The Easily Oxidizable Substances in Plants.

Many expressed vegetable and fruit juices, it is well known, graduallydarken when exposed to the air. In other cases, the cut surfaces of roots and branches, of leaves and fleshy fruits, slowly acquire a brownish tone. This interesting property, which is of some importance for an understanding of the chemical properties of the living cells of plants, has been recently more closely examined in his study of the chemistry of protoplasm.

There can be no doubt that this phenomenon is due to an oxidation of certain substances in the sap, or juice, by the oxygen of the air. For, if we grate up some potato tubers, for instance, the upper layer of the magma, which is in contact with the air, takes on a reddish color, and by frequent stirring this red color can be imparted to the entire mass. The juice that is expressed from potatoes has a yellow color, but in the air it rapidly acquires a reddish violet, finally a brown color. In time this color penetrates deeper and deeper, until finally the juice looks like brownish-black ink. By the exclusion of the air, the potato juice can be preserved for a long time colorless. On the other hand, it has been observed that this juice, which had become black if left standing until decay and fermentation began, loses color again, and that this can be accomplished by certain reducing agents like sulphur dioxide and sulphydric acid gases. [In the manufacture of evaporated apples the brown color is removed by burning sulphur before the drying is begun.—TRANS.]

The juice of the sugar beet, the pure white *Beta vulgaris*, is still more sensitive to the oxidizing action of atmospheric oxygen. In contact with air it immediately turns a dirty wine-red, then purple brown, and finally almost black.

These facts show that easily oxidizable substances are present in the living cells of plants, and that they attract atmospheric oxygen with avidity, forming with it oxidation products. Since these products, which are so easily recognized by their dark color, do not occur in the unwounded cells, it follows that there is either no free oxygen within the cells, or that, besides these oxidizable bodies, there are other substances having reducing properties, which prevent the oxidation of the former, or that in protoplasm oxidation produces other substances which are colorless.

[A fourth possibility which Reinke did not consider is that this easily oxidizable substance is produced by rubbing, cutting, or crushing of the cells.]

To decide which of these three supposable cases really exists is not yet possible. It is worthy of notice that a sugar beet cut smoothly across preserves the surface colorless for a long time, while the grated tissues rapidly darken.

The importance, from a physiological view, of the occurrence of an easily oxidizable substance need hardly be mentioned. When engaged in the study of the existence of oxidizing processes in the living cells of plants, one of the first questions that presents itself is, whether there are substances within the cell which at ordinary temperature unite with the oxygen of the air without need of the active assistance of living protoplasm.

To get a nearer view of this oxidizing process, it is, first of all, necessary to isolate that oxidizable substance and learn its chemical composition. For this purpose Reinke made the following successful experiments with the juice of sugar beets and potatoes.

He first proved with certainty, by chemical test, which we need not repeat here, that in the cells of the sugar beet there is a chromogen, soluble in water, but precipitated by acetate of lead, which can be extracted by ether. He named it *rhodogen*, because it oxidizes in the air to a red dyestuff. A direct chemical analysis was impossible because it changed so easily in the air. The properties of the red dye, "beta red," formed by the oxidation of the rhodogen, were examined. The chemical reactions, as well as the physical properties, particularly the absorption spectrum, exhibited so striking a similarity to alkanet red, that the two dyestuffs must stand very near each other chemically. At all events, like groups of atoms must be present which produce the characteristic spectra. The only difference was that the alkanet red changes less readily in the air than beet red.

"This investigation proves that there exists in the colorless cells of the sugar beet an isolatable, very easily oxidizable, colorless body, which of itself, without the aid of living protoplasm, is able to split the oxygen molecule (by reduction if you wish), and to oxidize itself to a colored substance."

The fact already mentioned, that the cut surface of the beet can lie exposed to the air for days and remain colorless, that no "beet-red" is formed in the living cells, seems to point to a noteworthy distinction between living and dead cells. Reinke does not think it probable that the absence of free oxygen in the living cell is the cause of its remaining colorless, nor that the oxidized rhodogen molecule should be immediately reduced again in the living cell. He considers it more probable that in the living protoplasm of the cell rhodogen suffers a much more energetic oxidation than in the air, so that instead of forming a dye, the rhodogen molecule is totally destroyed, forming carbon dioxide and other end products.

The isolation of the chromogen of the potato did not succeed so satisfactorily as with the beets. By a series of reactions a substance was obtained from the juice of the potato, which, of the known aromatic acids, corresponded most nearly with the hydrocaffeic acid. The quantity obtained was too small for a nearer chemical analysis.

The root tubers of the dahlia also yield a juice that becomes colored in the air. Similar treatment of this juice showed that they contain an easily oxidizable substance like potatoes.

Similar oxidizable bodies were discovered in the *Æthalium septicum*, and the juice of the grated roots of *Daucus carota*.

The general results and conclusions are thus summed by Reinke:

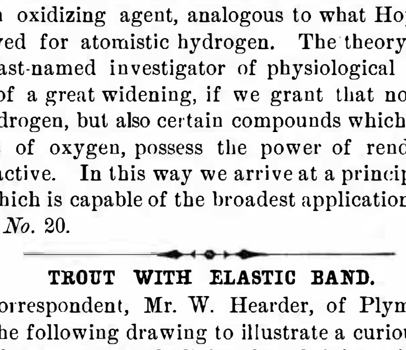
These experiments prove that there exist in the tissues of plants of very different families easily oxidizable substances, which probably belong to the aromatic series. That these substances perform a not unessential function in the exchange of matter can scarcely be doubted. In quantity, it is true, they are inferior to other constituents, and it would be a very tiresome and tedious labor to establish their exact chemical constitution, because for this purpose large quantities must be used. But it is just those very substances which are always present in very small quantities that interest the physiologist, because they are supposed to belong to the important members in the process of the interchange of matter (stoffwechsel), and which, therefore, never can accumulate in large quantities, but without a knowledge of them there can be no real understanding of that process.

The most natural hypothesis regarding the bodies mentioned is that from a physiological point of view they belong to the retrogressive series, and are, perhaps, formed directly by a splitting up of the albuminoids, or by synthesis from the products into which they split. We may also surmise that there is some connection between them and the functions of breathing.

In regard to this last point a short remark may be permitted. If in the living cell, for example, the rhodogen is oxidized to carbonic acid and water, and the former escapes in the breathing process, we could think that the whole breathing of the sugar beet consisted in this oxidation of rhodogen, and that other substances like sugar, that disappear in the breathing process, are only consumed indirectly to produce more rhodogen. But this supposition does not seem to me to be the most probable one. I believe that we have no cause for doubting the direct oxidation of carbohydrates by taking up oxygen; only such an oxidation is scarcely supposable unless the oxygen is first rendered active. Now, inasmuch as the rhodogen is able to split the O_2 molecule, and unite with one of its atoms of oxygen, it may render the other oxygen atom disposable for carrying out an energetic oxidation elsewhere. Thus, rhodogen may act as an oxidizing agent, analogous to what Hoppe-Seyler has proved for atomistic hydrogen. The theory advanced by the last-named investigator of physiological oxidation, permits of a great widening, if we grant that not only nascent hydrogen, but also certain compounds which break the molecule of oxygen, possess the power of rendering the oxygen active. In this way we arrive at a principle of oxidation which is capable of the broadest application.—*Naturforscher, No.* 20.

TROUT WITH ELASTIC BAND.

Our correspondent, Mr. W. Hearder, of Plymouth, has sent us the following drawing to illustrate a curious circumstance of a trout not only living but thriving with its gills compressed in what one would imagine to be a very painful manner, highly prejudicial to health. Mr. Hearder writes: "Mr. Charles Clarke, while fishing in the Plym, hooked a trout about eleven inches long, which had an India-rubber band over the head. The band slipped back over the gill



covers, and was compressing the gills. The horny part of the fish, which extends from the center of the lower jaw to the belly and divides the gills, is deeply dented where the band has evidently been pressing, and it has made quite a cavity under the lower jaw. I should like to know if anybody has marked the fish with the band, or whether it got its head through in an attempt to take it for a bait. How the fish lived is a mystery. It is in splendid condition, and I have preserved it for my museum."—*Land and Water.*

How Singers Should Live.

Women singers, especially in the country, are addicted to three habits which are about equally prejudicial to them as singers. These three habits may be described as the habit of taking irregular and insufficient food, the habit of tight lacing, and the habit of eating candy. I know half a dozen bright American girls, who have really excellent prospects as singers, whose voices are already beginning to betray the fact that their owners live on "lunches" and "candy" rather than three square meals a day. It is very certain that there never will be any tone to a voice that comes from an insufficiently and irregularly nourished body. On the subject of tight lacing a book might be written with ease. Many a girl who now finds great difficulty in taking a high note might do so with comfort if she would only give herself room to breathe. In brief, it may be truly said that no teaching however able, no industry or talent however great, in the pupil can amount to anything unless the would-be singer is content to live a good, clean, honest, healthful life, trusting to good common-sense rules of living, and plenty of fresh air rather than to quacks and nostrums. If vocal teachers, before commencing their lessons, would take the trouble to find out how the pupil lives, and would refuse to give any instruction until the pupil was ready and willing to conform to the simplest rules of hygiene, a great many troubles, especially throat troubles, would be avoided, and the act of singing, instead of being a painful, miserable, ear torturing effort, would be easy and as pleasurable to the singer as to the listener. The rules of life, which the student should observe, are just as important for the singer, private or public; if anything they are more so, for the strain is greater. One thing is certain, the reliability of a singer depends absolutely on the method and manner of life.—*Music.*

Earth Vibrations.

Professor H. M. Paul ingeniously employs reflected light as a means of testing the vibration imparted to the earth by moving vehicles. His arrangement is a very simple one. He sinks a stout post some four and a half feet into the ground, and upon this is a plank supporting a reservoir of mercury—or, rather, of amalgam of tin and mercury. The surface of the mercury is obviously a mirror, and when any vibration is felt by the earth the surface of the mercury is disturbed more or less. An object of a suitable kind is reflected upon the mercury surface, and when there is no vibration this reflected image is, of course, sharply defined. As soon, however, as any vibration occurs, the image moves, and becomes more or less exaggerated.

Professor Paul has hitherto employed a telescope to note the amount of vibration, taking optical notes the while; but the *Photographic News* thinks there is little doubt that photography would help materially in registering the degree of change or vibration. He has found that an express train passing at a distance of one-third of a mile affects the mercury very considerably for a space of two or three minutes, and a one horse vehicle, passing at a distance of five hundred feet, caused a disturbance of the image on the surface of the mercury whenever one of the carriage wheels passed over a stone.

A Dinner Within a Statue.

A few days ago M. Bartholdi, the designer of the colossal statue of "Liberty Enlightening the World"—which is to be erected near New York in commemoration of the American War of Independence—entertained a party of his friends at luncheon. The table was laid in the lower folds of the drapery of the figure. MM. Gaget, Gauthier & Co., of Paris, the contractors for the erection of the statue, have been obliged to take a plat of ground adjoining their foundry, and covering 3,000 square meters, upon which the scaffolding has been fixed. The interior of the statue contains an iron backing, to which are attached the exterior parts, consisting of bronze plates, about one-tenth inch thick by 4 feet 7½ inches square—the largest size made in the trade. The plates are kept together by rivets that are invisible from the outside. The plates of bronze are made to correspond with the contours of the model in an ingenious way. A skeleton of fine wickerwork was first formed, and this was covered with a thick coat of plaster moulded to an exact reproduction of the original. Upon the plaster 6-inch templates of thin wood are adjusted, and are then given to the bronze-workers for models. The weight of the figure will be about 150 tons; the height from head to foot about 110 feet; and from the end of the torch raised in the right hand to the feet, 140 feet. The cost of execution will exceed £28,000, and the work will require five years for completion.

Torpedo Experiments at Newport.

The examination of the graduating class at the Newport Torpedo School was completed August 4. Part of the exercises consisted in a public test of the device of Captain T. O. Selfridge for protecting a ship at anchor from an enemy's torpedo by means of a net and countermines. The vessel is surrounded by a line of torpedoes, which can be individually exploded so as to destroy an attacking torpedo passing near it. The same device can be used to guard the entrance to a harbor.

Another important experiment was a demonstration of the working and efficiency of Lieutenant J. C. McLean's electrical machinery for controlling the movement of a torpedo launch from the shore. The launch, no one being on board, was made to start, stop, back, go to port and to starboard, and to drop and fire mines and countermines, which were rigged at the ends of spars placed on each side of the launch's bow. Lieutenant-Commander Royal B. Bradford, who was at a keyboard on shore, had perfect control of the launch by the aid of one wire. The electrical part of the experiment was in charge of Lieutenant-Commander Caldwell, who was in the electrical building at the torpedo station, at a long distance from the spot where the keyboard was located.

THE State Bureau of Statistics has compiled from the reports of township assessors a statement of the number of rods of drainage tile laid in the several counties of Indiana. The aggregate shows nearly 26,000 miles of tile drainage, with nineteen counties to be heard from.