

coarse xerophytic herbs, largely composites (*Silphium laciniatum*, *S. terebenthinaceum*, *S. integrifolium*, *Lepachys*, *Solidago rigida*, *Aster*, *Liatris*), with legumes (*Amorpha canescens*, *Petalostemon*, *Melilotus*, *Baptisia*), and *Eryngium*, *Dodocatheon*, *Phlox* and *Allium cernuum*. These prairies are being formed from the basin of the former glacial Lake Chicago.

The formation of natural grass and forest regions in the Chicago region may be explained by a study of its glacial history. While the edge of the ice in the last advance was being melted back to the Valparaiso moraine and while it remained there, glacial water flowed off to the south. From northern Illinois this found its way by various valleys to the Mississippi. As the ice retreated farther to the north-east of the Valparaiso moraine, the depression between the ice front and the morainic ridge was flooded with the glacial water. The Lake Chicago so formed gradually enlarged as the edge of the ice retreated. Its waters rose until they reached a level of about sixty feet above the present surface of Lake Michigan.

At this stage Stony Island was completely submerged. When the outlet of Lake Chicago was lowered, it entered upon a second stage twenty feet below the first, but Stony Island was still under the water. As the outlet was lowered further the lake level fell to the third stage (the Tolleston stage), which exposed the very top of Stony Island. By the breaking of the waves a beach ridge was formed on top of the island and at this time the forest began its growth. Then when the ice sheet melted away and an outlet was established by way of the St. Lawrence Valley, the old lake fell to the present level of Lake Michigan, and the surroundings of Stony Island became land. These surroundings, rapidly drained, are to-day grassland, while Stony Island itself is practically covered with forest.

I believe furthermore that the grasses in the prairies are not a climax stage, but that the forests are gradually encroaching upon them. This process is very slow because the grass, when once firmly established, forms a mat which prevents the seeds of trees from getting into the soil and germinating. There are conditions, however, which aid the forest seeds in securing a place in the grass-covered soil. For example, disturbances of that mat are caused by man's digging or plowing, horses pawing the earth and erosion by running water. If tree seeds once fall in such places they will germinate and if undisturbed will grow. This would explain the presence of trees, either in patches or scattered throughout an area once covered with grass. Indeed, the savannah may be accounted for in such a manner.

The help of eroding forces in the formation of forest may be further shown by observation of sand dunes. Here the instability of the soil is preventing the grass from forming a mat, and forests are slowly encroaching upon the dunes, securing a foothold before a grass mat can be formed.

In view of the above observations, I am of the opinion that the natural prairies of the Middle West are due not to present physical conditions but to rapid drainage at the close of the ice age. Further I believe that the grass stage thus formed is not the climax, but that trees are slowly invading the prairie, being aided in their progress by erosive processes.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE PREPARATION OF COPPER HYDROSOL AND ITS USE IN ELECTROPLATING OF GLASSWARE¹

SOME time ago the author found it necessary to copper plate the bore of some capillary tubing. For technical reasons, a basic layer of another metal or of graphite was undesirable, even had it been possible to apply the latter. Cathodal deposition was also out of the question.

By employing hydrazine hydroxide as a reducing agent a suitable copper hydrosol was prepared. Gutbier found hydrazine hydroxide in 1-4,000 dilution sufficient for formation of the blue gold hydrosol² but since copper is immediately below hydrogen in the electromotive table a much stronger solution was found necessary in this case.

Method.—An article to be plated is well cleaned—that process followed by Brashear in his silver plating method³ should be satisfactory. It is then placed in a receptacle of just sufficient diameter to accommodate it and covered with a 50 per cent. aqueous solution of hydrazine hydroxide. (It is not necessary to prepare this from the salt—it appears to keep indefinitely when placed in the dark. After some months there may be a faint odor of ammonia, but there is no appreciable reduction in concentration.) To this is added, drop by drop and with constant vigorous shaking, a 5 per cent. solution of cupric sulphate until a deep golden suspension of colloidal copper is obtained. One or two drops of excess are then added and metallic copper is de-

¹ From The Hull Physiological Laboratories of The University of Chicago.

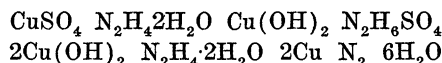
² Gutbier, *Zeit. für Anorg. Chem.* 1902.

³ Brashear, Miller's Laboratory Physics. Ginn & Co.

posited as a thin film upon the surface of the article and the walls of the container. This film may serve as a support and conduction pathway for a subsequent layer of electrolytically deposited copper.

The method finds some objection in the expense of the reducing agent employed.

The reaction is simply the formation of cupric hydroxide and its immediate reduction by the excess of hydrazine.



The rapidity of the reaction allows for the formation of a hydrosol which gradually precipitates due to the presence of the bivalent SO_4 ion. When a suspension of cupric hydroxide is used instead of the sulphate the precipitation is much slower.

However, the same effect is obtained by addition of an alkali to the hydrazide of copper. This substance, prepared by treatment of potassium hydrazine carbonate with dilute copper sulphate, is a blue, amorphous, insoluble powder, of empirical formula CuN_2H_6 . It shows all the qualitative reactions of a hydrazide.

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SPECIAL ARTICLES

ON THE APPARENT LARGE DIAMETERS OF MOLECULES FOR DEACTIVATION BY COLLISION

A RECENT paper by Tolman, Yost and Dickinson¹, devoted mainly to a criticism of some of the underlying physical assumptions made by Fowler and Rideal² in a theoretical study dealing with the rate of maximum activation by collision for complex molecules, with particular reference to its application to velocities of gas reactions, takes up the question of the apparent large diameters for deactivation-collisions to which the latter theory seems to lead.

The purpose of this note, in addition to one or two other observations, is to point out an error in Tolman, Yost and Dickinson's calculation on N_2O_5 . In agreement with Fowler and Rideal they show that the fraction of molecules possessing energy greater than ϵ_0 in a system containing N molecules per c. c. each molecule having s variables (coordinates or momenta) which contribute classical square terms to the internal energy, is

$$N_{\text{act.}} = N \frac{1}{\Gamma(\frac{1}{2}s)} \left(\frac{\epsilon_0}{kT} \right)^{\frac{1}{2}s-1} e^{-\frac{\epsilon_0}{kT}}$$

¹ Proc. Nat. Acad. of Sci. 13, 188, 1927.

² Proc. Roy. Soc. 113, 571, 1927.

If the maximum possible rate of deactivation by collision with unactivated molecules is given by

$$Z_{\text{deact.}} = 4 N N_{\text{act.}} \sigma^{*2} \left[\frac{\pi kT}{m} \right]$$

and if the principle of microscopic equilibrium holds, the maximum possible rate of activation by collision with unactivated molecules according to these authors, is given by

$$Z_{\text{act.}} = 4 N^2 \sigma^{*2} \left[\frac{\pi kT}{m} \frac{1}{\Gamma(\frac{1}{2}s)} \left(\frac{\epsilon_0}{kT} \right)^{\frac{1}{2}s-1} e^{-\frac{\epsilon_0}{kT}} \right]$$

σ^* being the mean diameter for a deactivation by collision. ϵ_0 is connected with the heat of activation q in the Arrhenius expression by the relation

$$\epsilon_0 = q + (\frac{1}{2}s - 1)kT$$

$s = 14$; $T = 300^\circ\text{K}$; $Q = 24,700$ calories; $\frac{Q}{RT} = \frac{q}{kT} =$

41.5; and $\frac{\epsilon_0}{kT} = 47.5$. By substitution one obtains for the rate of activation:

$$\begin{aligned} Z_{\text{act.}} &= 4 N^2 \sigma^{*2} \left[\frac{\pi \times 8.3 \times 10^7 \times 300}{108} \left(\frac{1}{6!} \right) (47.5)^6 e^{-47.5} \right] e^{-\frac{Q}{RT}} \\ &= 4.25 \times 10^9 \sigma^{*2} N^2 e^{-\frac{Q}{RT}} \end{aligned}$$

The rate of decomposition as found by Hirst and Rideal³ is

$$2.53 \times 10^{14} N e^{-\frac{Q}{RT}}$$

taking $N = 1.615 \times 10^{15}$ molecules per c. c. at 0.05 mm. Hg. and 300°K . and assuming equality in the two rates,

$$\sigma^* = 6.07 \times 10^{-6} \text{ cm.}$$

or about 15 times that to be expected from kinetic theory values. Tolman, Yost and Dickinson's value for the same calculation is 4.7×10^{-4} cms. or nearly 1,000 times greater than kinetic theory values. The difficulties they point out with respect to large diameters are thus greatly reduced in significance especially when we remember that several other cases of large effective radii are known. MacNair⁴ calculates the effective diameter of excited Cd atoms as 3×10^{-6} cms. from observations on depolarization effects. By comparing the per cent. of polarization of D_2 resonance radiation in sodium vapor at 10^{-6} mm. pressure excited by polarized light, with that predicted by the Heisenberg theory, Datta⁵ finds that the effective diameter of the colliding atoms is of the order of magnitude 10^{-4} cm. or over 1,000 times the kinetic theory value. Similarly Schütz⁶ calculates the effective diameter of a collision between normal mercury atoms and mercury atoms in

³ Proc. Roy. Soc. 109, 526, 1925.

⁴ Phys. Rev. 29, 677, 1927.

⁵ Zeit. f. Physik. 37, 625, 1926.

⁶ Zeit. f. Physik. 34, 260, 1925.