275 and about 200μμ (where the absorption of air and quartz becomes troublesome). It is not easy, however, to obtain a sufficiently intense and at the same time sufficiently monochromatic source of light for these shorter wave lengths and it is questionable whether the theoretical gain in resolution achieved by passing from 275μμ to say 225μμ would be realized in practice. Barnard employed an objective with light of wave length 257μμ and reproduces a photograph taken with this combination. From a comparison of this photograph with another taken with 275μμ, it is not at all certain that the differences are due to increased resolution on account of the shorter wave length rather than to adventitious circumstances.

If a further step is to be taken, it may well be best to pass directly into the region of Schumann rays. But for the present the possibilities of the equipment for ultra-violet light of 275μμ have not yet been fully utilized and the most promising results seem to be in sight through its more thorough use. Much is to be expected in this respect in the near future. A number of biologists are at present successfully using the apparatus and its use has also been extended to metallography (opaque objects) where it is opening up an entirely new field.

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SPECIAL ARTICLES

THE HYDROPHILIC EFFECT OF IONS ON AGAR AND PROTOPLASMIC COMPONENTS

PROFESSOR L. MICHAELIS says in his recently published American lectures on the effects of ions on colloidal systems:[1] "One can not talk of *the* hydrophilic effect of ions. In different cases different kinds of effects become manifest." This pronouncement was made with especial reference to conclusions of Loeb, based chiefly on experiments with gelatine, that the differential action of ions as expressed in the Hofmeister series does not hold. Michaelis was led to make this cautionary statement because numerous experiments in his own laboratory have shown that the series is valid in the hydration of agar in neutral salt solutions through a certain range of concentration. Scores of workers have shown that the lyotropic series *is* apparent when dealing with living cell-masses and the results of the senior author prove that it runs through the hydration reactions of agar and agar-protein mixtures, and that the differential action of univalent anions as well as kations is demonstrable in the artificial cell constructed of these materials.

It is to be noted that even Professor Michaelis does not realize the full force of his cautionary statement. Relying upon results of van Kruyt, de Jong and Dokan, he says:

> When a piece of agar jelly is put into water or an aqueous electrolyte solution, swelling occurs and the weight attains a constant value after about one day's swelling. The degree of swelling can be measured very exactly, and the swelling is found to be most pronounced when agar is exposed to pure water.[2]

Specifically this statement may be connected with some recent results by Dokan,[3] whose method was to dry a 2 per cent. agar gel to one third its original thickness, then allow it to swell twenty-four hours. Changes were determined by weight. Obviously only a narrow sector of the hydrating action was measured, and the data thus obtained might be expected to yield no fine distinctions. These, however, were sufficient to show that Loeb's generalizations as to the invalidity of the Hofmeister series would not hold. By this gross method univalent kations were equivalent in their effects in concentrations below 0.1 N, but the Hofmeister series was evident above this. A more exact method would have extended the series to extremely dilute solutions.

This has been done repeatedly in this laboratory during the last decade by a method in which 2.5 per cent. warm agar solutions, which cast as plates cool, set as a firm jelly and dry down to a thickness of 0.1 to 0.5 mm, according to the thickness of the original, and which in a freshly air-dried condition at 15° have a water content of about 25 per cent. Trios of small sections with surfaces of 8 to 10 sq. mm, and a volume of 2 to 5 cu. mm, were placed in a Stender dish covered with a triangular piece of glass plate on the center of which a vertical arm of an auxograph had a bearing. About 50 ml. of solution was poured in each dish and resultant swelling was recorded for a week or as much longer as desirable with daily replacement of the solution. Determination of losses by solution from the sections showed a loss of one seventh of the dry weight of such sections immersed in water during the first twenty-four hours. Such losses by solution do not appear to have been taken into account by workers who obtain data as to swelling by weighing the sections. It will be noted that if auxographic records were corrected for such

[1] Baltimore, 1925, Williams and Wilkins Company (see p. 97).

[2] *Ibid.*, p. 88 and Fig. 2.

[3] Dokan, Von S.: Die Wirkung der Elektrolyte auf die Quellung der Agar. Kolloid. Zeitschrift, *34*, 155 (1924).

losses, the excessive increases of agar in dilute solutions would be accentuated.[4]

The results illustrate in no uncertain manner that the chlorides of Na, K. Ca and Mg. at concentrations from 0.001 to 0.0001 M cause an excessive hydration of such sections of agar, that the effects of the kations are distinctive, and the differential effects of the anions, nitrate and sulphate, are also apparent. Excessive swelling was found by the use of HCl 0.0001 N, and in weak hydroxides, while still more marked effects were secured with solutions of amino-compounds such as glycocoll, histidine, phenyl-alanin, asparagin, alanin, etc.[5] These increases took place in the various solutions under a total range from Ph. 4.2 to Ph. 11. Mixtures of agar and gelatine also showed a great increase over that in water, especially in amino compounds.

Fairbrother and Mastin,[6] apparently unacquainted with these results, published similar data with regard to the effect of the common acids and alkalis on the swelling of agar.

Dokan's experiments dealt with the agar gel through only a third of the total range and took no account of losses by solution. Consequently the differential effects were lost and diminished totals found. The auxographic measurements recorded hydration increases of agar plates from a fresh air-dry condition at 15 to 20° C. to approximate satisfaction. The increased delicacy and effectiveness of this method extends the differential effects of kations and anions to extremely dilute concentrations. The range of swelling followed in such measurements is four times as great as in the method of Dokan, which was that employed by many workers. The measurement of the changes in volume of an agar plate from the air-dry condition in which it holds one fourth its weight in water to one in which it holds as much as forty times its volume of water doubtless comprises the changes in such a reversible gel of direct biological interest. It is by no means, however, the whole story of the hydration of agar.[7] If the water content of agar plates be reduced to a minimum by drying still further in a desiccator over phosphorus pentoxide, it will be found that their hydration capacity has been reduced so that an increase of only a few hundred per cent. is exhibited when they are placed in water as determined by weighing. In what manner the differential effects of kations would be shown if such desiccated material were placed in solutions of electrolytes is not known.

Professor Michaelis cites some hydration reactions of Konyaku, a polysaccharide of mannose and glucose obtained from the tubers of *Amorphophallus Konaku* measured by Dokan, which does show excessive and differential swelling in solutions of some electrolytes and hydroxides, but not in others. These comparative effects are reminiscent of the hydration increases of agar-gelatine mixtures in suites of solutions and suggest that the substance in question will be found to include a relatively high proportion of proteinaceous material: Glycolipins may also be present.

The results of scores of workers show that the action of ions on colloids, and consequently on permeability of walls and plasmatic layers, are not to be accounted for solely by electrostatic effects, determined by sign and valency. Such effects are due to the direct action of ions on colloidal particles. Differential or lyotropic effects among univalent ions, for example, are to be attributed to the varying attraction of the different elements for water molecules, thus exerting an indirect effect on the hydration of the colloidal particle, as is well described by Professor Michaelis, who suggests that the nature of such attraction depends on atomic radius. As noted above, he believes these effects are not seen at low concentrations, except in the case of the hydrogen ion. The results cited in this note establish well-marked differential action of common univalent and bivalent ions at extremely low concentrations in conformity with the lyotropic series, and give greater value to the proposal of Michaelis as to the physical basis of such effects.

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[4] MacDougal, D. T., and Spoehr, H. A.: "The solution and fixation accompanying swelling and drying of biocolloids and plant tissues." *Plant World, 22,* 129, May, 1919.

[5] MacDougal, D. T.: "Auxographic measurements of the swelling of biocolloids and of plants," *Bot. Gaz., 70,* 126, 1920; "Action of bases and salts on biocolloids and cell-masses," Proc. Amer. Phil. Soc., *60,* 15, 1921; and Spoehr, H. A., "The components and colloidal behavior of plant protoplasm," 59, 150, 1920.

[6] Fairbrother and Mastin, Trans. Chem. Soc., *123,* 1412 (1923).

[7] Clarke, B. L., *Journ. Amer. Chem. Soc., 47,* 7, (1925).

THE AMERICAN CHEMICAL SOCIETY

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The fate of intarvin in the normal and diabetic economy: MAX KAHN and HATTIE L. HEFT. Intarvin, the synthetic neutral odd-carbon fatty-acid fat (glyceryl trimargarate), is absorbed in the animal organism to the extent of about 95 per cent.; and upon catabolism yields