printed *in extenso,* in English, French and Italian, and referred to a special conference. The conclusions of the conference will be awaited with interest.

SPECIAL ARTICLES

A HIGHLY SENSITIVE PHYSICAL METHOD FOR DETECTING PROTEINS IN A SOLUTION

IT is generally believed that immunological reactions are the most sensitive, as they make it possible to detect such minute amounts as 0.00000005 grams of proteins (1/20000000). H. G. Wells, in his excellent book on the "Chemical Aspects of Immunity," remarks that "these figures give a striking illustration of the delicacy of the immunological methods and their value in studying certain problems in protein chemistry. In no other way would such minute amounts of protein be detected in a solution."

This statement, which expresses the conditions actually prevailing, led me to make some preliminary experiments which are reported in this paper and which show that it is possible, by a purely physical method, to detect the presence of still smaller amounts of protein, namely, 0.00000002 gr. or 1/50000000, in two hours or even less.

This method is based on the use of the tensiometer previously described[1] and on a phenomenon mentioned in 1922[2] and later in this journal,[3] under the title "Antagonistic action of colloids."

When a trace of powdered sodium oleate is added to pure water, or to a salt solution contained in a watch-glass, the surface tension decreases instantaneously and becomes very small. If the amount of sodium oleate added is smaller than 1/1000, the drop will continue for over one hour until a certain minimum value is attained. This value will then remain practically constant.[4] But when the same amount of sodium oleate is added to the same watch-glass containing some other colloid in solution, instead of pure water or saline, the surface tension, after reaching almost instantaneously its bottom value, starts up immediately and in a few minutes, according to the concentrations, tends towards its original value or even reaches it.

The presence of 1/1000000 of a gram of protein has no effect on the value of the surface tension of water, or very little, as the monomolecular layers are formed for egg albumin, for instance, at dilutions comprised between 1/80000 and 1/210000. Consequently it was thought that an indirect method, based on the above described "antagonistic phenomenon" was more likely to bring results. For this purpose a solution of 1/300000 of pure sodium oleate was prepared, and 1 cc was poured in a watch-glass; on the other hand, 1 cc of solution of 1/25000000 of crystalline egg albumin was added to it. The final dilution of the solutes was consequently 1/600000 for sodium oleate and 1/50000000 for egg albumin. Then, the drop of the surface tension of this mixed solution was compared with that of a solution of pure sodium oleate at 1/600000. The results of three series of experiments were as follows:

SURFACE TENSION IN DYNES

	Initial values			Static values (2 hours)		
No. of experiment	1	2	3	1	2	3
1. Water	75.4	75.3	75.3	75.3	75.3	75.3
2. Egg albumin crystal. 1/50 000 000	75.1	75.1	75.2	75.3	75.3	75.3
3. Sod. oleate. 1/600 000	75.0	74.9	74.7	70.8	72.0	71.0
4. Sod ol. + egg albumin same concentrations as above	75.0	75.0	75.0	75.1	75.2	75.2
Difference between the static values of Sol. No. 3 and 4, due to the presence of egg albumin				4.3	3.2	4.1

Consequently, the presence of 1/50000000 of egg albumin in 2 cc of liquid will prevent the lowering of the surface tension of water by sodium oleate in the proper dilution. This phenomenon is observed only when the sodium oleate is highly diluted. It would certainly be at a maximum for a concentration of 1/750000 in the watch-glasses which we use, filled with 2 cc of solution, as under such conditions, I have shown that an organized monolayer is formed.[5] However, it is difficult to prepare sodium oleate in such state of purity that it will entirely dissolve in true solution, and it happened that the sample used in the above reported experiments was not absolutely perfect. Nevertheless, the phenomenon is quite striking and clear at 1/600000. It is very probable that the sensitivity of this reaction can still be increased, and we have already secured evidence that it might show the presence of 0.00000001 gram of protein. Experiments are now being carried on to study the phenomenon more thoroughly.

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[2] du Noüy, P. L., *J. E. M.,* 1922, xxxvi, I, 115.

[3] du Noüy, P. L., SCIENCE, 1924, lx, No. 1554, 337.

[4] du Noüy, P. L., "Surface equilibrium of colloidal solutions. I.," SCIENCE, 1924, lix, No. 1539, 580.

[5] du Noüy, P. L., *Phil. Mag.,* 1924, xlviii, 264 and 664.