SUGAR—A GLANCE AT ITS HISTORY, PRODUCTION, AND MANUFACTURE.

At a recent meeting of the Massachusetts Institute of Technology, Wm. B. Rogers, the president, introduced Mr. Jacob A. Dresser, who spoke upon the "History, Production, and Manufacture of Sugar."

Mr. Dresser first referred to the very early knowledge of sugar in China and India, and the fact that before 1000 A. D. the substance and the cane had passed into Arabia, Egypt, and Cyprus. Thence it passed probably along the northern coast of Africa, and by the Moors was taken into Spain. Its use in Europe does not appear to have been at all general until introduced by the returning Crusaders. By Spain and Portugal it was transferred to the West Indies and Brazil. The cane was probably not indigenous to America. The wonderful development of the production of sugar from the beet-root has taken place in Europe almost wholly during the present century.

The entire amount of sugar produced in Europe is from the beet, and amounts to 1,500,000 tons, being fully three-fourths of the 2,000,000 tons now produced for commercial purposes in all other countries from the sugar cane, the original source of the substance.

The advantageous growth of the sugar cane seems to be confined to the belt within about 30° both north and south of the equator, with occasional variations coinciding with the isothermal lines, and an average temperature of seventy-five to seventy-seven degrees.

That of the beet, as illustrated in Europe, seems to range between 45° and 55° north latitude, but in our own country the range will, no doubt, be found, when developed, to be essentially below that, corresponding with the difference in the isothermal lines, perhaps more nearly from 35° to 45°. In this last season some 1,800 tons of fine quality were produced in Maine and Massachusetts.

As a statement of the total sugar production of the world it may be said that each of the great central empires—France, Germany, and Austria—produces about 400,000 tons, equal together to 1,200,000; Russia, 220,000; Belgium and Holland, 100,000—total, 1,520,000. Cuba, 600,000; Brazil, 200,000; Demerara, Surinam, and the Windward Islands adjacent, 400,000; and our own Louisiana and the Sandwich Islands, 150,000 tons. This gives us from America 1,350,000 tons; Europe, 1,520,000 tons; East of Good Hope, 700,000—total, 3,570,000 tons.

Confining ourselves to the consideration of the ordinary sugar of commerce, cane sugar, so called, no description seems to be necessary, excepting perhaps to say that the crystal where perfect is rhomboidal, of four or six sides, terminating in two or three sided summits; and, when allowed to crystallize under favorable circumstances, may attain a length of one or one and a half inches, although such are rarely seen. Its specific gravity is 1·6.

Mr. Dresser next proceeded to discuss the wholesomeness of cane sugar, and said that while in the absence of nitrogenous matter it did not offer any nutriment to the muscular system, it does offer a large supply of heat, and is admitted to be fattening in its qualities; also, statistics show that a consumption of 75 to 80 pounds of sugar per person annually produces no ill effects.

Our views of the process of extraction and manufacture will be more complete if we begin at the sugar cane or the beet root.

The first claims precedence for many reasons, so we take the cane. It contains about 90 per cent of juice by weight, of which about 18 per cent is susceptible of crystallization, but this is never realized in practice.

The first problem is to extract the juice; the next to clarify it or purify it as far as possible; then to concentrate the juice, or this solution of sugar, in water with certain impurities by evaporating the water; then to facilitate and induce crystallization of the sweet principles therein, so far as we can; then to relieve these crystals of the mother liquor from which they have sprung, and which will then be molasses, and some of which will continue to adhere to the crystals unless removed by external force and appliances.

At this point we have what is called Muscovado sugar, raw sugar, or, perhaps more properly, sugar of first production, as it has been made in Cuba and elsewhere for many years. According to its treatment from this point onward it may remain as Muscovado, or become either clayed or centrifugal sugar, and is so recognized in commerce. The first process, that of extracting the juice, has been accomplished very imperfectly in various simple ways; the most primitive being still used in the East, and scarcely superior to the mortar and pestle, and quite similar thereto, excepting that the pestle or its correspondent is made to revolve by the power of oxen diagonally around the side of the mortar upon which the cane is held and crushed.

But the mill with upright wooden rollers, similar to our cider mill, seems very early to have been devised, and both forms are said now to be in use in India and China.

The great advance in science and the mechanic arts in the Western world has given us now the magnificent and well-nigh perfect iron mill, driven generally by steam; and visitors to the Philadelphia Exhibition may remember some examples of those exhibited there of giant size and strength.

Another method of extracting the juice from both cane and beet, "by diffusion," so called, long known and more practiced with the beet than cane, is perhaps quite as effective.

In this the canes are cut in diagonal slices, and exposed to successive water baths, by which nearly all the juice may be removed at the expense of increasing the amount of water to be evaporated before crystallization twenty or twenty-five per cent.

Next, the juice thus obtained, constituting at best perhaps sixty to seventy per cent of that in the cane, is to be clarified or purified, that is, freed from mechanical impurities and foreign matters accompanying it in the cane, such as albumen and certain salts and acids derived from the soil. Great dispatch is necessary, because in exposure the nitrogenous materials rapidly induce fermentation.

Clarification is accomplished by heating in large vessels, formerly by open fires, but often now by steam.

By the introduction of lime the acids are neutralized, and by the heat the albumen is coagulated, and the impurities brought up and removed by skimming, which completes the clarification after a little time for subsidence.

The next step is to reduce the volume of water. This is accomplished by heat and evaporation, but with much peril in the process to the sugar, to which heat is destructive and time is ruinous.

At as low heat and in as little time as possible, therefore (two opposing conditions), must this be done; but under the system of open fires, long universal and still used extensively, the destruction of sugar, or its conversion into molasses with its discoloration, was enormous.

SUGAR REFINING.

The refining of sugar of first product, or raw, as now produced, is now almost universally demanded before its consumption by the civilized world, and it is hazarding little to say that but for one discovery and one invention, both made about the same time (1812), it would be impossible to answer this demand. That discovery was the effect of animal charcoal, or calcined bones, upon sugar solutions, and that invention was the vacuum pan, or the method of boiling in vacuo, by E. C. Howard.

The discovery was made in France (Devoine), the invention in England. Through these alone are the stupendous operations in sugar refining now possible.

The sugar may consist of several varieties, apportioned by the judgment of the manager, so as to best attain the particular result desired in quality. It is first dissolved in hot water (say one-third), in a large tank fitted with an agitator operated by steam, and a steam-heating coil for quickening the process. When dissolved it corresponds to the juice when extracted from the cane or beet by the mills, and all possible dispatch is made to restore it again to the crystal form. From the melting tank it is pumped to an upper floor of the refinery into cisterns, called blow-ups, fitted with steam connections for heating. Here it is further clarified by albumen, and any acid tendency is converted by alkali, usually lime milk, and its weight or quantity of sugar adjusted by addition of water or sirup to some 27° or 28° Baume saccharimeter, the test generally used. In some modes of working the blow ups are now omitted, and the liquor from the melting pan is passed directly to the bag filters, which by great numbers may be made to supersede the necessity of albumen.

Bag Filters.—The construction of these can be best understood by illustration and description. Their purpose is to remove mechanical impurities still remaining in the dissolved sugar.

They consist of two long bags, says 5½ or 6½ feet long, one of close material, and 15 or 16 inches wide, placed within another a little shorter and much smaller, but of very strong open material outside, to support the inner in doing its work. These are suspended inside and from the top of a close iron tank, the mouth of each bag being attached to a circular bell or opening downward in the top of the tank. The top of the tank outside is surrounded with a low but tight fence or inclosure, perhaps a foot high, into which the liquor flows, and is conducted through the openings above spoken of into the mouths of the bags. The inclosure in which the bags are suspended contains from one hundred to six or seven hundred bags, and is steam tight to admit of its introduction for heating and facilitating the flow of the liquor, as well as to remove any sugar that may remain in the impurities or scum arrested by the bags. The tendency of late years has been to increase the number and use of the bag filters, and to dispense correspondingly with the other clarifying agents.

Charcoal Filters.—From the bags the liquor, as it is called, now enters a new and most important phase, viz., the animal charcoal filters. The effect of animal charcoal in decolorizing sugar solutions was observed about the close of the last century, and used by M. Dérosus, about 1811, who introduced it then into practical use. But at first it was pulverized and mixed with the sugar in the blow-up, and removed with the scum and lost. Afterward it was placed in shallow tanks, and the sugar passed through them; but about the year 1822 M. Dumont devised the tall filters similar in form to those now in use, and with sundry variations in size, and open or closed they have continued until now. The present scale of business requires the use of enormous quantities of this charcoal, and the filters are now made correspondingly large, say eight or ten feet diameter, and eighteen to twenty feet high. The effect is not only to filter and decolorize the liquor, but to remove acids and lime, and in some mysterious way it also promotes or facilitates the crystallizing power, increasing it, according to some, as much as ten per cent.

The filters are generally capable of being closed, so as to allow the use of pressure, which insures a more uniform distribution of the sirup, so that none of the coal remains unused, as sometimes happens without pressure. This pressure also allows the liquor to be passed over from the bottom of one filter to the top of another, when further filtration of it is required, and saving in such case the cost and expense of pumping, and the heat so desirable while filtering.

CONCENTRATION OF THE SIRUP.

The evaporation of the water, or concentration of the sirup or liquor in the vacuum pan, is the next stage, and by means of this invention of Howard we are enabled to maintain a vacuum of twenty-seven to twenty-eight inches, and hence to boil at a temperature of 130° to 170°, instead of 220° to 250°, as would be required in open air. In the early days these pans were only about six feet diameter and four feet high in the center of the elliptical section, with a capacity of twenty or twenty-five barrels of sugar.

Now there are some in New York of seventeen feet horizontal diameter and fifteen to sixteen feet high. One in the refinery of Messrs. Matthiessen & Wiechers has a capacity of boiling four hundred barrels of sugar at once, and evaporates sixty thousand pounds of water in two and a half hours, or fifty gallons per minute.

The vacuum pan and the bone-black filters may be regarded respectively as the heart and the lungs of a sugar refinery, being as vitally important to its successful working as are those organs to the well-being of animal life.

A beautiful arrangement of the vacuum pan devised by M. Rillieux, of Louisiana, called "The Triple Effet," consists of two or three pans so connected that the vapor from the first, boiling without vacuum, is conducted to and boils the liquor in the second under a partial vacuum; and the vapor from the second is conducted to and boils the liquor in the third pan, in which, though the liquor is heavier, the pan, being connected with a condenser and pumps, is under a much higher vacuum, and hence is boiled by the vapor from the second. Between the pans is the usual safety receiver, to arrest any sugar that may be carried over by the vapor. This arrangement is used more largely on plantations and in Europe in treating the beet juice.

THE CENTRIFUGAL SEPARATOR.

Formerly the sugar was passed from the vacuum pans through the intervening heater, which received it directly into the moulds (as in the claying process), for separating the mother liquor from the crystals and making them white; but for this purpose centrifugal machines are now most generally used, thus substituting steam power for the slow process of gravity. This machine consists of a kind of round metallic basket, usually about thirty inches diameter (but some are now made larger), with sides of very finely perforated brass, twelve and fourteen inches high, and surrounded by an iron curb a few inches larger, which receives the sirup from the sugar in the basket and conducts it away. This basket is either suspended by a perpendicular shaft from above, or mounted on one from below, independent of the curb which surrounds it. After being filled from one-third to one-half its weight with semi-liquid sugar from the pan, it is made to revolve in a horizontal plane one thousand and fifteen hundred times per minute. The sugar immediately rises in vertical walls at the sides, the sirup being thrown out through the perforations, and from the native yellow color it begins to grow white immediately, and after a very few minutes, if it be of first quality, a little cold water from a sprinkler makes it beautifully pure and white. It is now in condition to be removed and sold as confectioner's or coffee A sugar, or by further treatment to be made into the well-known granulated sugar of commerce.

GRANULATED SUGAR.

This very popular and strictly American style of sugar was first made and introduced by our highly respected fellow-citizen, Mr. Thomas Lamb, who conceived the idea and devised the first apparatus for making it, which he put in operation about thirty years ago at the Boston Sugar Refinery in East Boston, of which he was then president and agent. Although extremely popular in the United States since its origin, it has become popular in England only within a few years past. The apparatus at first consisted of a steam table fifteen or twenty feet long and three to five feet wide, on which the moist sugar was, by an ingenious process or movement of wooden rakes, gradually worked the length of the table, becoming thoroughly dried in so doing. Afterward it was separated by sieves of different grades or mesh, into coarse and fine, and barreled and sold accordingly. This apparatus was superseded ten or twelve years since by a large cylinder of wood or iron, some four feet in diameter and fifteen to eighteen feet long, slightly depressed at one end. The inner surface carries small projecting buckets, by which, as the cylinder revolves, the sugar, entering at the upper end, is lifted and poured through the heated interior. The heat is supplied by a small steam cylinder running through the length and center of the large one, and the position of the buckets is such as gradually to work the sugar through the length of the cylinder, during which it becomes thoroughly dried. An arrangement of sieves, as before, completes the operation.

Loaf and crushed sugar, now somewhat rare, is made in refineries in moulds, much as the clayed sugar was described as being made on the plantations, but the process is carried out far more perfectly.

Cube sugar, so attractive, and now quite generally found in hotels and elsewhere here and in Europe, is made by sawing the large loaves, or by the centrifugal process, using moulds fitted to the machine, and with partitions dividing the sugar into thin layers, or by compressing the sugar when moist, and baking it instead of passing it through the granulator.

The polariscope, or saccharimeter, now used for determining the strength of raw sugar, is a beautiful instrument, of which, or of its operation, I can convey only a very imperfect idea. It is based upon the scientific fact that a beam of polarized light, in passing through a solution of a given strength of pure cane sugar in water, is rotated or twisted toward the right to a certain and uniform extent, and the relative extent to which a similar solution of any other sugar, under the same conditions, rotates the light, indicates the relative purity or crystallizing power of that sugar. The arrangement of lenses in the instrument is not easily made plain without diagrams, but it is such that the operation in itself is very simple, only requiring care, and the result is read in figures on a scale attached to the adjusting thumbscrew. Various elements possibly existing in the raw sugar make experience and judgment in using the instrument very necessary, and subtle and differing conditions in the samples tested require great care and appreciation in arriving at the result.

Mr. Dresser showed samples of the raw beet sugar and the loaf; also the Muscovado, and the various raw sugars as brought from the countries producing them; also the Dutch numbers of standard colors referred to in our tariff act, and for many years acknowledged in the commercial world.

President Rogers said:

When I think of the time when Black, of Scotland, not long after the middle of the last century, discovered the reduction of the boiling point of liquids by diminution of pressure, and then think of the beautiful and practical application of this principle in the vacuum pan, where the water is extracted from a solution of sugar, I am struck with a most forcible illustration of the application of science to the practical affairs of life.

Another such illustration is again furnished when we observe that the absorbent power of animal charcoal was determined in the chemical laboratory as a scientific fact, and that it is now of such great importance in the refining of sugar.

The explanation of this fact is, however, not so easy as that of the other. Both animal charcoal and vegetable charcoal possess this absorbent power to a great degree, and it seems to be clear that it depends largely on the great increase of surface due to the enormous subdivision in the interior of the mass. The amount of adhesion and detention of a liquid in a mass depends on the amount of surface with which it comes in contact. As a very striking illustration of this, we know that platinum will, with very great difficulty, combine with oxygen or hydrogen, but spongy platinum, or platinum-black, absorbs enormous volumes of gaseous matter, so that if such a mass be plunged into a vessel containing a mixture of oxygen and hydrogen it will imbibe so much and condense them to such an extent that they combine and the platinum is brought to a condition of intense ignition.

Sugar Cane Production in 1879.

An extra census bulletin gives the cane sugar product of the census year, 1879–80, as 178,872 hogsheads of sugar and $16,573,273 gallons of molasses. The area cultivated was 227,776 acres. The average and yield by States was:

Alabama	6,627	94	795,199
Florida	7,938	1,273	1,029,868
Georgia	15,053	601	1,565.784
Louisiana	181,592	171,706	11,696,248
Mississippi	4,555	18	536,625
South Carolina	1,787	229	138,944
Texas	10,224	4,951	810,605

The Elevated Railways in New York City.

The railway year in this State ends on the 30th of September. The first half, therefore, of the current year expired March 31. During the six months embraced in this period the Manhattan Railway Company carried over its lines 42,961,639 paying passengers. This would make the daily average, including Sundays, holidays, etc., 237,305, but if the Sunday travel, when two of the four lines are closed and the traffic on the other two is very light, was deducted from, it would give an average for weeks days of over 250,000, or considerably more than 10,000 an hour throughout the entire day if the traffic was equally distributed, which, however, it is not. The local travel in this city, no matter what proportions it may in time assume, must always be as now, very much heavier in the mornings and evenings than at other times. The reasons for this are so clear that to even refer to them seems superfluous, yet there are those who assert that if five cents was made the rate of fare at all hours the travel throughout the day would be uniform, or nearly so, and the pressure of traffic during the present commission hours would be greatly relieved.

This is in no sense true, as any one who stops to think a moment must readily see. People do not ride over the elevated roads at certain hours because the fare is five cents, but because their business requires them to be down town by a certain time in the morning, and permits them to return to their homes at certain hours in the evening. They do not time their riding to meet the commission fare, but the commission fare has been timed to suit them. No doubt if five cents was made the uniform rate of fare throughout the day the travel over the roads would be heavier during the hours in which ten cents is now charged, but it would not reduce the present commission traffic in the slightest, so that the argument that the roads could be more safely operated if the fare was made uniform at five cents is simply absurd and must so appear to every intelligent man.

During the six months to which we have referred several casualties have occurred, four or five resulting fatally, but they form no exception to those which preceded them, none of them being chargeable to the culpability or negligence of the company or its servants. So far in the history of the elevated roads not a single passenger has been injured through collision, derailment, explosion, fire, or any other cause where there was not more or less contributory negligence on the part of the sufferer, and we trust the last half of the current railway year may furnish no exceptions to this gratifying record.—*Elevated Railway Journal.*

Progress of Electric Lighting in New York City.

The installation of the first district of the Edison Electric Light Company in this city is almost completed. The district is nearly a square mile in extent, being bounded on the east by the East River, on the south by Wall street, on the west by Nassau street, and on the north by Spruce street, Ferry street, and Peck Slip. The buildings purchased by the company to be used as a central station to generate the electric current to be distributed over the district by means of underground cables, are located at Nos. 255 and 257 Pearl street, a little south of Fulton street. For the present only one of these buildings, the one at No. 257 Pearl street, is being fully equipped. The preparation of this district for lighting has involved a vast amount of work, which, generally speaking, may be divided into four branches, namely, the structure or the preparation of the building for the reception and maintenance of the plant, the manufacture and installation of the engines, dynamos, and other electrical apparatus, the manufacture and laying of the underground conductors, and the wiring of houses.

The work on the first of these items, to wit, the central station structure, includes the masonry foundation and concrete, a two story iron frame work, vaults under the side walk and streets, four boilers with an aggregate capacity of 1,000 horse power, boiler fittings, two smokestacks (each 5 feet in diameter and 80 feet high), steam conveyors for coal and ashes, shafting, blowers, and the pumping and blowing apparatus. The above work is all finished, and the hoists and ventilating apparatus, also belonging to the central station structure, alone remain to put in. The station equipment consists of six engines, six dynamos, and the resistance and regulators. The engines have been built by the Southwark Foundry and Machine Company, Philadelphia, and delivered to us. There are six of them, each having a normal capacity of 125 horse power, and a maximum capacity of 200 horse power, making a total maximum capacity of 1,200 horse power. The six dynamos, being built at the Edison Machine Works, Goerck street, New York city, are approaching completion. The resistance and regulator apparatus is also nearly completed. The weight of each of these six steam dynamos is 30 tons, making the aggregate weight of the six dynamos 180 tons. The weight of the entire structure and electrical apparatus, at No. 257 Pearl street alone, will be about 500,000 pounds—that is to say, about 250 short tons—and this weight will be distributed so as to average only about 200 pounds per square foot of structure. The boilers in this one building, when under full headway, will consume 1,680 tons of coal and 4,200,000 gallons of water per annum, equivalent to a daily consumption of about five tons of coal and 11,500 gallons of water.

As regards the underground conductors, work is being pushed as rapidly as possible. Prior to March 1, 1882, 39,403 feet of the underground mains had been laid. In the month of March 15,898 feet more were laid. In that month there were 27 working days and 4 Sundays, but owing to the loss of 5 days from rain and 2 from other causes, we worked only 20 days and 1 night, the average feet laid per day during the month being 588; the average for the days which we actually worked being 795; the least amount laid in any one day being 423, and the largest amount laid in any one day being 1,246 feet. There yet remains to be laid something over 18,000 feet of the mains, besides bridges and connections at street intersections, which, it should be stated, will take a much longer time, per foot, than the regular mains.

Regarding the wiring of houses, they were finished early in February. We have completely wired 107 places in Beekman street, 166 in Fulton street, 75 in John street, 78 in Maiden Lane, 97 in William street, 46 in Front street, 68 in Nassau street, 43 in Pearl street, 36 in Cedar street, 28 in Pine street, 24 in South street, 31 in Ann street, 12 in Spruce street, and enough more in other streets to make a total of 946 places wired.

The number of lamps arranged for in the places thus wired is 7,916 A (16 candle) lamps, and 6,395 B (8 candle) lamps, making a total of 14,311 lamps. The lamps themselves were made months ago and are now in store ready for use. The central station will supply electric current not only to illumine these and additional lamps, but also to run motors for elevators, hoistways, printing presses, and machinery of all kinds. From all that is stated above, it will be seen that little now remains to be done, except to finish the laying of the underground conductors before the first district will be entirely completed and the lighting-up commenced.

ON Feb. 8 the first eel taken in California was caught on the eastern shore of San Francisco Bay. It measured 3 feet in length, and was the first result of the "plant" of the California Fish Commissioners.

Drainage of the City of Mexico.

At a recent meeting, in this city, of the American Society of Civil Engineers, Mr. Ricardo Orozco, C.E., of Mexico, exhibited and explained the plans and profiles of the proposed works of drainage of the Valley and City of Mexico. The explanations were translated by Mr. Theophilus Masac, C.E.

The city of Mexico is situated in a basin without natural outlet. The Lake Texcoco, within a very short distance of the city, in times of flood overflows and affects deteriously the city to such extent that its sanitary condition has become very bad.

A short distance farther from the city are the lakes Chalco and Xochimilco, which also overflow toward the city.

Three other lakes, at more considerable distances, are in the same basin. There are no natural outlets, only evaporation lowering the areas of the waters.

The extreme desirability of securing drainage from this basin has been long felt.

In the seventeenth century Señor Enrico Martinez, an engineer under the Spanish authorities, constructed a tunnel partially through the mountain Nochistongo, which, however, never was entirely completed. Many years afterward the Jesuit fathers made an open cut down to the tunnel. This work cost a very large amount of money and many lives. Proper slopes were not maintained, and the work caved in frequently.

The drainage has never been properly kept up.

Señor Orozco's plan is to construct an open canal upon such grade as will entirely drain the lakes Xochimilco, Chalco, and Xaltocan, and also maintain at regulated surfaces the lakes Texcoco and Zumpango.

Through the city of Mexico are to be constructed sewers flushed by the waters from the lakes, which are carried to a common conduit, where the sewage is purified by deposition, the solid matter to be used for fertilization and the water carried away in the canal. The whole length of the canal would be about 50 miles. Expense about $7,000,000.

Maps, profiles, and plans, executed in a remarkably fine manner, were exhibited.

Ancient Chinese Coffins.

A recent number of the *Celestial Empire*, referring to a discovery of some ancient graves near Shanghai, gives, says *Nature*, an interesting account of Chinese burial in former times. A man of means purchased his coffin when he reached the age of forty. He would then have it painted three times every year with a species of varnish, mixed with pulverized porcelain—a composition which resembled a silicate paint or enamel. The process by which this varnish was made has now been lost to the Chinese. Each coating of this paint was of some thickness, and when dried had a metallic firmness resembling enamel. Frequent coats of this, if the owner lived long, caused the coffin to assume the appearance of a sarcophagus, with a foot or more in thickness of this hard, stone-like shell. After death the veins and the cavities of the stomach were filled with quicksilver for the purpose of preserving the body. A piece of jade would then be placed in each nostril and ear, and in one hand, while a piece of bar silver would be placed in the other hand. The body thus prepared was placed on a layer of mercury within the coffin; the latter was sealed, and the whole then committed to its last resting place. When some of these sarcophagi were opened after the lapse of centuries, the bodies were found in a wonderful state of pre servation; but they crumbled to dust on exposure to the air. The writer well observes that the employment of mercury by the Chinese of past dynasties for the purpose of preserving bodies ought to form an interesting subject for consideration and discussion in connection with the history of embalming and "mummy making."

Solvent for Gallic Acid.

Mr. Frederick Long says, in the *British Medical Journal*, that he has accidentally discovered a method of dissolving gallic acid. Having a short time since a case of hæmaturea, the result of uric-acid gravel, he chanced to prescribe a mixture containing half a drachm of gallic acid and a drachm and a half of citrate of potassium, and, to his surprise, he found he had a perfectly clear liquid, the gallic acid being completely dissolved. He has since made further experiments, and he finds that, with care, twenty grains of citrate will dissolve as much as fifteen grains of gallic acid in an ounce of water, and remain quite clear for any length of time. To be able to give gallic acid in perfect solution is a great advantage, as absorption must take place more rapid ly when the salt is in solution than when simply suspended in mucilage. The citrate, being a very simple salt, can do no harm in any cases in which gallic acid is required.

The Wisdom Teeth and Deafness.

Robert T. Cooper, M.D., in the *Dublin Journal of Medical Sciences*, reports several cases where he believes that the deafness owed its origin in each patient to a tardy or otherwise abnormal eruption of the wisdom teeth. That the teeth are often the unsuspected cause of deafness, he infers, first, "from the intimate sympathy existing between the teeth and the ears, and the consequent very obvious prejudicial effect of infantile dentition upon these organs. And, secondly, from observing the number of cases of deafness met with that date their initiation from the period of life at which these teeth appear."

Phosphorescence in Plants.*

In living vegetables emissions of light have been observed in a dozen phænogamous plants and in some fifteen cryptogamous ones. The phosphorescence of the flowers of *Pyrethrum inodorum*, *Polyanthes* (tuberose), and the *Pandani* has been known of for a long time. Haggren and Crome were the first to discover such luminous emanations from the Indian cress and marigold, and a few years ago I myself was permitted to observe, during a summer storm, a phosphorescent light emitted from the flowers of a nasturtium (*Tropæolum majus*) cultivated in a garden at Sarthe.

Several botanists have also spoken of the greenish light from the *Schistostegia osmundacea*, a small plant of the moss family, inhabiting caverns, more particularly in the north of Europe. In this case, however, the phenomenon, which is somewhat complex, is produced by the persistent protonema of the plant, which reflects a beautiful emerald-green color. Meyen, also, has called attention to a small alga of the group of the oscillatoriæ, which, inhabiting the waters of the Atlantic at the equator, is both colorless and luminous. But such emissions of light are especially peculiar to the fungi. The agaric of the olive tree (*Agaricus olearius*), which is remarkable for its beautiful golden yellow color, grows in Provence in the months of October and November, at the base of olive trees and on the trunks of the hornbeam and oak. Mr. Tulasne has remarked that this toadstool, when still young, gives out a bright light and remains endowed with this remarkable property as long as it continues fresh. The seat of the phosphorescence is most usually the surface of the hymenium, although the stipe or stem is also sometimes phosphorescent in some species. The agaric of the olive tree gives out its light only while living; with its death the phenomenon at once ceases. The light emitted is white, steady, and uniform, and resembles that from phosphorus dissolved in oil. This light contains the radiations belonging to the different regions of the spectrum; and when it is produced there is always observed an active absorption of oxygen. The light of a phosphorescent toadstool is extinguished in hydrogen, carbonic acid, or nitrogen. The brilliancy of the white light emitted, far from increasing in pure oxygen, is diminished. As well known, it is the same with regard to phosphorus, which does not shine in pure oxygen.

Below 3° to 4° the phosphorescence disappears, to reappear when the temperature rises; attaining its maximum at 8° to 10°.

We know of still several other luminous toadstools: *Agaricus igneus*, which grows in the Island of Amboin; *A. noctilucens*, observed at Manila (Philippine Islands); *A. gardneri*, which grows in the Brazilian province of Goyaz, on the dead leaves of a dwarf palm; and *A. lampas* and some other Australian forms. The *Agaricus gardneri* was discovered in Brazil by Mr. Gardner. This learned botanist met with this species during a dark night in December in walking through the streets of Villa de Natividate. Some boys were amusing themselves with what he at first supposed to be a kind of large firefly, but on inquiry he found it to be a beautiful phosphorescent toadstool which grew abundantly in the neighborhood on the dead leaves of a dwarf palm. The whole plant gives out at night a bright light similar to that emitted by the larger fire-flies, and having a pale greenish hue. This circumstance, and its growth on a palm, had given it the name among the inhabitants of "flor de coco." The same fungus grows also in Borneo.

"The night being dark," says Dr. Cuthbert Collingwood, in his account of the Bornean plant, "the fungi could be very distinctly seen, though not at any great distance, shining with a soft pale greenish light. Here and there spots of much more intense light were visible, and these proved to be very young and minute specimens. The older specimens may more properly be described as possessing a greenish luminous glow, like the glow of the electric discharge, which, however, was quite sufficient to define its shape, and, when closely examined, the chief details of its form and appearance. The luminosity did not impart itself to the hand, and did not appear to be affected by the separation from the root on which it grew, at least not for some hours."

The same writer also adds: "Mr. Hugh Low has assured me that he saw the jungle all in a blaze of light (by which he could see to read), as, some years ago, he was riding across the island by the jungle road; and that this luminosity was produced by an agaric."

Mr. James Drummond discovered in Australia two toadstools which at night gave out an extremely curious light. One species was growing on the stump of a *Banksia* in Western Australia. When the plant was laid upon a newspaper it emitted by night a phosphorescent light which enabled persons to read the words around it, and it continued to do so for several nights with gradually increasing intensity as the fungus dried up. The other species was detected some years afterward. This specimen measured sixteen inches in diameter, and weighed about five pounds. This plant was hung up to dry in the sitting-room, and on passing through the apartment in the dark it was observed to give out the same remarkable light.

The luminous radiations of these cryptogams are very varied in their character. We have already seen that the light emitted by the olive tree agaric is white, steady, and uniform; *Agaricus igneus* shines with a bluish light which recalls that which the leaves of the poke (*Phytolacca decandra*) give out at times; while *A. gardneri* emits a greenish light.

But this phosphorescence is in no wise confined to the genus *Agaricus*, for recently in our own country (France) I have observed *Auricularia phosphorea* and *Polyporus citrinus* emitting luminous radiations. The first of these grows on partially rotted trees, and the other on the trunks of willows, oaks, and apple trees. Some time ago, a remarkable case of luminosity was recorded as occurring in England: "A quantity of wood had been purchased, and afterward dragged up a hill to its destination. Among this was a log of larch or spruce. Some young people going to pass the night on the hill, were surprised to find the road strewn with luminous patches, which, when more closely examined, proved to be portions of bark or little fragments of wood. Following the track, they came to a blaze of white light which was perfectly surprising. On examination, it appeared that the whole inside of the bark of the log wa covered with a white byssoid mycelium, of a peculiarly strong smell, but unfortunately in such a state that the perfect form could not be ascertained."

Mr. Tulasne was the first to make known the spontaneous phosphorescence of dead oak leaves. "These leaves," says the learned mycologist, "were all of the preceding year, and had fallen naturally at the approach of spring. Their tissue still possessed elasticity and great cohesive strength. None of them was luminous on its whole surface. In general, the most brilliant points were those where the brown or gray color of the leaf was lightest—those especially that a peculiar alteration of the parenchyma had rendered very thin and almost whitish. I also saw shining in the same way, buds that were dried up and partially destroyed, as also a small twig that had certainly perished on the oak that had produced it. The disarticulated surface of this twig alone gave out a bright light. The brilliant surfaces of these different objects were all more or less moist with water. Wiping them off with the finger diminished their brilliancy, yet it was necessary to rub them briskly for some instants to render them dark, and no phosphorescent matter adhered to my hand."

The rhizomorphs, or vegetative apparatus, of a large number of fungi are likewise phosphorescent. These productions extend beneath the soil in long branching cords and threads in the vicinity of old stumps, especially of the oak, which are in a state of decomposition, and to which they are affixed by some of their threads.

All these plants that we have just mentioned emit light during their life and when they are in a state of decomposition. We might also cite the phosphorescence of the milky juice of certain *Euphorbiaceæ*, and of the pulp of certain fruits (such as that of the peach and apricot) that are beginning to decay, but we think that we have said enough to demonstrate the frequency of the phenomenon of phosphorescence in the vegetable kingdom.

* Abstract of an article by Louis Crie, in the *Revue Scientifique*.

Microscopic Notes.

BORING ANNELID.

At a recent meeting of the New York Microscopical Society, Mr. J. D. Hyatt exhibited some specimens of a boring annelid, and described, by the aid of blackboard drawings, the probable method of excavating in hard substances. He showed two mounted specimens, one with the jaws extended, and one in which the head was retracted far back into the body of the animal.

The track of an annelid, as Mr. Hyatt had found by cutting sections of shells, was always downward and then back to the surface in a line parallel with and close to the original channel, so that frequently a section across the borings shows either two channels with a very thin partition between them, or else without any wall of division.

Remarks were made by several members of the society, particularly concerning the method of boring. It was thought by some that the apparatus for boring described by Mr. Hyatt could not be hard enough to penetrate solid rock, but the weight of evidence seemed to be conclusive that no chemical action assisted in the process.

STRUCTURE OF SPONGES.

Mr. Hitchcock described the structure of sponges. His remarks were principally based upon the description of sponges in Saville Kent's "Manual of the Infusoria." According to Mr. Kent's observations and also to others by Carter and by our countryman, Prof. H. James Clarke, the sponge consists of a mass of clear, homogeneous, jelly-like matter, the cytoblastema, traversed by ramifying canals which are enlarged in places. The cytoblastema is covered with an imperfectly differentiated investing membrane, and the spicules are embedded in it. The canals are enlarged into chambers at different points, and these chambers, known as ampullaceous sacs, are lined with spherical or oval monads, each of which has a hyaline, bell-shaped collar at the anterior end, through the center of which a long flagellum extends into the chamber. These collared monads also line the channels in some species of sponges. By the constant lashing of the flagella, currents of water are drawn through the pores, the small openings on the surface of the sponge, into the ampullaceous sacs, and from these they pass to larger channels which lead to the larger openings or oscula at the surface. This constant circulation provides the sponge with air and food.

Within the cytoblastema are a great number of amœboid bodies which are difficult to distinguish from the mass in which they are embedded. By the coalescence of these amœboids, which seem to be derived by a direct transformation of collared monads, one process of reproduction is accomplished. The other processes of reproduction were described.

Sponges appear to belong to the protozoa, although some authors believe they should be classed among the metazoa. The speaker was fully convinced of their protozoic nature.

DETECTION OF QUINIA.

At a recent meeting of the State Microscopical Society of Illinois, Mr. E. B. Stuart read a paper entitled "Notes on the Iodo-sulphate of Quinia."

The speaker stated that some time ago it became desirable to ascertain if a certain sample of muriate of morphia contained traces of quinia. He found no published reference to the action of morphia on the iodo-sulphate test of Herapath. This test had been a favorite with him for some time, partly on account of the ease with which it could be applied, and partly on account of the certainty of the reaction. He first tried the reaction on a solution containing one part of quinia and nine of morphia. The morphia in this mixture did not prevent the formation of the iodo-sulphate of quinia; nor did it have any effect when the morphia was in the proportion of 1,000 to 1 of quinia.

The mode of performing this test was to dissolve the salt in dilute alcohol, by the aid of sulphuric acid, and the solution warmed to about 100° F. Very dilute tincture of iodine is then added, drop by drop, with constant agitation. When a sufficient quantity of iodine has been added, the precipitate appears and quickly subsides.

In a mixture of the four principal cinchona alkaloids, the quinia is first separated, then the cinchonidia, which is followed in turn by the quinidia, and finally by the cinchonia. The latter reaction takes place very slowly, however, and only in tolerably concentrated solutions.

The separation of cinchonidia from quinia by this method is far from complete, and unless present in large proportion, all the cinchonidia is likely to be precipitated along with the quinia. On recrystallizing from alcohol, however, the two salts separate and can be distinguished by the microscope, although not very readily. After crystallization, the shape of the crystals becomes definite, mostly appearing in thin rhombic prisms.

DETECTION OF FATS.

Mr. Wm. Hoskins spoke of the differences between the crystallization of the fat of butter and that of lard, tallow, and other fats. The speaker stated that, upon melting and then cooling the clarified fats slowly, the differences in the crystallization of the various fats were very marked, and that he was enabled in this way to distinguish positively, adulterations of suene, oleomargarine, etc., in butter.

Important Discoveries in Central America.

The French explorer, M. Desire Charnay, announces that he has succeeded in penetrating the country of La Candones in Northern Guatemala, where he has visited the large city popularly known through Central American explorers as "The Phantom City."

Mr. Rice, of the *North American Review*, to whom M. Charnay sends this report and at whose request the attempt was made, tells the *Tribune* that when the explorer Stephens visited the village of Santa Cruz de Quiche, Guatemala, forty years or more ago, he learned of the existence of a great inhabited city in the Sierra de Guerra (land of war), the region in the northwestern part of Guatemala occupied by the Candones or Lacandones, a tribe of people said to this day to perpetuate the traditions and the mode of life of their Maya forefathers. Though nominally subject to the laws of the Republic of Guatemala, the Lacandones are in fact absolutely independent, and jealously refuse white men entry into their settlements. Stephens thought that a force of 500 men would be necessary in order to overcome the resistance of the natives to the intrusion of an exploring party.

Mr. Stephens was assured by the *cura*, or parish priest of Quiche, that he himself, while still a young man and living in the village of Chajul, had climbed to the summit of a bare and lofty peak of the neighboring sierra, and had then, at a height of ten thousand or twelve thousand feet, looked over an immense plain, extending to Yucatan and the Gulf of Mexico, in the midst of which, at a great distance, he saw a large city spread over a considerable space, with turrets white and glistening in the sun. This place was, according to the *cura*, "a living city, large and populous." From other sources Stephens learned that from the sierra a large ruined city was visible; while others, who had climbed to the same elevation, had seen nothing, owing to a "dense cloud resting on it." Later writers pretty generally relegate this city to the class of phantoms and mirages, or of fables. Yet in itself the *cura's* story is in no wise improbable, for there are throughout that entire region, in Guatemala, Yucatan, Chiapas, Tabasco, etc., to be seen, in ruins, it is true, hundreds of places, cities, which, while they flourished, must have presented just such an appearance as that described by the old *cura*. And it is worthy of note that Stephens—an embodiment of common sense, an explorer who had never a pet theory to support—saw no reason to doubt the truth of the padre's story.

M. Charnay's telegraphic announcement of his success does not tell by what means he was able to penetrate to the "Phantom City," nor in what condition he found it. Whether inhabited or not it is expected that it will be the means of throwing much light upon problems of Central American archæology.