or other small bird would be overwhelmed. As it is, the cow-bird studies the limits of endurance in its victims and rarely exceeds the bounds. The most eggs I ever found in a nest infested by cow-birds was nine, and the species generally lays only two or three eggs, thus generally keeping the outside limit to six or seven, with the owner's eggs.

THE USE OF THE TERM "CARBOHYDRATES."

BY W. E. STONE, PH.D., PURDUE UNIVERSITY, LAFAYETTE, IND.

IT has frequently happened in the history of chemistry that names and terms have lost their original significance so soon as the knowledge of the bodies to which they were applied has become more extended. "Organic" chemistry is better named the "chemistry of carbon compounds;" the "aromatic" bodies have disappeared in the broader designation of benzine derivatives. In the same way it appears that we have reached, or already passed, a transition stage in the use of the term "carbohydrates." Treatises on chemistry still retain the old definition of the term, while those familiar with recent progress in this field no longer feel themselves restricted to these ancient limits. It is the purpose of this paper to consider the present status of this subject.

Von Lippmann, in his work "Die Zuckerarten und ihre Derivate," adopts Fittig's view that the carbohydrates are derived from the hypothetical heptatomic alcohol $C_6H_7(OH)_7$, which, by loss of water, forms the simple or complex anhydrides, $C_6H_{12}O_6$ or $C_{12}H_{22}O_{11}$, known as sugars. His treatment ignores the existence of any carbohydrate with less than six carbon atoms, although he says that, with the (at that time, 1882) slight knowledge of the constitution of the carbohydrates, it was impossible to regard this definition as final and complete.

In 1888 appeared Tollens' "Handbuch der Kohlenhydrate," in which the definition of "carbohydrates" was limited strictly to the bodies composed of C, H, and O, containing six carbon atoms, or some multiple of six, and H and O in the same proportion in which they are found in water. But already Kiliani had shown that arabinose, which had long been regarded as a true carbohydrate on account of all its reactions, had really the composition $C_5H_{10}O_5$. Moreover, it had already been established that the best known sugars, such as dextrose, levulose, galactose, and arabinose, had the constitution of aldehydes or ketones of the hexatomic, respectively pentatomic, alcohols. In anticipation, therefore, of evident progress along this line, Tollens remarks in his preface that such bodies as arabinose and the impending erythrose might well be regarded as carbohydrates, but he retains the hexatomic nature as a requirement for the "true carbohydrate," and puts all non-conforming but similar bodies under the head of "den Kohlenhydraten nahestehenden Körper."

Up to this time a sort of understanding had prevailed that the carbohydrates were exclusively products of natural forces. It had also been noted that these bodies gave certain reactions, which were also presented as a basis for the classification given.

These reactions, as stated by Tollens, are:—

1. Reduction of alkaline metallic solutions.
2. Rotation of polarized light.
3. Subject to alcoholic fermentation by yeast.
4. Formation of levulinic acid.
5. Formation of characteristic compounds with phenylhydrazin.
6. Certain color reactions.
7. Solubility, either before or after hydrolysis.
8. Decomposition by heat.

All of which hold strictly true for the hexatomic carbohydrates. This classification was probably as liberal as the state of knowledge at that time would justify.

But this classification is evidently arbitrary and ought not to have weight in comparison with any classification based on chemical constitution. If a similar constitution can be proven for a series of bodies, the fact that they respond to certain reactions will only be additional proof of their relationship. Such reactions must, of course, be general in their nature, while special reactions will only serve to characterize individuals. In this way the class of carbohydrates must eventually include only bodies of certain constitution, while the characteristic reactions will be limited to a smaller number, of more general application. A similar development has taken place in the manner of classifying the hydrocarbons, alcohols, acids, glycerides, etc.

Of the carbohydrates conforming to the old definition, dextrose, levulose galactose, and mannose are types. They respond to the reactions given and have been found to possess the constitution of ketones or aldehydes of the hexavalent alcohol, $C_6H_{14}O_6$. But we know two bodies of the formula $C_5H_{10}O_5$, arabinose and xylose, which are also aldehyde alcohols, and which give the same reactions as their homologues, with the exception of fermentation and the formation of levulinic acid. Again, we know an aldehyde of the tetratomic alcohol erythrit, called erythrose, of the formula $C_4H_8O_4$, which responds to the same general reactions as its homologues. Glycerose, $C_3H_6O_3$, has also been studied and found to correspond to the others of the series in constitution and general reactions. It is even fermentable with yeast like the regular carbohydrates, which shows this to be an intermittent reaction when applied to an homologous series. Beginning again with the group $C_6H_{12}O_6$, we find that there have been prepared synthetically three other homologues representing aldehydes, respectively of the hept-, oct- and nonatomic alcohols. These also respond to the general reactions given, except that they do not form levulinic acid. Heptose and octose do not ferment, but nonose, with its multiple of three carbon atoms, is fermentable.

It is no argument against the carbohydrate nature of these bodies to say that they do not occur in nature, since two of the hexoses (galactose and mannose) have never been found free, but are only known as derivatives of certain natural products. In this respect they are on precisely the same footing as arabinose, xylose, erythrose, and glycerose.

It appears, therefore, that we have an homologous series of aldehyde or ketone alcohols of the general formula $C_nH_{2n}O_n$ with these common properties: 1° sweet to the taste; 2° optically active; 3° reducing alkaline metallic solutions; 4° yielding with phenylhydrazin characteristic crystallinic compounds. Other reactions, such as great solubility, decomposition by heat, and color reactions, are less characteristic, although possessed in common. Those containing three, or multiples of three, carbon atoms undergo alcoholic fermentation with yeast, and this periodical reaction seems an additional argument for their common nature. Individually they yield, when heated with strong acids, characteristic derivatives; for instance, the pentoses yield furfurol; the hexoses levulinic acid; others have not been carefully studied in this direction.

Following are the members of this homologous series which are known, although several additional isomers are possible:—

Triose, $C_3H_6O_3$.— Glycerose.
Tetrose, $C_4H_8O_4$.— Erythrose.
Pentose, $C_5H_{10}O_5$.— Arabinose, xylose.
Hexose, $C_6H_{12}O_6$.— Dextrose, levulose, galactose, mannose, all in isomeric forms.
Heptose, $C_7H_{14}O_7$.— Heptose.
Octose, $C_8H_{16}O_8$.— Octose.
Nonose, $C_9H_{18}O_9$.—Nonose.

By the definition of carbohydrates, now extant, only the hexoses are included. It is the purpose of this paper to propose the extension of this term to all members of the homologous series, on the basis of a common constitution, viz., as aldehydes or ketones of the normal polyatomic alcohols of the aliphatic series. As characteristic properties of all these, must follow their behavior toward polarized light, toward alkaline metallic solutions, and toward phenylhydrazin.

Such a classification would exclude the bodies of the cellulose group, of which there are many, more or less well defined. But it is not yet evident that they possess a constitutional relation to the bodies under discussion, and have certainly no claim to be classed with the aldehyde or ketone alcohols because convertible into them.

As for the disaccharides of the hexoses, to which belong sucrose, lactose, etc., if it be true, as supposed, that they are anhydrides or ether-like forms of the hexoses, then they are entitled to a place among carbohydrates as derivatives or modifications of the same.

E. Fischer proposes to apply the name "sugars" to all the members of this homologous series, to which he has lately added the glycol-aldehyde $C_2H_4O_2$ as the simplest possible example. The popular conception of the properties of a sugar are not, however, easily reconciled with the properties of some of these bodies, while "carbohydrates" at least possess some reference to their impirical composition. With regard to glycol-aldehyde, moreover, its optical inactivity would exclude it from the list under the conditions here proposed, although its constitution undoubtedly satisfies the requirements.

ELECTRICAL NOTES.

Variations in Resistance.

IN a recent article in the *Philosophical Magazine* appears a paper by Mr. Fernando Sandford, entitled "A Necessary Modification of Ohm's Law." Why it should have been given this title does not appear, for it nowhere calls in question the law which goes by Ohm's name. A better title would have been "On the Variation of Resistance of a Conductor with Change of the Medium Surrounding It." The facts observed are of interest, though not new, as it has long been known that the resistance of a wire changes when immersed in different gases. Chatelier, for example, found that the resistance of a silver wire changed enormously when immersed in hydrogen gas, and that if left in it for some time its temperature coefficient changed also. Mr. Sanford has extended the list considerably, his experiments, though made with a wire of one metal only, i.e., copper, embrace a great variety of mediums, both liquid and gaseous. That the variation is due to the causes noticed in the experiments of M. Chatelier and not to heating of the conductor, as proposed by some, is probable from the following considerations. The total heat generated in the wire, using the ordinary coefficients of emissivity for polished copper, would not raise the temperature of the wire more than the one ten-thousandth of one degree centigrade, and the increase of resistance from this cause would be inappreciable. But the effect of a thin film on the wire would be far different. It was first pointed out by Mr. Kennelly to the writer that the extremely thin film of tin on electric conductors was sufficient to lower the resistance of moderately small wires as much as five per cent. If we suppose that when a wire is placed in a gas like SO_2 a thin film of a compound of the copper and the gas is formed, only the one twenty-five-thousandth of an inch in thickness, it will account for all the phenomena observed by Mr. Sanford. For, as the wire experimented on was one millimetre in diameter, the formation of a layer $\frac{1}{25000}$ of an inch thick would reduce the cross section of the copper by two-tenths of 1 per cent, and therefore increase the resistance by 0.2 per cent, or nearly the maximum change observed by Mr. Sanford. This thickness of film is not much greater than the thickness of the films which cause the iridescent colors on steel, being about three to five times as thick; so that we see that the slightest action of the gases on the surface of a wire would change the resistance quite appreciably, and on exposure to air the wire would recover itself again. It should be added, moreover, that such films would not necessarily be visible.

An easy way of settling the question would be to use wires of different diameters. With a wire whose diameter was .0035, or No. 40 B.W.G., and which is furnished for commercial purposes, the resistance should vary as much as one and a half per cent, while with a wire one centimetre in diameter it should be inappreciable. R. A. F.

A JOINT meeting of the Scientific Alliance of New York, in memory of Professor John Strong Newberry, will be held at Columbia College, Monday evening, March 27, 1893, at 8 o'clock. An address will be given by Professor H. L. Fairchild, "A Memoir of Professor John Strong Newberry." Remarks will be made by others, and a number of letters regarding Professor Newberry will be read.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Does the Ether Absorb Light?

WHETHER or not light is absorbed in any degree by the ether through which it passes has been argued a good many times, and to-day is not settled on any experimental basis. That it is not so absorbed to any considerable degree is evident from the light from such distant stars that reaches us. From theoretical considerations some have concluded that many more stars would probably be seen by us if in some way their light was not stopped by the ether, and that the midnight sky would or should be brighter than it really is.

In all the treatments of the subject which I happen to have seen, there is one important element which has not been considered at all, and to me it seems as if that one would account for the limit to the number of stars we see without assuming that the ether possesses the ability to transform energy within itself, which would be the case if the energy of waves like light waves were changed into any other kind of energy not capable of affecting our eyes This fact is, that, in order to see, some energy is needful. I mean that there must be some limit to the amplitude of the vibratory movement beyond which we could not see, simply because the energy of the wave is insufficient; so that no matter what the intrinsic brightness of a given light may be, if it be far enough removed from an observer it will cease to be visible, simply because the energy of the waves is too small to excite the sensation. As the energy of such radiant energy on unit area varies inversely as the square of the distance, and as the amplitude of the vibrations at the initiating atoms or molecules can at best not exceed the diameter of the atoms or molecules, the extreme minuteness of the amplitude at the distance of the fixed stars from us shows how exceedingly delicate is the eye for perceiving it at all. The enormous frequency of the waves gives them a degree of energy they could not otherwise have; but if there were no amplitude there would be no energy, and it is to be conceived that if space be illimitable and the number of stars be infinite, yet with eyes constituted like ours only the light of stars within a limited space would be visible, and such optical data would give no reason for holding that what could be seen was the whole, nor for the conclusion that the light from more distant stars was absorbed by the medium through which it was distributed.

The photographic work done in this field testifies to the same conclusion when we are presented with the image of a star which had never been seen. The photographic plate acts cumulatively and if one minute's exposure is not enough, take ten minutes or ten hours, but the eye cannot so act; if one cannot see an object in a second, he can see it no better by continued looking. I conclude, therefore, that we have no evidence that the ether absorbs any of the energy of the ether waves. A. E. DOLBEAR.

Tuft's College, Mass., March 9.

Natural Selection at Fault.

IN your issue of Feb. 17, Mr. Richard Lees replies to the rather misleading article of Mr. J. W. Slater in your issue of Jan. 20, and takes, it appears to me, the right view of the case as regards the Felidæ, but misses it when he attempts to account for the hen's cackle. No one reason will account for the latter. Frequently the hen that is a member of a large barn-yard flock may be observed cackling at the top of her voice prior to the laying of the egg, and it has been my observation that in 9 cases out of 10 this is due to the fact that she has found a usurper in her nest in the person of another hen engaged in egg laying. Close observation, covering many years, leads me to think that the cackling after the egg is laid has nothing whatever to do with nest-disclosure or nest-hiding, but is simply a notification to the cock of the flock that the important task of the day is accomplished.