starches by using taka-diastase and salivary amylase have been described.

The amylases used in the present investigation were taka-diastase, 0.5 per cent. (Parke, Davis and Company) and salivary amylase (human saliva centrifuged and diluted 10 times).

From the data given in Table I, which is only a rough indication of the color zones obtained with several starches, it can be seen that tuber starches can be easily differentiated from those of cereals, as the latter give deeper and more differently colored zones than those of tubers. Amongst cereal starches wheat and maize give violet-colored zones. Thus the method affords an easy way of identifying the common starches adulterated in foodstuffs, particularly when the starch is cooked and its structure destroyed, in which case there is no method available in literature for its identification. With the help of a colored chart prepared by the analyst for a number of starches it is possible to identify the individual varieties, whether cooked or otherwise, in which latter case the method is a good supplement to the conventional microscopic method.

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SPECIAL ARTICLES

THE SIGNIFICANCE OF THE PERSISTENCE OF THE CRYSTALLINE STATE ABOVE THE MELTING POINT[1]

THE purpose of this paper is to show that the application of Boltzman's law allows the original objectives of van der Waals to be more effectively pursued. Additional gains in our understanding of liquids are also made thereby. The process of vaporization may be readily visualized on the basis of kinetic theory and by this means Trouton's rule is readily derived. This holds approximately for liquids except those boiling at very low temperatures. One is accustomed to regard the process of fusion as one formally similar to evaporation, each representing a kinetic exchange process across an interface at which an amount of energy is given up by or imparted to molecules crossing the interface. One might expect, therefore, that a Trouton's rule might govern the melting point. For "monatomic" substances, there is a rough approximation to this, but it is not even approximately true for more complex substances. The explanation of these facts must be that in the process of fusion, molecules do not pass over into a state which remains unchanged with increase in temperature until the boiling point is reached, but that the process of fusion represents but a partial breakdown of the crystalline structure. The failure of the van der Waals equation arose from the application of the misconception that molecular forces are of long range, instead of very short-range forces as we now know them to be. De Bye and Keesom, by applying the idea of short-range forces and the well-established Boltzman equation, obtained the expression

$$\overline{U}\rho = \frac{N_A^2}{V}\int \varepsilon(r)e - \frac{\varepsilon(r)}{kT}\ dV$$

for the average energy added to the internal energy of a gas containing N_A molecules in volume V, $\varepsilon(r)$ being the potential energy of two molecules at distance r apart. k is the Boltzman constant. (See Herzfeld's chapter on imperfect gases and the liquid state in Taylor's "Treatise on Physical Chemistry," 2nd edition. van Nostrand Company, 1931.) This equation reduces to that of van der Waals at high temperatures. It is equivalent to the precise equation of state of Onnes. This treatment accounts for deviations from the perfect gas law, not through long-range forces, but through the formation of clusters of molecules. In 1923 C. V. Raman (*Nature*, pp. 428, 532, 1923) utilized a similar idea to account for the viscosities and the temperature coefficient of the viscosities of liquids,

$$\eta_{\text{liq.}} = \eta_{\text{vap.}} e^{\frac{F}{RT}}$$

where $\eta_{\text{liq.}}$ is the viscosity coefficient of the liquid, $\eta_{\text{vap.}}$ is that of the vapor and F is the heat of fusion. The perfection of the fit of this equation is very striking for most liquids of not too great complexity. However, the supposition that the energy term F is to be identified with the heat of fusion for all substances is not borne out, and from the foregoing discussion of the process of fusion, this is not surprising and does not condemn the more fundamental elements of Raman's theory. Furthermore, η should be the viscosity of the ideal liquid rather than of the vapor. A large amount of evidence has been accumulating from other quarters to support Raman's concept of the nature of a liquid, which may be consolidated with the present uniform view of the organization of matter. This evidence was reviewed in the 1933 discussion of the Faraday Society on "Liquid Crystals and Anisotropic Melts." There should be mentioned: (a) The x-ray investigations of G. W. Stewart, which led him to believe that ordinary liquids consist chiefly of orderly arranged aggregates of molecules but also in part of molecules having a much more random distribution. (b) The work of Ornstein and his collaborators, who arrived at a similar view of the structure of liquids through investigations of dielectric losses, measurements of dielectric constants in magnetic fields and x-ray investigations of liquids in electric and magnetic fields. (c) And that of Bernal and Fowler (*Jour. Chem. Physics*, I, 515, 1933) on the nature of water. Diffusion coefficients and viscosity coefficients of liquids are related to each other in a reciprocal fashion in accordance with the Einstein-

[1] Read before the National Academy of Sciences, Cleveland, November, 1934.

Sutherland relation (Einstein, *Zeits. Elektrochem.*, 14: 235, 1908) $D = \frac{RT}{6\pi\eta rN}$ (η is the viscosity of the solvent and r is the radius of the solute molecules), whereas in the gas phase the two coefficients are proportional to each other, being related by the equation $D = \frac{\eta}{\rho}$ (Loeb, "Kinetic Theory of Gases," p. 224, McGraw-Hill Book Co., 1923). The former relation assumes the validity of Stoke's law, which is valid for large spheres but for small molecules could not be justified on a kinetic conception of viscosity analogous to that for gases. This should at once suggest that new kinetic factors prevail in the liquid phase. It is apparent that the micro-crystals which augment viscosity in proportion to the fraction of the volume which they occupy will hinder diffusion to a corresponding degree, and thus account for the reciprocal relation. The concept of micro-crystals should shed its light upon other properties of liquids. Thus their resolution into single molecules with increasing temperature would add a term to the specific heat expression for a liquid. The measured compressibility of a liquid is a composite of the compressibility of the liquid and microcrystalline portions. The micro-crystals in liquid surfaces offer centers for catalytic action which would not have been suspected without them. These questions have not been developed sufficiently for presentation.

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THE ETIOLOGY OF EPIDEMIC COLDS IN CHICKENS*

DEBLIECK[1] was the first scientist to report on the cause of colds in the chicken. This investigator discovered a hemophilic bacterium which appeared to be involved in the disease in Holland. The first American investigator to report on a similar disease was Nelson.[2] This worker found a Gram negative bacterium which appeared to be responsible for the outbreaks investigated. The chickens affected with this disease did not appear sick, and there was no mortality. Production was seriously affected; and some of the birds showed a bilateral discharge, while distinct gurgling sounds were heard in the trachea. At necropsy considerable exudate was found in the nasal passages, the infraorbital sinuses and the trachea. The disease was transmitted to healthy birds by fresh tracheal exudate from diseased birds and by a hemophilic bacterium isolated from the exudate on culture media.

Delaplane and Stewart,[3] working independently and at the same time as DeBlieck and Nelson, found a Gram negative hemophilic bacterium which they considered to be the cause of a serious outbreak in Rhode Island. The symptoms were those of an exudative rhinitis and sinusitis with little involvement of the larynx, trachea or bronchial tubes. The eyes, turbinates and infraorbital sinuses showed various degrees of inflammation. The mortality in the Rhode Island outbreaks was comparatively high.

Lewis and Mueller[4] report a series of experiments which lead them to believe that the agent of the "common cold" in chickens is not a filtrable virus, and further work by Eliot and Lewis[5] indicates that a pleomorphic, hemophilic, Gram negative bacterium is the responsible agent. They suggest the name *Hemophilus gallinarum* for the microorganism. In their filtration experiments Lewis and Mueller used Berkefeld, Mandler, Chamberland and Seitz filters with negative results.

Six widely separated outbreaks of coryza or colds in chickens have been studied in Massachusetts, using both bacteriological and filtrable virus methods. Five of these outbreaks presented symptoms similar to those described by Nelson, and one in a flock of game birds was like that described by Delaplane and Stewart. A hemophilic streptococcus was isolated from one,[6] a hemophilic bacterium from three[7] and no pathogenic microorganisms could be found by cultural methods in two of these outbreaks. Filtrable agents were not demonstrated in any of these cases when Berkefeld, Coors and Seitz filters were used. These findings are in agreement with those of DeBlieck, Nelson, Delaplane and Stewart, in that Gram negative, hemophilic microorganisms may be present in colds of chickens and aggravate the symptoms and lesions of the diseases, as well as taking some part in immunity.

Tracheal exudates from the two outbreaks in which hemophilic microorganisms could not be isolated were studied by means of a series of graded acetic-cellodion filters prepared according to the directions of Cox and Hyde.[8] The causative agent passed successfully through these filters, and was transmitted directly to healthy chickens by intranasal and intratracheal inoculation of bacterial free filtrates. The outbreaks from which the hemophilic microorganisms were isolated occurred before the series of graded acetic-cellodion filters were used in this laboratory and were not tested by this method.

Since there is no satisfactory standard for measuring the size of the pores in the filters used in this

* Contribution No. 214, Massachusetts Agricultural Experiment Station, Amherst, Mass.

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[6] C. S. Gibbs, *Poultry Sci.*, 12: 46, 48, 1933.

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