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M. Henri Braconnot

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lected the multiplied and apparently incontrovertible indications and proofs of both theories, which, like all other theories of nature, must, when impartially examined, centre in the great creative, omnipotent Power—the formator, protector, and governor of all.

Yours truly,

Jan. 31, 1820.

GAVIN INGLIS.

XVI. *Memoir upon the Conversion of ligneous Bodies into Gum, Sugar, and a particular Acid, by means of Sulphuric Acid; and on the Conversion of the same ligneous Substance into Ulmine by Potash.* By M. HENRI BRACONNOT.

[Concluded from p. 56.]

Examination of the artificial Gum produced by the Action of Sulphuric Acid on Linen.

WE have seen that this gum, obtained by saturating sulphuric acid with chalk, contains in combination, lime which may in fact be separated by oxalic acid. This gum may be also purified by adding to a solution of it some of the sub-acetate of lead: this produces a very abundant white precipitate, which being decomposed by an excess of sulphuric acid, the liquid is evaporated to a sufficient degree, the sulphate of lead is separated, and the gum precipitated by alcohol. I prefer however in place of chalk to saturate the sulphuric acid with the oxide of lead heated: there results from it a liquid of a sugary, smart taste, owing to the lead held in solution: the latter is separated by passing through a current of hydrosulphuric gas; and the filtered liquor being evaporated, the artificial gum is obtained as pure as possible. Barytes may also be used in place of the oxide of lead; but as this gum retains barytes in combination, it is necessary to separate it by sulphuric acid.

This gummy matter, such as I have obtained, resembles gum arabic. It is transparent, of a slight yellow colour, inodorous, insipid, though it reddened the tincture of turnsole, and seemed to act in the manner of acids. Its fracture is vitreous. It adhered strongly to the vessels in which it was dried, always when it was prepared with care, and formed on them a very shining kind of varnish. It forms a mucilage less tenacious than that of gum arabic: its cohesive properties are also inferior: but this does not prevent its being of use in many of the arts. Exposed to the fire, it consumed, giving out a penetrating odour of sulphurous acid, owing to the decomposition of the sulphuric acid which it contains in a particular state of combination, such as the usual reagents

reagents cannot indicate. The residum shows after incineration some traces of sulphate of lime.

When this gum is exposed with potash to the fire to decompose it partially, no sulphurous acid is disengaged. If the residuum is dissolved in water, and nitric acid added, a brown flocculent matter is precipitated, which is known more particularly by the name of artificial *ulmine*. If nitrate of barytes is added to the filtered liquor, it produces a precipitate of sulphate of barytes.

The solution of this gum in water is not disturbed either by nitrate of barytes or by acetate of lead; but the sub-acetate of lead produces a very white and abundant magma entirely soluble in weak acetic acid. If the lead which the liquor above this precipitate contains is precipitated by carbonate of ammonia, and then evaporated to dryness, the residuum is a triple combination of gum, acetic acid, and ammonia. The hydrochlorate of the protoxide of tin also precipitates this gum from its dissolvent. Lime water or barytes in excess produces slight flocculent precipitates, which are nothing but combinations of gum with lime or barytes. The red sulphate of iron does not affect in the least the solution of this gum, while it coagulates abundantly that of gum arabic. Treated with sulphuric acid, this gum furnishes a large quantity of oxalic acid in fine crystals, but no mucous acid.

Sugar from Liuen.

The gummy matter the properties of which we have mentioned, being boiled for some time with diluted sulphuric acid, experiences such a change of equilibrium in the nature of its principles, that in separating they produce two very remarkable substances: the one which forms almost the whole of the matter is crystallizable sugar; the other contains the elements of the sulphuric acid which were disseminated in the gummy matter, and constitutes a singular enough acid, which I will designate under the name of the *vegeto-sulphuric acid*. I was led accidentally to this result, by treating a solution of the acid mucilaginous mass, produced by the action of the sulphuric acid on linen, with the oxide of lead, subjected to a long continued heat of 100° centigrade; but after having passed through the liquor a current of sulphurated hydrogen gas to precipitate the lead contained in solution; and after evaporating it, I was agreeably surprised to see that the whole of the gummy matter was entirely converted into an acid sugary mass. I digested this mass with very concentrated alcohol, by which the vegeto-sulphuric acid was dissolved: the sugary matter remained a little coloured, and of a very fresh flavour. Twenty-four grammes (370.6 gr.) of old cloth well dried,

dried, were reduced into mucilage by 34 grammes (525 gr.) of sulphuric acid, observing the precautions before indicated; the acid mixture, dissolved in a certain quantity of water, precipitated the ligneous matter a little altered; when dried it weighed 3·6 grammes (55·5 gr.) The acid liquor thus diluted with water, was boiled about ten hours; after which it was saturated with carbonate of lime. This liquor did not precipitate the subacetate of lead; it no longer contained any gum; the residue was evaporated and dried as much as possible until it began to exhale an odour of calomel. In this state it weighed 23·3 gram. (359·8 gr.) which were furnished by 20·4 grammes (315 gr.) of cloth, deduction being made of what was not reduced: but I believe that there were some losses; for the sulphate of lime, although well washed, had a slight coloured tint, different from what results from the preparation of artificial gum: however, like the latter, in place of burning in the fire and disengaging sulphuric acid, it became whiter, and did not exhale any very particular odour. I made these 23·3 grammes (359·8 gr.) of sugary matter into the consistence of syrup*; at the end of 24 hours it began to crystallize; and some days after, the whole was solidified into a single mass of crystallized sugar, which was pressed strongly between several folds of old cloth; crystallized a second time this sugar was passably pure; but treated with animal charcoal it became of a shining whiteness. The crystals were in spherical groupes, which appear to be formed by the union of small diverging and unequal plates. They are fusible at the temperature of boiling water. This sugar, of a fresh and agreeable flavour, produced in the mouth a slight sensation of coolness. It dissolves in hot alcohol, and crystallizes by cooling. Dissolved in water and mixed with a little yeast, it fermented; the vinous liquor which resulted furnished alcohol by distillation. Burnt with potash, and its charcoal washed with diluted nitric acid, it yielded a fluid not troubled by nitrate of barytes. It would be useless to insist further on the properties of this sugar; it is evident that it is perfectly identical with the sugar of grapes, or of starch.

The conversion of wood into sugar will no doubt appear remarkable; and when persons not familiarised with chemical spe-

* This syrup was weakly affected by sulphuric acid, while a concentrated solution of gum obtained by saturation with chalk was sensibly precipitated by the same acid which separated it from the sulphate of lime; from which there seems reason to presume that in converting this gum into sugar, by boiling it a long time with weak sulphuric acid, the elements of that acid which it contains do not entirely reunite to form the vegeto-sulphuric acid; but that a part separates from it in the state of free sulphuric acid, and the rest continues mingled with that which serves to effect the saccharification.

culations are told that a pound weight of rags can be converted into more than a pound of sugar, they may regard the statement as a piece of pleasantry, though nothing can be more real.

It appears to me, that from the conversion of wood into gum and sugar, some important consequences may be deduced, which may throw light on many obscure points of vegetation. In fact, since the observation seems to indicate that woods consist of gum or mucilage with less of oxygen and hydrogen than the proportions necessary to make water, we can, by remounting to the origin of the formation of ligneous matter, appreciate the means which nature puts in operation to create it. If we examine it a little before its birth, we see that it presents the form of a mucilage containing some small white grains which appear to be a first germ of wood: this mucosity, on account of the important part which it acts in vegetation, has received the name of the *organizing substance* or *Cambium de Duhamel*. Aided by the vital influence, this substance appears to abandon by little and little a part of the elements of water, to form first the cortical beds, the sap, the parenchyma; and at last the wood, properly so called, which must be extremely variable in the proportion of its principles, according as it is of new or old formation. This manner of viewing the transformation of cambium into wood, appears to be probable enough, when it is considered that we can retrograde the latter to its primitive state of mucilage. It is scarcely necessary to remind the reader, that wood often concretes in great abundance in the heart of mucous and sugary matter, as we see in nuts, in ligneous concretions of pears, &c. It may be further observed, that the death of the vegetable does not put an end to this subtraction of oxygen and hydrogen; it continues to take place in all the different states through which the ligneous matter passes, till it is at length entirely destroyed.

Of the Vegeto-Sulphuric Acid.

We have said that after having saturated a solution of the acid mucilage formed by the action of sulphuric acid upon linen with the oxide of lead, exposed to a long continued heat, there was formed sugar, and an acid of a particular nature, which we separated by rectified alcohol in which it was dissolved. This alcoholic liquor, however, retains also some sugar. I evaporated it to the consistence of a syrup, and agitated it with ether, which took a slight straw colour, and left after its evaporation an almost colourless acid, very sharp, almost caustic, and setting the teeth on edge. This acid is deliquescent, uncrystallizable, and attracts the humidity from the air. It gradually became brown in the air when above mean temperature. Put into a capsule plunged

plunged in a sand-bath, it decomposes and becomes black a little before the water begins to boil. When treated in this state with a little water, flocculi of vegetable matter partly carbonized are separated; and when some nitrate of barytes is poured into the liquor, an abundance of sulphate of barytes is precipitated. When this acid is subjected to a temperature higher than that of boiling water, its decomposition is more rapid, and suffocating vapours of sulphurous acid are emitted. This acid does not produce any change on metallic solutions. Nitrate of barytes and sub-acetate of lead are not in the least affected by it. It makes a strong effervescence with carbonates, and appears to dissolve all the metallic oxides, with which it forms salts, uncrystallizable, deliquescent, insoluble in acetified alcohol. These saline and neutral combinations, subjected to fire, decompose, emit sulphurous acid, and leave sulphates and charcoal. The same acid dissolves iron and zinc, liberating abundance of oxygen gas. It forms with oxide of lead and barytes very soluble salts, which have a gummy appearance. It seems to have a strong enough dissolving faculty; for it even dissolves to a certain degree sulphate of lead.

This acid is composed of sulphur, carbon, hydrogen and oxygen; or of a vegetable matter, and the elements of sulphuric acid, but in proportions with which I am unacquainted.

Action of Sulphuric Acid on Silk.

In treating silk with sulphuric acid, I conceived the hope of returning it to its primitive state of silky liquor, such as is extracted from the bodies of certain caterpillars, and with which, according to Reaumur, the Mexicans prepare their admirable varnish. I hoped by means of a similar liquor artificially prepared with pieces of silk, that it would be easy to fabricate cloth not spun. I have not however obtained this result, though I have not abandoned the hope of attaining it. Be this as it may, the sulphuric acid can convert the silk into two mucilaginous substances very distinct.

If some pieces of white silk are slightly moistened with this acid, and, after a few minutes have been given to allow it to act, the mixture is treated with a quantity of water, a very thick white mucilage is obtained resembling gum tragacanth. When a greater quantity of water is added, the whole of the mucilage is precipitated, and the supernatant liquid, which is as colourless as pure water, retains only a small quantity of silk in solution. This mucilage well washed with water is insipid to the taste. It is not sensibly affected by cold water; but a great quantity of boiling water dissolves it: the liquor being evaporated, there remain some insoluble membranes: an infusion of nut-galls produces a precipitate.

precipitate. This mucilaginous matter differs from that which is found in the caterpillar, inasmuch as it does not dry so rapidly, and is resoftened by water.

If a greater quantity of sulphuric acid is made to act a longer time on the silk, different results from those which I have mentioned are obtained.

Five grammes (77·2 gr.) of white silk cloth torn into small pieces were triturated in a glass mortar, by adding successively sulphuric acid until the whole was reduced to a homogeneous mucilage; there was a production of heat, but no sulphurous acid was disengaged. Twenty-four hours afterwards the mixture was treated with water, which produced an entire solution without precipitating the least particle of carbon: all that was separated was a yellow flocculent matter, which when dried weighed 0·15 gramme. The acid liquor was saturated with carbonate of lime, and part of it reduced by evaporation, in order to favour the precipitation of the sulphate of lime which it retained. The process was finished by evaporating it to perfect dryness. There remained 4·2 grammes of a residuum reddish and transparent resembling isinglass. This residuum dissolved in a small quantity of water did not congeal by cooling. With potash it did not disengage ammonia. Distilled it yielded carbonate of ammonia, and left after its incineration sulphate of lime. The infusion of nut-galls and the sub-acetate of lead precipitated it abundantly from its solution, but it was only slightly precipitated by the acetate of lead.

When therefore sulphuric acid falls upon a vestment of silk, or linen, or of cotton, it does not burn them, as it is said; but it perforates them, and the portion affected is converted into gummy matter soluble in water.

Action of Sulphuric Acid upon Gum and Sugar.

Gum arabic pulverized has been treated with concentrated sulphuric acid in quantity sufficient to dissolve it; but, far from producing carbon, as Fourcroy pretends, the mixture was scarcely coloured. At the end, however, of twenty-four hours it had contracted a brownish colour: diluted with water, it did not precipitate the least particle of carbon. The liquor saturated with chalk produced a gum, which had exactly the same properties as that which we formed by the action of sulphuric acid upon wood. Exposed to the fire it burned, exhaling an odour of sulphurous acid. The acetate of lead did not trouble its solution, but the sub-acetate of lead produced a very abundant white coagulum.

Cane-sugar acted a little differently with sulphuric acid: it was coloured almost immediately, and became of a blackish maroon, which deepened in course of time; but it did not form sulphurous acid, and the whole matter was entirely dissolved in water

water without depositing any particle of carbon. The liquor saturated with chalk furnished by evaporation a deep brown residuum of a sharp sugary savour. When heated, it exhaled vapours of sulphurous acid.

Conversion of ligneous Bodies into Ulmine by the Action of Potash.

We have seen that wood appropriates to itself the elements of sulphuric acid and water, in order to pass into the state of gum, and that the latter by a new distribution of its principles can be transformed almost entirely into sugar and a small quantity of a particular acid. We now proceed to show that, by extracting from wood the proportions of oxygen and hydrogen necessary for making water, it may be converted into a substance in which the carbon predominates, and which appears to me to have a great analogy to ulmine. M. Vauquelin is, I believe, the first who has made known natural ulmine as a particular substance*. He found it in combination with potash in the purulent ulcers of old elms, the mass of the wood of which had been in part eaten up and destroyed by suppuration. It was not until seven years after that Klaproth made mention of it: it appears that he had lost sight of the experiments of the French chemist; which may be believed, since he attributes to it properties which do not belong to it. Berzelius, Smithson, and Thomson afterwards directed their attention to it. The first of these chemists thought that it formed a constituent part of the bark of almost all trees; but it appears to present many varieties. I have found it in large enough quantities in the bark of the beech tree, partly combined with potash associated with a gum, a particular red matter, a small quantity of tannin, and a principle the odour of which is exactly similar to that of vanilla.

It is by studying the action of potash upon wood, that I succeeded in producing ulmine artificially. I began by ascertaining for certain that, contrary to the opinion of Mr. Thomson, pure ligneous matter is insensibly soluble in potash; but that it is otherwise when, along with that alkali of commerce made caustic, an equal quantity of sawdust and a little water are heated in a silver or iron crucible, in order to torrefy it; for, by taking care continually to agitate the mixture, the sawdust at length softens and dissolves almost instantaneously, swelling considerably.

If the crucible be withdrawn from the fire, and a little water poured into it, the whole matter dissolves with extreme facility, except a slight residuum formed of silex, carbonate of lime, phosphate of lime, and some traces of vegetable matter; and a deep

* *Ann. de Chimie*, t. xxi. p. 44.

brown liquor is obtained which retains in solution the potash combined with ulmine : an acid separates the latter in the form of a very abundant brown precipitate, which only requires to be well washed. If the acid liquor, separated from this precipitate, be saturated with chalk, and evaporated to dryness, alcohol, when digested on it, will separate acetate of potash. Sawdust thus treated with potash can furnish more than a fourth of its weight of dried artificial ulmine. Old linen cloth gives the same results : it disengages nothing but water, and a small quantity of yellow empyreumatic oil.

Dried artificial ulmine is of a black brilliant as jet : it is very brittle, and divides easily into angular fragments. Its fracture is vitreous. It is nearly insipid, and inodorous. In this state of dryness it is insoluble in water ; but when it has been precipitated, it dissolves in small quantities, and communicates a yellowish brown colour. The fluid does not contain more than $\frac{1}{100}$ of ulmine in solution ; it bubbles on agitation like a solution of natural ulmine. The same artificial substance gives to boiling water a deep brown colour like prepared coffee. If nitrate of mercury, or nitrate of lead, is poured upon it, it produces immediately brown precipitates, and the liquor is entirely dissolved. It is also precipitated by the nitrate of silver, sulphate of red iron, nitrate of barytes, acetate of alumine, chlorate of calcium, and chlorate of sodium ; but the precipitates do not manifest themselves till some time after the mixture. Lime water does not produce any change on it ; but if a little lime, in powder, is added, the liquor is greatly discoloured ; and with litharge it is entirely so.

I ascertained that the ulmine of the bark of the beech-tree presents similar results to those I have mentioned. I dissolved it in the water of very pure gallic acid with gelatine ; no change was produced ; but by the solution of artificial ulmine there was deposited a weighty brown elastic matter soluble in an excess of gelatine. Artificial ulmine not dried, and heated, reddens paper tinted blue with turnsole.

The same substance combines with great facility with potash, and neutralizes entirely its properties. This combination is very soluble in water : it is precipitated abundantly by acids, earthy and metallic salts, and lime water ; evaporated, it leaves a blackish shining residuum, unalterable in the air, and which, after combustion, leaves potash. This combination may perhaps be useful as a colour. It combines promptly with diluted ammonia : after being evaporated to dryness, there remains a residuum of the nature of varnish, very soluble in water, and which slightly reddens paper tinted with turnsole. Lime disengages the ammonia from it ; and the acids produce abundant gelatinous precipitates.

precipitates. This compound imparts a yellow colour to linen, silk, and cotton.

The same artificial substance is soluble in concentrated sulphuric acid, like ligneous bodies; but it is abundantly precipitated by water.

It is very easily dissolved in alcohol, and yields a deep brown liquor which is precipitated by water. If this solution is allowed to evaporate spontaneously, it forms at its surface pellicles which have a crystalline texture; but if the evaporation is forced more rapidly, a black shining residuum is obtained which resembles resin. Exposed to the flame of a lamp, it swells, and burns with a slight flame. Twenty grammes (318·10 gr.) of artificial ulmine from old linen were distilled in a glass retort; a liquid product was obtained from it of the weight of seven grammes: consisting of four grammes of a colourless fluid, and three grammes of oil, empyreumatic, brown, fluid, and soluble in any proportion in alcohol in an alkaline ley.

The colourless liquid contains nothing but acetic acid, and some traces of oily matter. There remains a charcoal of the appearance of bronze of the weight of 9·8 grammes, which left after its combustion 0·75 gramme of gray ashes, composed chiefly of carbonate of lime, phosphate and sulphate of lime, silice, and oxide of iron.

The artificial ulmine was treated with six times its weight of nitric acid at 38° Baumé; it was reduced almost to the consistency of honey; and being mixed with a little water, it assumed a deep brown colour, and left an abundance of matter, which well washed and dried was of the colour of Spanish tobacco. This matter, heated in a glass tube, was consumed without emitting light and without fusing; it produced an empyreumatic vapour, which seemed to be slightly nitrous. Its savour is bitter without being acid to the taste, although it reddens the tincture of turnsole. It is partly dissolved in boiling water, and produces a deep brown liquor which does not disturb a solution of isinglass. The brown acid liquid separated by water from this pulverulent matter, still retains something of the latter; it precipitates the animal glue, and furnishes by evaporation crystals of oxalic acid.

Such are the properties which I have recognised in this substance, produced by the action of potash upon wood, and which I have compared to the ulmine which exudes from the ulcers of trees. I may observe that the latter is also produced in analogous circumstances in diseased trees, the wood of which in putrefying separates quite from the potash which must concur in the formation of the ulmine. I ought not to neglect to state that M. Vauquelin had already compared this production of

of alkali, by vegetable suppuration, to that which is effected by combustion.

Ulmine exists in many ancient products of the vegetable kingdom. I found it long ago in making the analysis of an earth found in the roots of an old tree*; but I did not then examine all its properties. It even appears that the soluble part of certain earths, which have been ranked with the extractive, is formed of ulmine and ammonia. I have also found ulmine in great abundance in turf as well as in a variety of ligneous earths. It makes, doubtless, too, a constituent part of soot; but I have found it impossible to produce ulmine with oil.

XVII. *An Account of a Membrane in the Eye, now first described.* By ARTHUR JACOB, M.D. Member of the Royal College of Surgeons in Ireland, Demonstrator of Anatomy and Lecturer on Diseases of the Eye in the University of Dublin. Communicated by JAMES MACARTNEY, M.D. F.R.S.†

ANATOMISTS describe the retina as consisting of two portions, the medullary expansion of the nerve, and a membranous or vascular layer. The former externally, next to the choroid coat, and the latter internally, next to the vitreous humour‡. All however, except Albinus and some of his disciples, agree, that the nervous layer cannot be separated so as to present the appearance of a distinct membrane, though it may be scraped off, leaving the vascular layer perfect. That the medullary expansion of the optic nerve is supported by a vascular layer, does not I think admit of doubt; but it does not appear that Albinus was right in supposing that the nervous layer can be separated in form of a distinct membrane, though shreds of a considerable size may be detached, especially if hardened by acid or spirit.

Exclusive of these two layers, I find that the retina is covered on its external surface by a delicate transparent membrane, united to it by cellular substance and vessels. This structure, not hitherto noticed by anatomists, I first observed in the spring of the last year, and have since so frequently demonstrated, as to leave no doubt on my mind of its existence as a distinct and perfect membrane, apparently of the same nature as that which lines serous cavities. I cannot describe it better, than by detailing the

* *Annales de Chimie*, tom. lxi. p. 191.

† From Philosophical Transactions for 1819, Part II.

‡ Ruysch. *Epist. Anat. Prob.* xiii. Albinus, *Annot. Acad. lib. iii. cap. xix.* Haller, *Elem. Phys. t. v. lib. xvi. sect. 2.* Zinn. *Descrip. Anat. Oculi, cap. iii. sect. iii.* Sabatier, Boyer, Charles Bell, Cuvier, &c.