



## V. Observations on the various changes which take place on treating uric with nitrous acid, and on a new acid callea "erythric" thence produced

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An annular iron plate or shelf is then applied round the bell externally at about half its height, and on this shelf a fire of turf is kindled. The door of the furnace is then closed, and the flame plays round the upper part of the bell, till the whole of that portion of it which surrounds the vessels or saucers containing the amalgam becomes strongly heated. The distillation of the mercury then takes place; it rises in fumes, which falling condense in the lower part of the bell and the vessel of water beneath. In about eight hours the whole of the mercury is separated, the furnace is suffered to cool, and the silver (containing however some metallic impurities, particularly copper,) is found forming beautiful spongy cakes in the iron saucers. This is afterwards melted and refined in the furnaces adjoining to the amalgam works, where much of the richer ores, and the produce of that which containing larger proportions of other metals had been reduced in the blast-furnaces, is likewise melted and refined.

The operation of which I have now given a sketch, is undoubtedly the most interesting object which Freyberg and its neighbourhood afford. The process of amalgamation, in itself so curious, is there more extensively and better performed than in any other part of Europe.

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V. *Observations on the various Changes which take place on treating Uric with Nitrous Acid, and on a new Acid called "Erythric" thence produced. By Dr. GASPER BRUGNATELLI\*.*

My father (Professor Lewis B.) being occupied in making experiments on the human urinary calculi, for a work which will be published in the present year, I wished to employ myself in examining some of the substances which are most generally found with such calculi. In studying the chemical constitution of uric acid, I was particularly led to observe some changes which it experienced under certain circumstances. Of those observations I now undertake to give a brief account, although not without that diffidence which juvenile inexperience in the chemical art should inspire. Uric acid differs from the greater part of the other known acids, by having a chemical constitution much more complicated, the number of its component principles amounting to four, which is not the case in the others. Hence it is natural to infer, that in whatever manner it may be decomposed, a great

\* From Brugnatelli's Journal, 1st and 2d bimestre in 1818.

variety of products must be obtained. This inference is particularly confirmed, when it is exposed to the action of nitric or nitrous acid; and the phenomena which accompany this action are so singular, as to excite curiosity respecting the chemical alterations which are its effects.

Scheele, the celebrated discoverer of uric acid, first observed in like manner the violent action of nitrous acid on this substance, and the red colour which its solution leaves on the skin, or which it acquires in evaporating; but by one drop of nitrous acid it is instantly destroyed. He likewise observed that this solution had always an acid taste, that it did not alter the metallic solutions, nor precipitate with muriate of barytes; but, on the other hand, it yielded in lime-water a white precipitate which was soluble in nitrous and muriatic acids without effervescence.

Bergman observed, that when treated with potash in excess it did not become turbid, but by digestion acquired a reddish colour which readily tinged the skin, and the solution thus joined to potash precipitated in a particular manner the metallic solutions\*. He also considered as very remarkable the fine red colour which he obtained by treating uric with nitrous acid, and examined the circumstances which accompanied the appearance of this colour, and its destruction effected by acids or caustic alkali†. The same chemist and Scopoli afterwards observed that the reciprocal action of these acids produced a considerable quantity of oxalic acid‡; a change which my father found to be greater and more rapid, if, instead of nitrous acid, chlorine were used§. These observations directed Fourcroy to determine what were really the changes produced on uric acid by chlorine, which there was every reason to believe could not be very dissimilar from those effected by nitric acid. He found that under water chlorine changed uric acid into ammonia and carbonic, oxalic and malic acids. The first acid formed is the malic, which with the continued action of the chlorine changes into oxalic; and this increasing, both acids are resolved into carbonic and water||. These are the changes which chemists have hitherto observed as taking place in uric acid when treated in this manner. To me, however, it appears that many others are produced, as will be seen by the subsequent observations. When a little uric acid dissolved in nitrous acid is reduced to dryness, having a red colour, and exposed to the flame of a lamp in a

\* Scheele, *Mem. de Chym.* t. i. † Bergman, *Opusc.* t. iv. *Observ. de Cal. Urin.*  
 ‡ Crell, *Ann.* 178. See Brugnatelli's Memoir on the Sediment of Urine, where the history of this discovery is related, p. 116.  
 § *Ann. de Chimie*, xxxi. p. 133. || Fourcroy, *Syst. des Con. Chim.* t. x. p. 222

watch-glass, there is often seen in the centre a kind of spume formed of a brown or yellow colour. This is more conspicuous if the experiment be performed on a larger scale. In such a case, having projected the nitrous on the uric acid, without diluting it, until the rapid decomposition has ceased, after some repose, a copious deposit of minute grains is formed \*. On evaporating the whole with a moderate heat, many suffocating white vapours are disengaged, which become still more numerous in the process. After a time, the whole mass acquires a yellowish colour and becomes fluid, but coagulates immediately if removed from the fire. Continuing therefore the heat, the vapours finally cease to be suffocating, and the mass acquires a brown colour, while the edges usually become of a rose colour. Urging the fire still further, white vapours continue to be disengaged; mean time the mass becomes a bulky charcoal, which with a crack is in an instant almost entirely destroyed.

But, stopping here to consider the brown matter above mentioned, it is at first so hard that with difficulty can it be removed from the vessel, although in a little time it attracts humidity and softens. Placed in water it dissolves, and communicates a citrine yellow colour, leaving behind a blackish matter. The solution has a slight acid taste, and reddens the blue tincture of vegetables. Caustic potash either immediately or after a slight concentration produces a flaky precipitate, and at the same time ammonia is sensibly disengaged. Subcarbonate of potash produces a similar precipitate, which has a colour inclined to red. Treated with lime-water, the solution requires to be more concentrated to produce the precipitate, which assumes the form of very light flakes, which, on being reduced to dryness, become yellow shining scales. Similar scales are obtained even by evaporating the original simple solution. These salts have a sweetish taste, and are much more soluble in warm than cold fluids; they are deliquescent; but it appears that this property is greatly augmented by a particular yellowish matter which accompanies them, and which greedily attracts the humidity of the air, deliquescing itself, dissolving them with it, and even rendering them more soluble in water.

The above solution decomposes immediately when brought into contact with a solution of lead or silver, and becomes turbid. If it be mixed with acetate of lead, the precipitate collected, and afterwards very well washed, and dried with a moderate heat, the salt of lead may then be decomposed by dilute sulphuric acid.

\* Bergman, operating directly on the calculi of uric acid, observed the constant formation of this deposit. It is indeed immaterial to this experiment, whether pure uric acid is used, or that which is found well formed in human calculi.

In effecting this decomposition, and taking care that in the fluid no sulphuric acid remains, an acid of a yellowish colour and sour astringent taste is obtained. It reddens the tincture of turnsole, and when evaporated does not form crystals, but attracts a little humidity. The salt of lead from which this acid is extracted, is very soluble in acetic and dilute nitric acid. From many of the above characters which this acid substance possesses, it may be concluded to be malic acid. It is not, however, easy to conceive how the malic acid can exist in the brown mass obtained by the long action of nitrous on uric acid, while in it there was no longer found any trace of oxalic acid; and as this acid is formed at the expense of the malic, which is altered by the nitrous acid, so much greater is the force that can thus entirely decompose the malic acid. This reflection made me suspect that the acid substance was not malic acid, but one of those acids which have much affinity with it, among which the illustrious Scheele distinguished the lactic acid\*. The characteristic difference which he established between these two acids is the insolubility in alcohol of the calcareous salt of the former, and on the contrary the solubility of the calcareous salt of the latter. Hence, having observed that alcohol projected on the calcareous salt which I obtained became turbid with a drop of oxalic acid, I concluded it to be lactic acid, which I endeavoured to ascertain. As the salts of potash and of lead are soluble in alcohol, so also is the salt of potash which is obtained in an irregular form by the above method; and when the alcohol is evaporated by a gentle heat, it is found elegantly crystallized in long and slender needles. The regular form is likewise obtained when the pure acid is directly united with potash.

To the opinion that the acid obtained may be the lactic acid of Scheele, supported by the solubility of its salts in alcohol, it may be opposed, that this is perhaps owing to the presence of the particular yellow matter above mentioned; and in fact, experiments prove that it at least augments the effect. But it may be answered, that the acid obtained by Scheele should not be entirely devoid of this matter. Berzelius found lactic acid united to a particular matter in all the animal fluids, and it is the opinion of this chemist that the acid obtained by Scheele was very far from being pure. When the yellow solution is extracted from the original brown mass, there remains, as already noticed, a blackish matter. This dissolves rapidly in potash, and the alkali is in a great measure neutralized. The solution has a deep ruby colour, if it is concentrated and the potash in excess; otherwise the colour is a deep yellow. This solution, provided that it

\* Crell, *Ann.* part ii. 1785, p. 303.

has not too much alkali, has a sweetish taste, and tinges yellow either blue or white paper. Acetic acid produces in it a light gelatinous precipitate, analogous in appearance to uric acid when obtained by a similar process. The substance precipitated has a yellow colour more or less deep; it does not readily crystallize like uric acid, but presents here and there some shining points, and in drying it contracts and breaks in many pieces. It scarcely alters the blue tincture of vegetables, and destroys the colour previous to reddening it. In cold water it is almost insoluble. Lime and ammonia dissolve it; but the addition of an acid to the solution precipitates it again, although of a less deep colour. Hence these combinations, like the urats, are always dissolved in an excess of base. The combination with potash produces yellow coagulations in the solutions of silver and lead. The above-mentioned substance which the acids precipitate burns with all the characters of animal matter. Nitric acid projected on it is decomposed, and when the solution is evaporated no red colour appears; but, on the contrary, a residuum of a yellowish colour is found. Hence therefore results a substance in many characters analogous to uric acid, but which in many other essential qualities is distinct from it. To this substance is also united that particular yellow matter which we have seen accompanying the supposed lactic acid. In decomposing with acetic acid its combination with potash, the acetate of potash which passes the filter is coloured yellow. By removing this salt, and evaporating the residue, we obtain matter equal to that which was produced by washing the original brown mass, if the acid combined with the ammonia which it contains be removed. This peculiar yellow matter is soluble in water and in alcohol, but in a much greater degree when hot than cold. By evaporating it slowly it maintains its colour, and is reduced to a mass having a gummy appearance, which seems disposed to crystallize and readily attracts humidity. But if it is evaporated more rapidly, placing it in a watch-glass over the flame of a lamp, and removed from the heat when it has acquired much consistence, it appears chiefly remote from the centre where it attains the colour and appearance of wax. If the heat be continued it burns, emitting the smell of animal matter; it swells extremely on being converted into charcoal, and finally, with a slight crack the whole is destroyed in an instant. Nitric acid poured on it rapidly decomposes, and the solution after some time yields a white granular deposit; evaporated, it entirely changes into a white mass at first sufficiently hard, but afterwards attracts humidity, when it is very difficult to reduce it to charcoal by heat. It would be difficult to determine the precise moment when each of the above-mentioned substances begins to be formed; and we can only form

form conjectures on the different appearances of colour, or the different odours, which are developed during the process. It would be equally difficult to ascertain, that with the same elements of these substances there may not be formed, and afterwards destroyed, other peculiar combinations. The animal substances are endowed with so much mobility, and suffer such notable alterations in consequence of a small change in their parts, although imperceptible to the senses, that we need not be surprised if in this case some of them should have escaped our attention. But without digressing from my subject, I can adduce examples in which nature betrays herself, and reveals in the mean time that in the course of her operations important changes are effected. These facts will not be reluctantly learned while they are accompanied by many interesting phænomena.

It is well known that the solution of uric in dilute nitric acid, reduced to dryness and heated, has the property of communicating to bodies a deep red colour. This dye is therefore very soluble in water, and we may obtain from it a beautiful liquor of a light ruby colour\*. Being provided with an abundant quantity of this liquor, I evaporated it to obtain the colouring matter in a solid state. At a certain period of the process, the fire becoming somewhat strong, the rosy colour in an instant disappeared, and was succeeded by a yellowish hue. This change has occurred every time I repeated the experiment. It appears that in this case even the water had a part, since we know by other means this colouring matter may be obtained unaltered in a solid state. In seeking to discover some means of restoring the faded colour, I found that potash, ammonia, and lime answered this purpose, only the colour reproduced was more rosy and delicate. The potash in the smallest quantity produced the effect better than the others. In like manner it at the same time yielded a rosy precipitate, which when left to repose attracted all the colouring matter, and the solution remained discoloured and alkaline. If, when the precipitate is immediately formed, it be collected on a filter and dried, it retains a delicate rose colour, interspersed with very minute shining points. Those points, which have a most agreeable effect in the light of the sun, are found even beyond the space where the colour extends. Lime yields a deeper colour, and when collected on the filter has the appearance of velvet, and also presents brilliant points.

\* I have almost always used the washings of the red spots left on the skin by the above solution, and it is often very deep. The red residuum which is obtained by the heat of the fire makes the washings naturally more easy to be changed, or to differ from themselves. It is remarkable that such red liquors, when slowly evaporated, yield prismatic crystals, and dissolving anew in water, we again obtain a reddish liquor.

Desirous of assigning some reason for the change of colour in the red liquor in consequence of heat, many arguments induced me to suspect that it must be owing to the influence of an acid. In fact, the acids produce a similar effect; and if at first they are unable to do it, the assistance of heat renders them immediately capable of effecting it. Besides, the crystallized points which we found detached from the colouring matter have all the appearance of a salt. It is certain that, if all that remains on the filter be burnt, the water which washes the carbonaceous residuum has alkaline characters. I have also observed that potash revives the colour of the first reddish liquor, but scarcely separates any of the coloured flakes: lime produces a similar effect. I have likewise seen that the coloured precipitates were insoluble in water, but very soluble in very dilute sulphuric acid. It is singular that this solution is effected with a species of effervescence, which appears to me to be increased in proportion as the brilliant points are more numerous. Hitherto however I have obtained them in too small quantities, and too impure, to subject them to that particular examination which they merit. At present, indeed, it appears to me that the above phenomena may receive a satisfactory explanation, supposing that the action of heat on the red liquor determines the formation of an acid, or puts it in a state to alter the colour in the above-mentioned manner; and that this acid may be scattered in very minute molecules, by uniting of which to a base, they may likewise give origin to those very small crystals. The solution, indeed, changed by heat, has a nauseous sweetish as well as acid taste, and does not sensibly redden the blue tincture of vegetables: but this may be attributed to the weakness of the supposed acid, in which the extraneous residuary matter may be more than sufficient to neutralize it. In obtaining the red colour by the action of fire, it was observed that, in finally drying, a yellow acid liquor destroyed the red colour previously formed as soon as it touched it. Neither are the metallic solutions inactive on this red liquor. Some make the colour yellow without affording a precipitate, as for instance, copper; others yield precipitates of the most beautiful colours, and separate all the colouring matter. Thus the solutions of silver, mercury and lead, yield sufficiently agreeable violet colours of different intensity, which fix themselves tenaciously on the paper in which they are collected. It is to be hoped that painting may derive something from such colours, as they serve to make sympathetic ink and other chemical sports. But it must be observed that they are changed as much by acids as by alkalies. In fact, the substance on which depends the faculty of dissolving uric in nitrous acid, and of becoming red with heat, has all the characters of an acid.



PART II.—Having intimated the discovery of a new acid in the preceding part of this memoir, thanks to the care with which my father superintends my studies, I am now enabled to describe it more completely. This acid, as already observed, originates from the action of nitrous on uric acid, and is distinguished by the singular property of reddening when exposed to heat; for this reason I propose to call it *erythric*, from *ἐρυθράζειν*, to redden. I now proceed to describe the properties of this new substance, but must observe, and regret, my imperfect success, as it is a compound which often changes and readily becomes of a quite different nature; and hence my disappointment in sometimes not being able to give an exact account of all the phenomena, and sometimes being obliged to abandon certain subjects without any research, to avoid entering into a too extensive and difficult field. Nevertheless, I hope that my observations will be of some utility to those who may subsequently examine this complicated subject under more favourable circumstances.

#### *Mode of obtaining the Erythric Acid.*

1. I have already related Bergman's observations on the rapid decomposition and deposit obtained by pouring nitrous acid on uric acid or urinary calculi. That deposit is the *erythric* acid, which I found disposed in regular figures; and to obtain it pure, the following is the easiest process to be adopted. Unite in the manner before mentioned the nitrous and uric acids; leave the mixture at rest until the numerous floating yellow flakes have settled at the bottom of the receiver; then pour off the liquor, collect the solid part on blotting paper, and dry it as much as possible; afterwards dissolve it in water, and evaporate it slowly in the air; by this method most beautiful crystals of pure erythric acid may be obtained. This liquor transmits nitrous vapours, and also contains erythric acid in solution.

2. Chlorine, iodine, and oxalic acids with uric acid can give origin to this new acid. Put uric acid in a bottle full of chloric gas, it will instantly be decomposed, and a substance which tinges the skin of a lively red colour will be produced. In like manner, a mixture of uric acid with iodine, or with oxalic, acid exposed to the action of heat, a decomposition is seen to take place, and finally a bright rosy residuum is produced. This appearance of colour indicates the formation of erythric acid.

#### *Characters of the Erythric Acid.*

3. The crystals of erythric acid have a rhomboidal form, are colourless and perfectly transparent; their taste is at first pungent, and afterwards becomes sweetish; exposed to the light of the sun they redden, and preserved in paper they impart to it

many reddish spots; exposed to heat they decrepitate, and also assume a red colour; left in contact with dry air, they effloresce, lose their transparency and become white. When found in this state they do not redden on exposure to the solar light; and if deprived of their water of crystallization, and exposed to the fire, they become yellow, and burn without reddening. Hence we may observe, that the presence of water is necessary in order to their becoming red.

4. The crystals of erythric acid are very soluble in water and in alcohol, without either impairing the transparency or changing the colour of those fluids. The watery solution has a sweetish taste, no smell; but it appears that it acquires a smell in time, which may be the index of its being about to undergo some alteration. It reddens the blue tincture of vegetables, and their colour may be restored by the alkalies. Lime-water becoming turbid discovers the presence of the smallest quantity of erythric acid.

5. The solution of erythric acid by spontaneous evaporation in the shade, crystallizes again without being altered: but if rapidly evaporated it becomes a solid red coloured mass, which is revived on dissolving in water, of which it colours a great quantity. In like manner the erythric liquid tinges the skin and other bodies red, more promptly than usual with the common solution of uric in nitrous acid.

6. To discover if in the act of changing any peculiar substance was evolved, the erythric acid was distilled with a strong fire. It does not boil out at a high temperature. Towards the conclusion of the evaporation, it became yellowish, afterwards red; but no product could be found in the simple water which was distilled.

7. In the solution of erythric acid reddened at the fire, a small portion only of the acid suffered change. In fact, the smallest drop renders turbid a great quantity of lime-water; and if by evaporation the solvent water is diminished, we see the erythric acid depositing itself. It is not, however, the same when the red solution is obtained by washing the spots left by erythric acid on the skin, cloth, &c.; in this case the erythric acid appears almost entirely altered, and lime-water scarcely discovers its existence, presenting after some time a thin net on its surface.

8. The colouring matter which reddens the erythric acid may be dissipated by heat. In fact, if the erythric acid be reddened in a watch-glass over the flame of a lamp, afterwards dissolved in water and again exposed to the same heat, beautiful red vapours are seen rising, particularly at night, and the fluid loses its colour. This fluid is found to be erythric acid, which may be again reddened. If the red liquor be rapidly heated in a retort, it loses  
its

its colour, and furnishes a fluid of a faint rose colour, and of a sweetish taste, which does not render lime-water turbid.

9. The red erythric acid in more or less time loses its colour, and in its stead usually yields white flakes. But if in obtaining the redness the heat be stronger than necessary, the red erythric acid changes colour much more easily and becomes yellow. This change, indeed, takes place instantaneously with the prolonged action of the fire; a strong smell of bitter almonds is then evolved, which is communicated to water in which the residuum is dissolved. This proves that carbon, azote, and hydrogen, as was easy to be imagined, enter into the composition of erythric acid.

10. The circumstances therefore of the formation of erythric acid not only induce the belief that it also contains oxygen, but that it contains it in an abundant quantity, so much and so rapid is the decomposition of nitrous on uric acid required to produce it. Moreover, it appears from the circumstances already mentioned, that the erythric acid acquires the red colour in consequence of a slight change effected in some one of its constituent parts, in which likewise water necessarily concurs. These considerations led me to try the action of the Galvanic pile on erythric acid, hoping by such means to throw some light on the unknown chemical changes that accompany the formation of the red colour.

*Effect of the Galvanic Pile on Erythric Acid.*

11. The pile which I used consisted of sixty pair of metallic plates with a superficies of two inches and a half square. At the negative pole a tumbler filled with a solution of erythric acid was placed, and another with distilled water at the positive pole. A platina wire communicating with the respective poles was immersed in the tumblers, between which passed a piece of amianth moistened with distilled water. The electric current was scarcely put in motion, when a phenomenon appeared which indicated that this experiment should succeed in the highest degree. Many bubbles of gas arose from the positive pole where the water was, and none, or scarcely one, and that with difficulty, issued from the other pole with the erythric acid. After about an hour the acid began to become yellow, and with the usual gradation of colour observed when the fire acted on it: finally, it acquired a deep red colour. After some time the disengagement of gas appeared copious even at the negative pole, but never so much as it was at the other. Although the erythric acid was become of a deep red colour, yet there existed a great quantity unaltered in the solution, but which after twenty-four hours was considerably diminished in volume. A portion also of the erythric acid was transported to the positive pole, as was indicated by lime-water.

platina wire at the positive pole became of a yellow colour, and that at the negative was almost covered with a crust of red colouring matter.

12. The experiment was afterwards reversed, that is to say, a solution of erythric acid, reddened either by the pile or by heat, was placed at the positive pole, and pure water at the negative, arranged as before. The development of gas appeared from both poles. After a longer time than that which it had employed to redden, the liquor began to diminish in colour, and finally became, as at first, colourless. It was pleasing to see on the amianth a light rosy tint which terminated in a beautiful little red ring: it was insensibly moved towards the negative pole, and the tumbler of the positive pole was also marked by red rings or bands at the part towards the other pole and near the amianth. Changing the position of the tumblers, putting to the positive water, and to the negative acid without colour, the latter reddened and the colour vanished on the amianth.

13. These experiments seem to prove that the change in the red colouring matter of the erythric acid proceeded from the loss of oxygen which the acid sustained. Indeed at the negative pole, where it reddens, is the precise point where the developing hydrogen can subtract from it this principle; and from the positive pole the colouring matter is carried in the state of alkali to the other pole.

14. I have found another proof which confirms the opinion that the appearance of the red colour in erythric acid depends on the cause here assigned. Immersing red-hot iron nails in this acid, the red colour is immediately seen to appear. I also hoped to obtain a similar change with phosphorus. I put a small piece in erythric acid, and left it at the light of the sun; in the fluid no notable colour appeared, and the phosphorus only acquired a violet hue. Neither was the action of fire fit in this case to make the fluid become red.

#### *Erythrats of Lime and Barytes.*

15. Erythric acid poured into lime-water, as before observed, makes it very turbid; with the addition however of fresh erythric acid it is dissolved, but not with that of any other acid although weak, not even the carbonic acid, which is capable of decomposing the erythrat of lime. This salt is found in the form of light, white flakes, which are seen suspended in the fluid, and even rise to the surface if any extraneous substance is found in it.

16. This erythrat of lime has scarcely remained any time in contact with the air, when it experiences a change. It is found that at its expense a carbonat is formed, judging from the vivid effervescence

effervescence which takes place when dilute sulphuric acid is poured on it.

17. Dissolving the erythrat of lime in an excess of acid, a transparent, tasteless fluid is obtained. The oxalic acid discovers the lime, but to that carbonic acid must not be added; the alkaline carbonats however immediately render it turbid. Alcohol produces a similar effect, but it appears that it separates the neutral erythrat. The acidulous salt slowly evaporated yields crystals, in which the acids produce no effervescence whatever. The solution of these crystals does not become turbid with lime-water, and it has lost all the characters of the original salt. It being necessary to examine the changes which occur in erythric acid when united to bases, we must leave for the present the investigation of this phenomenon.

18. A drop of erythric acid produces a copious precipitate in barytic water. This erythrat presents phenomena analogous to those before observed in erythrats of lime. The erythric acid decomposes rapidly the sulphuret of barytes, and yields a violet colour.

*Erythrats of Potash and of Soda.*

19. Caustic potash immersed in the erythric liquid produces no precipitate, nor any remarkable change of colour; but their combination has a very sweet taste. The erythrat of potash renders lime-water turbid, and precipitates some metallic solutions, such as that of lead and silver, in white coagulated matter; on the contrary, with others it forms soluble coloured compounds, among which are distinguished the products from the solutions of iron by their beautiful blue colours.

20. The erythrat of potash changes its nature very easily. In fact, on examining it some time after it was formed, it was found that from being neutral, or even somewhat alkaline, it had become acidulous, as was indicated by turnsole; nor would it yield a blue colour with the salts of iron, unless some drops of potash were newly added.

21. The same and perhaps still more rapid changes take place, if the neutral erythrat be exposed to the light of the sun. In this state it is generally seen to become yellowish, and afterwards to redden. Removed from the solar light, and after a time, it loses the colour it had acquired; but if it remains exposed to that light it finally becomes a solid mass, sweet, of a lively red, and possessing much tenacity; dissolved in water, it gives to the liquid its beautiful colour. This red liquor does not so easily lose its colour by the action of the fire, as happens when it has no potash; but for this effect it is necessary to add much water.

22. The action of a moderate fire accelerates the above effects, the red hue appearing and becoming still deeper. Towards the conclusion

conclusion of the evaporation, if the fire ceases to act, a very tenacious sweet mass is obtained; but if the fire be continued, an abundant red spume is produced. This spume dissolves rapidly in water, disengaging numerous bubbles, and communicating the usual red colour: in alcohol it is scarcely soluble.

23. That the erythrat of potash is subject to an almost immediate change, is confirmed even by another proof. Putting potash on the crystals of erythric acid, they are dissolved; neutral erythrats are produced in the state of a white powder, which if left in contact with the air spontaneously reddens. In water, with which however it has not much affinity, it furnishes a solution which yields a blue colour with salts of iron; after some time it loses this property, and re-acquires it by means of the addition of fresh potash. But that which evidently demonstrates the change which take place, is the fact that, after the lapse of several hours, the deposit which was before in a great measure insoluble in water, becomes entirely dissolved if a small quantity of water be kept over it. This new solution requires the addition of potash to produce the blue colour with salts of iron.

24. The same things are produced, if instead of caustic potash carbonat be used. The erythric acid has the power of developing carbonic acid, and hence originates an alkaline erythrat, which like the others is subject to equal changes. Analogous phenomena are obtained with carbonat of soda; the erythrat of soda differs from that of potash in having a pungent taste, whereas the erythrat of potash is sweet.

25. From these it may be concluded, that erythric acid in contact with potash gives origin to a new acid endowed with a greater capacity of saturation, producing at the same time a peculiar matter which occasionally manifests itself with a red colour; circumstances which lead to the suspicion that the new acid may be even more oxygenated than the erythric. Let us see if the action of alcohol gives greater importance to this conjecture.

26. The erythrat of potash is so much the less soluble in alcohol the more it is alkaline. Thus, if in alcohol which contains dissolved potash erythric acid be poured, an abundant precipitate appears, which is speedily dissolved by the addition of a little more erythric acid, and again reappears by adding fresh alcohol. This, therefore, does not alter the erythrat of potash in which the acid is in excess. The alcohol precipitating the erythrat deposits beautiful arborizations, which are formed of uniform shining crystals. These rapidly dissolve in water, and give it a sweetish taste. The solution is highly alkaline, does not precipitate lime-water, nor give a blue colour with solutions of iron; it acquires in no manner a red colour, and contains, indeed, an acid

acid very different from the erythric. Alcohol keeps dissolved a peculiar matter which is discovered by evaporation. If the action of the heat be not too strong, it leaves a colourless mass which is very tough; otherwise it is reduced to a very white spume, as we have seen occurring in the erythrat of potash, where the alkali was in excess\*. This spume dissolves in water, evolving many bubbles, and burns with all the phenomena which accompany the combustion of animal substances.

27. If, instead, alcohol be poured on erythrat of potash already altered, in this case it also becomes turbid, notwithstanding its acidity. The crystals which it produces are cubic, and dissolve in water. The solution is sweet, neutral, and, like the others, presents no phenomena which could induce the belief that erythric acid is present. In such cases, the alcohol with evaporation at the fire becomes red, and is finally converted into a red spume.

28. The erythrat of potash reddened by heat becomes violet with the addition of fresh potash†: thus the red erythric acid takes the same colour by adding to it an excess of potash. This combination left in the air loses its colour and crystallizes, giving origin to a salt similar to that which is obtained by means of alcohol. In like manner, if an alkaline solution of an alkaline erythrat of potash be left to evaporate, we obtain crystalline groups of the same salt, that are involved in a glutinous matter.

### *Erythrat of Ammonia.*

29. We recognise in this erythrat, phenomena analogous to those which were observed in the preceding. In adding ammonia to erythric acid, the union is accompanied by no sensible phenomenon. This salt precipitates with lime, yields a blue with solution of iron, but after a time loses this property, which fresh ammonia restores: exposed to the sun it reddens.

30. Ammonia poured on crystals of erythric acid dissolves it, and it becomes yellow; afterwards it spontaneously grows turbid, deposits yellow flakes, and remains of a rose colour, transmitting at the same time a peculiar disagreeable odour. Those yellow flakes dissolve in water, and give it a rosy colour; the solution possesses slightly the property of colouring salts of iron, and afterwards loses it.

\* It is remarkable that the solid erythrat of potash, which often spontaneously reddens, yields a neutral solution, which does not redden on exposure to heat, but also produces this very white spume.

† The addition of ammonia to red erythrat of potash produced a very surprising phenomenon; it developed a disagreeable odour, and immediately, or after some time, yielded a black powder mixed with a substance which exposed to the light of the sun presented the beautiful green colour of the emerald. This singular change sometimes did not succeed, for which I can assign no reason.

*Erythrat of Iron.*

31. Erythric acid combined with iron presents so numerous and variable phenomena, that to explain them would require exclusively a long study. Boiling erythric acid over iron filings, the metal dissolves, and the solution varies in colour according to the concentration of the acid, and the action more or less strong of the fire. Thus sometimes it is yellow, sometimes purple, and sometimes of a most beautiful blue colour. The latter however it acquires in every case, by means of adding an alkali, which does not produce any other precipitate.

32. Similar combinations are obtained by boiling erythric acid over black oxide of iron. It seems, however, that in such a case we cannot immediately obtain the blue colour, but always if it had the citron yellow. To have that colour, the addition of an alkali is also necessary: after some time, indeed, the blue disappears, and a colour similar to the first returns.

33. Erythrat of iron concentrated by heat leaves green bands and deposits yellow grains, which with slow evaporation may also be crystallized in close prisms. It is worthy of remark, that in this erythrat, what the heat of the fire cannot do, that of the sun can; that is, communicate to it the blue colour. It is however fugitive, the yellow colour returns, and is ready to again become blue if exposed to alkali or the sun, and in these changes only a black powder is seen to be deposited. Erythrat of iron long exposed to the action of the sun is entirely in blackish matter, from which water is tinged red.

34. Erythric acid unites even cold with peroxide of iron: this solution has a yellow colour: if it be deep, alkali in a small dose produces a turbid coagulation, which on the addition of alkali dissolves and becomes blue. This coagulated matter, if left a long time quiet, spontaneously dissolves, and a yellowish matter reappears.

35. The erythrats of iron exposed to the electric current at the negative pole, cover the platina wire with a blue crust which afterwards tinges the whole liquid. This singular fact unites these phenomena with those which we have before observed in the simple erythric acid, and demonstrates that the various colourings to which this acid is subject, depend on a common cause modified by the bodies with which it is found in contact.

36. These experiments, although very incomplete, seem to me sufficient to show, that the blue colour which often accompanies the erythrats of iron is not a property of these, but most likely it belongs to a substance generated in the act in which the erythric acid changes into that other acid of which we have before spoken. In the passage of one acid to another originates,  
if



if I may use the expression, a secretion which in company with the erythrats of iron often tinges blue. It is with much reason that the alkalies make this colour appear, as they expressly promote such a secretion, which in their union with erythric acid is accustomed to manifest itself by a rose colour.

37. It is very probable that the alkalies with erythrats of iron may constitute triple salts; this may also happen with other metallic erythrats, as will presently appear. The triple prussiat of potash and the decoction of galls discover iron, from the erythric solutions producing the customary colours\*.

#### *Erythrat of Lead.*

38. I have already observed that the erythrat of potash decomposes the solution of lead, and forms a white precipitate. A similar precipitate is likewise obtained from the same solution decomposed by the erythrat of potash, in which the acid is said to be altered. We shall now see if we can directly obtain these two different species of erythrat of lead, which will confirm our opinion on the mode with which erythric acid acts with bases.

39. Pouring erythric acid on litharge, it is only necessary to agitate them a little in order to produce their combination. Thick clouds are seen in the liquid, and the erythrat of lead, which is precipitated, is insoluble in acetic acid, and even in an excess of erythric acid itself. If this erythrat of lead be decomposed by sulphat of iron, and potash be afterwards added to it, the blue colour is obtained.

40. But if the turbid fluid obtained by agitating erythric acid with litharge be exposed to heat, after a slight ebullition the turbidness disappears, and the solution assumes a red colour. Continuing to boil it, the turbidness returns, and deposits a white powder, which is the erythrat of lead in which the acid is altered. The red liquor has a considerable quantity of it in solution, but simple water dissolves much less; therefore the red liquor with the addition of sulphat of iron and potash gives the blue colour, which is not produced by the aqueous solution.

41. From the second erythrat of lead may be extracted that acid which is generated at the expense of the erythric. This salt may be decomposed with dilute sulphuric acid in such a manner

\* Whence is it that muriatic or hydrochloric acid, boiled on the most pure uric acid, gives a blue colour with triple prussiat of potash to such a degree as to create the belief that uric acid always contains iron? Can it ever be that these two acids should produce the same blue substance which was observed in the erythrats of iron? I shall only observe that Scheele's assertion of muriatic acid boiling on uric acid without any alteration, does not seem very correct. If the experiment be made, it will be found that caustic potash will develop from uric acid a very distinct odour of ammonia, which is a proof of its being in some degree altered.

that

that no turbidness results from the above solution of lead, nor any other of this metal; thus a colourless liquid of a pungent acid taste will be obtained. It reddens turnsole, but does not render lime-water turbid: united with potash, having acquired a sweet taste, it becomes insoluble in alcohol, and in a word possesses all those characters which belong to erythrat of potash spontaneously altered.

42. Erythric acid also attacks metallic lead, making the former boil on the latter: the acid after some time reddens, and it is discovered by sulphuric acid, that it contains lead in solution.

#### *Other metallic Erythrats.*

43. Erythric acid agitated with red oxide of mercury becomes turbid, and much more so by the action of fire. In time no colour appears in this, the salt is deposited in the progress of evaporation, and the liquid abandons it copiously in cooling; of the mercurial salt a very little remains in solution, and the precipitate is then entirely insoluble in distilled water.

44. In a similar manner the erythric acid acts with oxide of silver. Boiled also on the flowers of zinc, it dissolves the metal without changing colour, and becomes very turbid in cooling. Boiling it on the contrary over metallic zinc, it assumes a yellow colour on uniting with it. Potash at first produces a precipitate in this solution; but afterwards on adding it, the whole dissolves, and takes a beautiful rose colour.

45. Erythric acid boiled over copper acquires a yellow colour without dissolving any. It unites however in the cold way with the brown oxide. The erythrat of copper has a green colour; it crystallizes elegantly in the form of the plumage of feathers, gives a blue colour with ammonia, and, what is very singular, likewise yields a blue colour even with potash without producing any precipitate. Thus, potash forms with the solutions of metallic erythrats combinations still soluble, which renders it presumable that a triple salt is formed.

#### CONCLUSION.

46. No one who considers the effects of nitrous on uric acid can see them without surprise at the multitude of products which are derived from them. The greater part of these, however, is the fruit more naturally peculiar to other bodies; on the other hand, erythric acid is that which exclusively belongs to the decomposition of uric acid; and hence is the more valuable and eminent product. Erythric acid is a substance so singular for its physical changes, rather than for its chemical properties, that the lovers of the natural sciences will willingly make it the object of their study. In these observations I only proposed to myself to recognise and account for the principal phenomena which erythric

thric acid presents; many others remain to be noticed which my limited time did not permit. I have demonstrated that the red-dening of erythric acid depends on a loss of oxygen; that in the union of this acid with bases the same modified causes produce various colours, and that contemporaneously the erythric acid is transformed into another peculiar acid. Though these facts are not perhaps in all parts proved with the highest rigour, yet I hope that they have such a degree of probability, that chemists will not refuse to admit their truth, until new researches shall demonstrate their fallacy.

## APPENDIX.

In the first part of this memoir I have noticed some phenomena which occurred in the red washings of the spots made by a solution of uric in nitrous acid. Now that erythric acid is known, it is much easier to account for these. I had then observed that the washings exposed to a strong fire lost their colour. This, indeed, ought to take place, heat having the power of dissipating or destroying the red colouring matter (8·9). I have then found that the alkalies and earths renew this colour. This may be easily explained, admitting that the very small quantity of erythric acid (7) which remains in those solutions is found disposed to become altered from the bases, and hence to produce new colouring matter (21). Finally, I have remarked that some metallie solutions precipitate the colouring matter, rendering it of a violet colour, and others make it yellow without producing a precipitate: for this I cannot adduce any plausible reason, and only consider that the solutions of those metals, which with erythric acid produce insoluble salts, are those which precipitate the colouring matter. Of the rest, I must frankly confess that the above-mentioned appearance and disappearance of colours are not always constant: this, however, in such compound and volatile substances is not very surprsing.

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VI. *Account of an electrical Increaser for the unerring Manifestation of small Portions of the Electric Fluid. Invented by HENRY UPINGTON, Esq. of Blair's Hill, Cork. Communicated by Dr. PEARSON.*

*Letter from Mr. Upington to Dr. Pearson.*

Blair's Hill, Cork, Feb. 24, 1817.

SIR, — THE electrical increaser for the unerring manifestation of exceedingly weak and small portions of the electric fluid, respecting which I took the liberty of addressing you on the 4th instant, was constructed by myself in the year 1810, for my private experiments; and at the same time I communicated its properties