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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

LAKE ERIE AND THE NEW YORK WATER SUPPLY.

We have had brought to our notice the general outlines of a scheme for providing a source of water supply that would meet the present and future needs of New York city. We present this scheme here in its broad outlines as being an interesting, and not impracticable, study of a problem which is pressing for solution with an emphasis that increases as the years go by. It is suggested that in the vast body of fresh water, Lake Erie, there is an unfailing supply of good drinking water which can be tapped at an elevation of 580 feet above the sea level. The lake is about 300 miles distant from New York city, and it is suggested that, because of this difference of level, by the construction of a suitable aqueduct or aqueducts this water could be brought to New York city, and delivered under a pressure, approximately, of 200 pounds to the square inch, which is 50 pounds more than the highest pressure under which water is now delivered in the most favored portions of the city. Beginning at Lake Erie, the proposal is to build a suitable intake, which would discharge the water into ducts of steel and concrete construction, the steel furnishing the necessary tangential strength to resist the considerable water pressure. It is proposed to take advantage of the reconstruction of the Erie Canal and lay the ducts along the canal right of way, carrying out this work contemporaneously with the enlargement of the canal. At Schenectady the ducts would leave the canal and be carried in an approximately straight line to New York city. In view of the extraordinary rate at which the population of the city is increasing, the ducts would be built of sufficient size for the delivery of a maximum supply of one billion gallons of water a day, should that amount be ultimately required. The structure would be placed beneath the ground, at a sufficient depth to protect it from injury; and for the greater part of its length, after leaving Schenectady, it would follow the undulations of the ground, and involve a minimum amount of tunneling.

To accomplish the necessary reduction in pressure for city use, both in New York and at the various towns along the route which would also be served by the aqueducts, the water, at points of suitable fall, would be carried through waterwheels, and the power thus generated would be a valuable asset. The passage of the water through waterwheels would accomplish the following result: First, it would reduce the pressure; second, it would aerate the water; and third, it would serve to generate power which could be used for municipal lighting for pumping sea water for fire service, and for other city purposes.

It is suggested that this proposition be intrusted to a competent State commission, with power to regulate the water supply and sewage of any city in the State having 100,000 inhabitants or more, making it optional for smaller cities to be included at their request. It is claimed that by making the question of the water supply, not merely of New York but of the cities that lie within reach of the proposed aqueduct, a State matter, and by carrying it through on the broad lines suggested, the whole question would be simplified, the expense per capita reduced, the cities affected connected with a vast natural reservoir of cold, pure water, placed, as if for the purpose, on the very borders of the State, and that thereby the whole miserable business of the Ramapo water company and other complications of the kind would be swept out of the way for good, and this, the most important question affecting the welfare not merely of New York city but also the other leading cities of the State, settled once and forever.

Among the many plans for water supply that have been suggested during the past few years, this is one which seems to be worthy of more than casual consideration.

The correspondent who sent to this office the pamphlet containing the above suggestions is one of the minority who consider that it is inexpedient to carry out the enlargement of the present Erie Canal, on the ground, presumably, that to render the canal efficient it should be built to a much greater depth than 12 feet. He suggests that rather than spend over a hundred million dollars in deepening the canal, it would be wise to abandon the canal as such, and utilize the present bed for the construction of the proposed aqueducts. At present the canal is 56 feet wide at the bottom, 70 feet wide at the surface, and about 7 feet in depth, which would, with some dredging, provide ample cross section to contain ducts of a total capacity of one billion gallons per day. Although this scheme is impossible for the reason that the State is committed to the widening of the canal, the point is certainly well made that, if the construction of such an aqueduct line were carried on simultaneously with the canal enlargement, considerable economy of construction would be realized.

THE TEMPERING OF BRONZE.

M. Leon Guillet has lately made some experiments as to the effect of tempering upon bronzes. It is known that some kinds of bronze are softened by tempering. On the other hand, M. Riche showed that bronzes which contain a considerable proportion of tin, 15 to 20 per cent, are malleable when hot, while they are brittle when cold. The experimenter wished to find the influence of tempering upon the mechanical properties, using different specimens of metal. To carry this out he submitted bronzes having from 5 to 21 per cent of tin to a tempering which varied in different cases from 300 to 800 deg. C. He draws the following conclusions from these tests. 1. Alloys containing more than 92 per cent copper have their breaking strain increased somewhat by tempering at a low temperature between 400 and 600 deg. The elongation varies in about the same way. 2. For metals containing less than 92 per cent copper, the breaking strain and elongation increase in marked degree when the temperature of the tempering exceeds 500 deg. The maximum breaking strain is reached for all the specimens for a tempering carried out at about 600 deg. On the contrary, the maximum of the elongation seems to vary with the composition of the alloy. It occurs at a tempering of 800 deg. for the bronze containing 81 per cent copper and 19 tin, and at 600 deg. for 79 copper and 21 tin. The difference between the breaking strain of the non-tempered cast metal and the pieces which are tempered at the most favorable temperature is greater according as the proportion of copper is smaller. In general it is to be concluded that the tempering of bronze between 600 and 800 deg. C. brings about much better results as to traction tests. As to the resistance to friction, the effect is to be studied in the further experiments.

SUBURBAN TRAFFIC IN LONDON.

The suburban traffic of the railroads of London has suffered severely from the competition of the street electric railroads of the County Council. The decrease in the number of passengers carried during the past year has amounted in one instance to as many as 2,100,000. In order to combat the effect of this competition, the London, Brighton, and South Coast Railroad have decided to convert a section of their suburban road between Battersea and Peckham Rye, which extends through thickly-populated districts, to electricity. This electrification scheme is the first installment of a complete transformation of the whole of the suburban roads. Owing to the many disadvantages and dangers attending the adoption of the third rail, a single-phase alternating-current system with overhead conductors is to be employed, such as is already in operation on railroads for the local services at Hamburg and Berlin, and similar lines running in Belgium, Bavaria, and Austria. Bare overhead wires and a single high-tension conductor are to be employed. The advantages of this system are greater economy, both in the cost of installation and expense of working and maintenance, since currents can be generated and distributed directly to the overhead conductor without requiring any transformation, thereby dispensing with the erection and maintenance of sub-stations, as well as obviating the losses of energy due to the transformation. The rapid acceleration of electrically-operated trains is so important a factor, that the average speed of suburban trains can be nearly doubled. Moreover, the use of trains with motor coaches at either end makes the total time occupied in getting in and out of a terminus much less than that required for steam trains.

BACTERIAL SOIL INOCULATION FOR VEGETABLES.

The recent announcement in these columns that Dr. George T. Moore, of the United States Department of Agriculture, had dedicated to the public his patents on soil inoculation with bacteria, attracted attention to the results of his work.

The primary object of this investigation of the fixation of nitrogen by the root nodules of legumes was to devise, if possible, some method of bringing about the artificial introduction of the necessary organisms into a soil which was naturally devoid of them, and at the same time to attempt as far as possible to correlate and reconcile the vast amount of conflicting evidence that has been accumulated by various investigators, in regard to the exact nature of the organism where the nitrogen is fixed, the effect upon the host, and similar problems.

The actual benefit of the presence of root nodules upon various leguminous plants has been thoroughly demonstrated by numerous observers both in this country and abroad. The early work of Helriegel and Willfarth, together with that of Lawes and Gilbert, and of Warington in England, and of Atwater and Woods in this country, was quite sufficient to demonstrate the close connection between the fixation of nitrogen in some way by the plant and the presence of the tuber-like swellings on its roots, and there are few, if any, who would maintain that this peculiar function is not under most circumstances distinctly beneficial.

Hundreds of examples can be cited, demonstrating the great benefit which a leguminous crop has upon the succeeding crop. From these we can easily see that it is the almost universal belief, as the result of definite experiments, that a leguminous crop is equal to a considerable amount of nitrogenous fertilizer, and that the crop which follows the legume is benefited to a marked degree. It has been found, however, that although in a great many instances the organisms producing nodules are naturally abundant in the soil, and the mere planting of the legume seed is sufficient to produce a crop capable of fixing nitrogen, there are also some localities which are devoid of the necessary bacteria, and in such places the leguminous crop is of no more benefit to the soil than the corn or wheat or other crops, whose yield might be a greater source of revenue.

It therefore has become necessary to devise some means of artificially introducing into the soil the nodule-producing bacteria, and naturally the simplest means of accomplishing this has been to transfer earth known to contain the proper organisms and capable of producing nodules, to the fields where it was desirable to introduce such bacteria. This soil inoculation method is one which has been practised widely both in this country and abroad, ofttimes with the best results, but not with universal success. In order to escape the difficulties involved in the above-mentioned method, Nobbe conceived the idea of bringing about inoculation by means of pure cultures. This was to be accomplished by isolating from the nodule, by means of a gelatine plate, the right organisms and then transferring to tubes or bottles containing nutrient agar. To this culture of nodule-forming bacteria was given the trade name of "nitragin." Seventeen different kinds of nitragin were prepared from the nodules of as many different plants, and arrangements were made to have them put up on a large scale and placed upon the market by a well-known firm of manufacturing chemists. Experiments with nitragin in Germany met with varying degrees of success. In some instances its use seemed to produce an abundant formation of nodules, while in other cases no benefit could be obtained. In this country the results were very uncertain. Consequently, even though this preparation has been found to be satisfactory in Europe, the necessity for devising some method of producing nitrogen-fixing nodules, free from the objectionable features of transferring soil, remains the same. For this reason, the Laboratory of Plant Physiology of the Department of Agriculture undertook a scientific investigation of the root-nodule organism, and as a result it is believed that a thoroughly practical and satisfactory method of bringing about artificial inoculation has been devised.

There has been the widest difference of opinion as to the morphology and life history of these bodies. It has been determined that the nodule-forming organism is a true micro-organism having three well-defined stages, consisting (1) of minute motile rods which produce the infection, and frequently form zoogloea masses; (2) larger rods either motile or non-motile, and (3) capsulated forms, the so-called "branched organisms," which are made up of two or more rods held together in a sheath. Further, there is but one species of legume organism—*Pseudomonas radicicola* (Beyerlinck) Moore. The difference in the infective power of bacteria from different posts is due to slight physiological variations, which can be broken down readily by cultivation.

The usual method of growing a nodule-forming organism has been to make a medium from a decoction of the particular legume upon which the organism originally grew. As a result of numerous trials, however, it has been found that although the bacteria increased most rapidly upon a medium rich in nitrogen, the resulting growth is usually of very much reduced virulence, and when put into the soil these organisms have lost the ability to break up into the minute forms necessary to penetrate the root hairs. They likewise lose the power of fixing atmospheric nitrogen, which is a property of the nodule-forming bacteria under certain conditions. This condition was met by using an agar for plating out from the nodule to which no nitrogenous salt was added, the usual combination being 1 per cent agar, 1 per cent maltose, 0.1 per cent monobasic potassium phosphate, and 0.02 per cent magnesium sulphate to 100 cubic centimeters of distilled

water. While such a medium is not, of course, absolutely devoid of fixed nitrogen, the percentage is so much less than that found in a legume extract-peptone combination, that the results are quite satisfactory. Silica jelly was also used as a solid base to which the above salts were added, giving a culture medium as free from nitrogen as could be obtained.

Various external conditions, such as heat, moisture, alkalinity, amount of nitrogen in soil, etc., all have a direct effect upon the legume bacteria, and the failure of nodules to develop may often be traced to such causes.

After it was definitely established that the legumes were actually able to obtain free nitrogen from the atmosphere, naturally the next question was in regard to where and how this gas was fixed. Numbers of theories have been advanced by various scientists, but it has now come to be generally accepted, after exhaustive experiments and investigations, that the nitrogen is fixed by the bacteria in the nodule, and becomes available by the action of the plant in dissolving and absorbing the combined nitrogen in these organisms.

Painful as it may be to disturb one of Nature's mutual-benefit societies, there seems to be no other way than to consider the nodule-forming bacteria as true parasites, which penetrate the roots of the plant for the purpose of obtaining the necessary carbohydrates for food. Fortunately for the host plant, there are certain conditions under which it can overcome the bacteria and consume them, thus obtaining a considerable amount of nitrogenous food which would not otherwise have been available. The only co-operation between bacteria and host seems to consist in the microbe having the best of the situation at first, when it is able to secrete substances injurious to the cells of the legume, and later the host plant retaliates by secreting still other substances which result in the complete destruction of most of the bacteria.

The Department of Agriculture has distributed samples of cultures very widely for experimental purposes, with some very interesting results. One of the most striking effects reported by some careful observers was the apparent beneficial action of the culture without the formation of nodules. As the result of the careful microscopical examination of the roots, it was found that although no nodules were evident—in fact, did not exist—the cells within the smaller roots were packed with the characteristic branching forms of *Pseudomonas radicicola*, and that undoubtedly the plant was able to obtain considerable benefit from the presence of these organisms.

Even though the efficiency of the culture be at its highest point, the mere fact of its having to grow for a considerable time under artificial conditions is apt to weaken it. Consequently, the means of preserving and distributing the bacteria after they are propagated are fully as important as the method of obtaining them in sufficient quantity for distribution. If it had not been possible to devise a satisfactory way of delivering these organisms to the farmer, it is probable that but little success could ever have been obtained by the pure culture method. Fortunately, the large rods will withstand desiccation for a year or more, and therefore, because they may be sent dry any distance, and upon being revived be in the same condition of efficiency with which they started, the problem becomes a very simple one.

The method which has been employed in the Department of Agriculture for the past year has been to saturate absorbent cotton in a liquid culture of the organism. In this way millions of the bacteria are held within the cotton, and after this is carefully dried out, they remain dormant in it. It is difficult, when preparing to treat large quantities of seed, to prevent the entrance of other bacteria, molds, yeast, etc., all of which may have a deleterious effect upon the growth of the organism. For this reason it has seemed best to prepare the water in such a way as will facilitate the growth of the desired bacteria, and yet delay or prevent the development of the form which might be introduced from the outside, and consequently, two packages of nutrient salts have been distributed with the cotton culture.

AN IMPORTANT DISCOVERY IN THE PURIFICATION OF CONTAMINATED WATER.

The necessity of finding some cheap and practical method of preventing or removing algal contamination of cress beds first led the Department of Agriculture to undertake an investigation of the matter. The success of the first experiments in 1901 was so marked that it seemed wise to extend the work, and authority was, therefore, granted by Congress "to study and find methods for preventing the algal and other contaminations of water supplies."

The progress of the investigation has been noted from time to time in the annual reports of the Bureau of Plant Industry. Though the work is not yet completed, the results already obtained have been published for the consideration of boards of health and officers in charge of public water supplies.

Dr. Moore and Mr. Kellerman, the officials in charge of the work, have shown that it is entirely practicable cheaply and quickly to destroy objectionable algæ in small lakes, ponds, storage reservoirs, and other similar bodies of water by the use of extremely dilute solutions of copper suphate or of metallic copper. The fact that an extremely dilute solution (one to one hundred thousand) will also destroy the most virulent typhoid and cholera bacteria at ordinary temperatures in three hours is of great importance and significance. Solutions of copper as dilute as this are not considered injurious to man or other animals. The value of copper, especially colloidal, in preventing or treating typhoid and other related diseases should be carefully investigated by competent pathologists.

The investigators state that, so far as bacterial contamination of water is concerned, the methods proposed are not to take the place of, but are simply to supplement the standard methods of filtration; neither can too much stress be laid upon the importance of using boiled water for drinking purposes when taken from a contaminated source.

Upon application to the Department of Agriculture by proper authorities, information and assistance will be furnished in determining the organisms causing the trouble in cases of algal pollution, and the proper treatment will be recommended.

The conclusions drawn by the investigators are the following:

The disagreeable odors and tastes so often present in drinking water are due almost exclusively to algæ, although the economic importance of studying these plants has not been recognized until recent years.

These algal forms are widely distributed, and reservoirs in many States have been rendered unfit for use by their presence.

The methods now known for preventing or removing the odors and tastes caused by algæ have proved unsatisfactory, either because of prohibitive expense or failure to accomplish result.

It is therefore desirable that some new, cheap, harmless, and effective method be devised for ridding reservoirs of these pests.

It has been found that copper sulphate in a dilution so great as to be colorless, tasteless, and harmless to man, is sufficiently toxic to the algæ to destroy or prevent their appearance.

The mode of application makes this method applicable to reservoirs of all kinds, pleasure ponds and lakes, fish ponds, oyster beds, watercress beds, etc. It is also probable that the method can be used for the destruction of mosquito larvæ.

At ordinary temperatures 1 part of copper sulphate to 100,000 parts of water destroys typhoid and cholera germs in from three to four hours. The ease with which the sulphate can then be eliminated from the water seems to offer a practical method of sterilizing large bodies of water, when this becomes necessary.

The use of copper sulphate for the prevention of disease is regarded as incidental and is not designed in any way to supplant efficient preventive measures now in use. It is believed, however, that up to this time no such satisfactory means of thoroughly, rapidly, and cheaply sterilizing a reservoir has been known. Since the selective toxicity of copper sulphate renders it fatal to pathogenic forms peculiar to water, while the saprophytic or beneficial bacteria are unaffected, the method is particularly well adapted for this purpose.

Definite knowledge in regard to what organisms are present, the constitution of the water, its temperature, and other important facts are necessary before it is possible to determine the proper amount of copper sulphate to be added. A microscopical examination thus becomes as important as a bacteriological or chemical analysis.

No rule for determining the amount of copper sulphate to be added can be given. Each body of water must be treated in the light of its special conditions.

The cost of material for exterminating algæ will not exceed 50 to 60 cents per million gallons and will usually be less. The destruction of pathogenic bacteria requires an expenditure of from $5 to $8 per million gallons, not including the cost of labor.

THE WHISPERING GALLERY IN THE CAPITOL AT WASHINGTON.

BY WALLACE C. SABINE.

It has recently come to the writer's attention that one of the most curious and in its way famous architectural features of Washington, the whispering gallery in the old House of Representatives, now the Hall of Statues, has been unintentionally destroyed. It became necessary to replace the old ceiling, which was of wood, by a new ceiling. In order to preserve the whispering gallery, a feature which always interested visitors, the superintendent of the building, who was in charge of the reconstruction, had measurements made of the dimensions of the old ceiling and reproduced them as accurately as possible in the new. Notwithstanding this care the whispering-gallery property of the room almost entirely disappeared, and since then the fact has been frequently cited as another of the mysteries of architectural acoustics and a disproof of the possibility of predicting such phenomena. So far, however, from being either a mystery or a disproof of the accuracy of the scientific considerations in dealing with architectural acoustics, this disappearance of the whispering gallery is exactly the opposite, and was in fact predicted by the writer two years before in the American Dictionary of Architecture. Under the head of "Whispering Galleries" the dictionary being published in 1899, is the following paragraph:

"Whispering galleries are usually accidental, but may without difficulty be predetermined. There are two general types—focusing and conducting. In the one the sound diverging from the source is received upon some concave reflecting surface, and is concentrated again at the conjugate focus. One of the best and most accessible examples of this type is the Hall of Statues, the old chamber of the House of Representatives, in the Capitol at Washington. The ceiling of this is a very considerable portion of the surface of a sphere whose center is near the floor. Standing at the center of this sphere one can hear his own whisper returned to him. Standing at one side of this point he can whisper, especially if he turns his face toward the ceiling, to a person standing at a great distance on the other side of the center. For any position of the speaker there is a corresponding point at which the whisper is more or less accurately focused. *The ceiling, painted so that it appears deeply paneled, is smooth. Had the ceiling been paneled, the reflection would have been irregular, and the effect very much reduced.* The most accurate form for a whispering gallery is that in which the reflecting surface is a very considerable portion of the surface of an ellipsoid, that has for its foci the two points between which there is to be communication."

The above, written before any changes were contemplated, exactly covers the case. The new ceiling differs from the old in two respects. Instead of being of wood it is of plaster on iron supports. This alone would produce no deterioration in the whispering gallery, for plaster on iron is an even better reflector than wood. But plaster as now handled admits of an architectural treatment to which it did not formerly so readily lend itself, and the coffering which was but painted on the old ceiling is copied in relief on the new, with the result that it ceases to be in any way a remarkable whispering gallery. So far from being a disproof of the possibility of prediction in architectural acoustics it is, as far as a single case can be, a confirmation of its reasonable accuracy, and in this particular case of its entire accuracy.

It is not difficult to explain the basis for the prediction that coffering the ceiling would have this effect. The focusing of the sound by the concave ceiling is in every respect similar to the focusing of light by a concave mirror. Just as scratching the mirror dims the image of light, so paneling the reflecting wall dims the focused whisper, for a panel, a pilaster, or a column on a wall surface is to sound what a scratch on the surface of a mirror is to light. That in the case of light the scratches may be so fine, while in the other cases the "scratches" must be of the dimension of columns and pilasters, is because of the relative wave lengths of light and sound. The wave length, that which corresponds to the distance from crest to crest in a water wave, is in the case of light about one fifty-thousandth part of an inch, while in the case of sound it is for the ordinary tones of a man's voice several feet. For this reason a column or a pilaster of vast magnitude bears to the sound of a man's voice the same relation that the merest scratch bears to light. We thus have the great acoustical mirror of the Hall of Statues now dimmed by the coffering which breaks the formerly smooth surface. To this argument it may be, in fact it has been, objected that while the waves of sound of a man's voice are several feet in length this coffering is of but a few inches in depth, and therefore insufficient. The answer to this is that while the full rounded tones of a man's voice and for that matter, though to a less degree, of a woman's voice, are of long wave length, a whisper by either man or woman is of a very different character. The component tones of a whisper are very high and of very short wave length, so that irregularities that would not disturb the focusing of the full tones of the voice will utterly ruin a whispering gallery.

The loss of the whispering gallery is of course only the loss of an architectural curiosity. It was, however, remarkably perfect, and so interesting and even famous as to be well worth the well-intentioned but misdirected efforts for its preservation.

The electric waves measured by Hertz—and named after him—were found by the great scientist to be 150 feet from the top of one wave to the top of the next. The waves used by Marconi in telegraphing across the Atlantic are much longer; in fact, they are 600 feet or more. They travel at the same speed as light—the incredible and almost inconceivable rate of 184,000 miles per second. But the light wave measures only a few millionths of an inch.