formed, thus indicating the unsaturated nature of cinobufagin.

Bufagin, $C_{24}H_{32}O_5$, when treated with alkali, forms a hydroxy-carboxylic acid with the opening of a lactone ring and splitting off of formic acid. On acetylation one acetyl group is introduced. Under the influence of hydrochloric acid formic acid and one molecule of water are split off. Several attempts to secure a ketone by oxidation with chromic acid have failed. From these findings one may conclude that the molecule of bufagin contains a lactone, a formoyl and a tertiary hydroxy group, thus accounting for the five oxygen atoms in the molecule. On catalytic reduction tetrahydrobufagin is formed, indicating that bufagin is also of unsaturated nature. Catalytic reduction of cinobufagin and bufagin also gives by-products of acid character, probably formed by the opening of the lactone ring.

From the foregoing one can see that the chemical behavior of cinobufagin and of bufagin is quite similar to that of the plant cardiac aglucones. By splitting off the acid radical which is attached to a hydroxy group (acetic acid from cinobufagin and formic acid from bufagin), one obtains compounds which are C_{23} derivatives, as are the aglucones of the plant glucosides.

$$\underset{\text{Cinobufagin}}{C_{25}H_{32}O_6} \xrightarrow{+H_2O} C_{23}H_{30}O_5 + CH_3COOH$$

$$\underset{\text{Bufagin}}{C_{24}H_{32}O_5} \xrightarrow{+H_2O} C_{23}H_{32}O_4 + HCOOH$$

While the cardiac poisons of the plant kingdom are combined with carbohydrates these principles of toad poisons are coupled with acetic acid or formic acid, or, as in the case of the nitrogen containing principles, which also have a cardiac action, with suberylarginine and an acid radical.

It has already been mentioned that bufagin under the influence of hydrochloric acid will lose formic acid and one molecule of water.

$$\underset{\text{Bufagin}}{C_{24}H_{32}O_5} \xrightarrow{HCl} \underset{\text{Bufagien}}{C_{23}H_{30}O_3} + HCOOH + H_2O$$

Bufagin is a mono-hydroxy lactone containing three double bonds and should give on catalytic reduction a compound of the composition $C_{23}H_{36}O_3$. It is hoped that the latter substance may be identical with one of the known reduced anhydro compounds of the cardiac aglucones of the plant glucosides[5]. If this should be true it would be a direct proof of the chemical relationship between these two groups of natural compounds. This reaction is now being carried out and attempts are also being made to convert cinobufagin by similar steps into the corresponding compound. The results so far obtained and those which are being accumulated will be published later in greater detail.

Another method of approach to show the possible chemical relationship between the cardiac principles of toad poisons and those of the plants may be as follows: Bufagin and cinobufagin are converted with alkali into the corresponding hydroxy-acids and these are then catalytically reduced, giving C_{23} derivatives, which may be identical with compounds obtained from the plant aglucones in a similar manner. This method is being investigated.

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[5] See reference 4; W. A. Jacobs and A. M. Collins, *Jour. Biol. Chem.*, 63, 123, 1925; W. A. Jacobs, R. C. Elderfield, A. Hoffman and Th. B. Grave, *J. Biol. Chem.*, 93, 127, 1931.

CRYOLYSIS OF LYOPHILIC COLLOIDS, AND ITS BEARING ON THE MECHANISM OF ENZYME ACTION

IN a recent publication[1] evidence has been furnished that the surface tension of a solution containing lyophilic biocolloids is increased by ethylene as well as by acetylene. At the same time the observation was made that the viscosity of the same solutions was decreased. These observations were interpreted on the basis that ethylene or acetylene are in a state of physical adsorption on the surface of the lyophilic colloids. The gases exert accordingly a protector action on the combined carrier-enzyme surface, the latter being increased when submitted for shorter or longer time to the influence of freezing.[2] In order to obtain a detailed information of the latter observation solutions of different concentration of egg albumin, gelatin, gum arabic and sodium oleate were investigated by means of cryolysis. The measurements of the surface tension of all the solutions in all concentrations, having been frozen once or repeatedly at different temperatures, furnished a decided increase. The viscosity, however, was decidedly increased solely in the case of egg albumin, decreased when using solutions of gelatin or gum arabic and immaterially influenced in the case of sodium oleate solutions. The electrical conductivity

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[1] F. F. Nord, *Trans. Faraday Soc.*, 26: 760. 1930.

[2] F. F. Nord, *Nature*, 120: 82. 1927.

of solutions in the range of a concentration of 0.01 per cent. was decidedly increased, whereas in a concentration above 0.1 per cent. it was decreased, and finally the speed of cataphoretic mobility of the colloid particles, when measured in solutions of gelatin and egg albumin, was practically doubled after freezing.

The fact that the values of viscosity determinations were decreased in some cases, but the values of surface tensions, however, showed a thoroughgoing increase, may be understood if we recall that, for instance, a zymase solution or a gelatin solution may be considered as in every respect a more heterogeneous system, when compared with a solution, for instance, of egg albumin. It is necessary, therefore, to assume that under the effect of freezing, lyophilic colloids not only may undergo a disaggregation of the colloid particles, but also an aggregation of the same.

In so far as the values of surface tension measurements are concerned, we noticed that the reapproachment to the value of the surface tension of conductivity water was the greater, the more the respective solutions were diluted. In order to understand this fact we may assume, in accordance with the considerations of Gortner and coworkers[3] concerning the bound $\leftrightarrows$ free water equilibrium, that the surface tension of a lyophilic colloid solution is a resultant of three factors. namely, (a) the surface tension of colloid particles, and (b) the surface tension of the aforementioned two parts of the water system. Under the assumption that the increase of the value of surface tension of a frozen and afterwards thawed solution of lyophilic colloids, if not caused by dehydration of the particles, is due to a decrease of the radius of the colloid particles and subsequent increase of the surface of the same, then the bound $\leftrightarrows$ free water equilibrium is shifted in disfavor of the free water component. Accordingly, the surface tension increases only to the extent of the difference between the surface tension value of the particles and the value of surface tension of the water system. The diluted solutions on the other hand contain less particles, and accordingly the additional amount of bound water, when the surfaces are increased on account of freezing, as well as the difference between the value of the particles and the value of water, is smaller. The increase of the value of the surface tension is therefore greater in the case of diluted solutions. It was noticeable in this connection that sodium oleate solutions showed a decided diminution of volume in frozen state, compared to the unchanged volume of frozen proteins or gum arabic. This observation may be due to the possibly much less material rôle of the bound water in the case of colloidal electrolytes.

The disaggregation-aggregation hypothesis is supported also by the results of the measurements of conductivity and cataphoretic mobility of the particles, since we assume that the conductivity of dispersoid systems, containing the same amount of substance in dispersion of different degree, is reciprocally related to the square of the radius of the particles. The conductivity itself is based on the particles of highest dispersion of the system. The increased cataphoretic mobility on the other hand may be due to the fact that on account of increased dispersion, electrolytes went into solution out of the proteins, causing an electrical charge of the particles, which again causes an increase in their mobility.

Since, according to our present knowledge, proteins have to be considered not only as the substance of crystalline enzymes, but also as being responsible for the properties of the so-called carriers, so we may consider the results of our measurements as the first exact proof of the colloidal carrier's dependence of functioning on its physical state. At the same time it may be also mentioned that the biochemical behavior of physically transformed lyophilic colloids is distinctly different from the original systems.

It is intended to report in detail the experiments in the *Kolloid Zeibschrift.*

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SEX DIFFERENCES IN THE STUDY OF GENERAL SCIENCE

THE purpose of this study is to investigate sex differences in the difficulty of the course in ninth-grade general science, and variations in difficulty from one part of the course to another.

Since competent writers of general science textbooks do not agree upon what to include in the course, the selection of material for investigation must necessarily be arbitrary. Seven hundred forty-eight statements were chosen from text-books commonly adopted, the intention being to obtain a varied and random sampling of material sometimes used. To validate the use of these statements, ten text-books were surveyed to discover the extent to which these statements were incorporated into the course. A statement was counted as being in a book if found stated directly or if material was found from which it could be readily deduced. Table I summarizes these findings.

This list of statements agrees as well with the textbooks as they do with each other and is better justified than a list of statements found in all text-books, since

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[3] R. A. Gortner, "Outlines of Biochemistry," p. 230, New York, 1929.