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.