p. 394) he adds, "As it is very urgent that some fixed point be adopted I venture to suggest that for quantitative water analysis . . . . 18 on our scale be taken as a standard. This means, of course, that such a solution would require 18 cubic centimeters per liter of normal alkali to render it neutral to phenolphthalein." This usage, as amount per liter, has been generally adopted by plant pathologists, while the animal pathologists, in general, use the scale as denoting amount per 100 c. c.

It should be pointed out that Fuller does not

[1] Since Fuller's scheme has several decided disadvantages it is being supplanted by more accurate methods. (See Report of the Committee on the Descriptive Chart for 1919. *Jour. Bact.*, 5: 127-143. 1920).

use the plus (+) sign to denote degree of acidity although he does use the minus (—) sign for alkalinity. In a table which shows the relationship of different degrees of reaction to the number of bacteria developed (p. 393) he presents under "reaction" the following figures: 40, 35, 30, 25, 20, 15, 10, 5, 0, —5, —10, —15, —20, —25, adding, "Numbers refer to cubic centimeters per liter of normal acid or alkali necessary to change it to phenolphthalein neutral point. Minus (—) means an alkaline solution." The plus (+) sign was apparently not used by Fuller, the figure itself without any sign standing for acidity. While the writer has not definitely ascertained when and by whom the plus (+) sign was first used, it is probable that it was first brought into general use by the *Report of the Committee of Bacteriologists of the American Public Health Association* (2) in 1898. This committee, of which Fuller was a member, made the following recommendation (2, p. 75): "Manner of expressing the degree of reaction of culture media: Since at the time the reaction is first determined culture media are more often acid than alkaline, it is proposed that acid media be designated by the plus sign and alkaline media by the minus sign, *and that the degree of acidity or alkalinity be noted in parts per hundred*" (writer's italics). "The bulk of available evidence from both Europe and America points to a reaction of +1.5 as the optimum degree of reaction for bacterial development in inoculated culture media" (p. 76).

It is quite evident that animal pathologists and bacteriologists in general have substituted for the methods proposed by Fuller those proposed by the Committee of the American Public Health Association of 1898, although they usually cite or designate Fuller's scale, while plant pathologists use Fuller's original recommendations with the exception of adding the plus (+) sign to indicate acidity.

Since +10.0, +15.0 in 1,000 c. c. of the medium correspond to +1.0, +1.5 respectively in 100 c. c. of the medium it is evident that the degree of acidity recommended for plant pathogens corresponds to the acidity recommended for bacteria in general, and it is necessary to know the author's interpretation of Fuller's scale when considering the degree of acidity described or recommended.

H. R. ROSEN
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF ARKANSAS

(1) FULLER, GEORGE W. *On the proper reaction of nutrient media for bacterial cultivation.* Jour. Amer. Pub. Health Asso., 20: 381-399. 1895.

(2) *Report of a Committee of Bacteriologists to the Committee of the American Public Health Association on the Pollution of Water Supplies.* Jour. Amer. Pub. Health Asso., 23: 56-100. 1898.

(3) PARK, W. H., and WILLIAMS, A. W. *Pathogenic microörganisms.* Lee & Febiger, publishers, Philadelphia, 1920.

(4) SMITH, ERWIN F. *Bacteria in relation to plant diseases.* Vol. 1. Published by the Carnegie Institution of Washington. 1905.

(5) SMITH, ERWIN F. *An introduction to bacterial diseases of plants.* W. B. Saunders Company, publishers, Philadelphia, 1920.

THE AMERICAN CHEMICAL SOCIETY

(Continued)

DIVISION OF RUBBER CHEMISTRY
W. W. Evans, *chairman*
Arnold H. Smith, *secretary.*

Report of committees, executive, physical testing, abstract, chemical analysis and accelerator.

Mineral rubber: C. O. NORTH. The purpose of this paper is to bring out the desirable and undesirable properties of M. R. in order that M. R. makers will appreciate more fully how their product is employed. Changes in stress strain relations, hysteresis losses, permanent set, energy of resilience and abrasion with increase in M. R. ratio to rubber are shown. M. R. is essentially a plastic material. When a stock containing it is stretched, the M. R. flows with the rubber. On release the M. R. flows back with the rubber. The principal evidence of its presence is a slowing up or logging of the return.

The Tetra-hyroxyphenyl derivative of rubber and its tetra-methyl ether. HARRY L. FISHER AND HAROLD GRAY. The tetra-phenoxy derivative of rubber described by Weber (ber. 33, 791) is shown to be the tetra-hydroxyphenyl derivative not only by the method of formation, and by its solubility in aqueous NaOH, but especially by the