protracted, these means should come under contemplation. If, on the contrary, no ground for such predisposition exists, but still untoward circumstances strikingly manifest themselves, we are to inquire if the proper use of these means does not involve infinitely less hazard than the indefinite continuance of ineffectual labour. Where the labour is advancing, though slowly, we are not authorized to interfere. Our interference may disturb the process and prolong it; or, by adding new sources of irritation, diminish the chances of ultimate recovery. In such a case, the means recommended under the first method, are peculiarly applicable; and by the powerful impression they are calculated to make on incipient disease, we may anticipate from their use, very favourable results. The patient, however, who, during labour, has discovered strong tendencies to disease, but which have disappeared immediately after delivery, is not hence to be presumed safe, and our preventive practice abandoned. One part of the plan, at least, should be persisted in, viz. the purgative; and Dr. Gordon, of Aberdeen, assures us, that in a very fatal puerperal epidemic in that city, of those who were freely purged the day after delivery, only one died of puerperal fever.

Some authors have believed fully, that puerperal fever is a contagious disease. The writer, just mentioned, felt as convinced of this as of any fact in medicine.

Prevention, under this doctrine, consists in merely removing the patient from the society and attendance of those, who have either visited or nursed patients ill of puerperal fever. Whether the doctrine of contagion be true or false, the practice here recommended is certainly not unreasonable, and where it is possible should be adopted.

The management of the puerperal state, viz. that which immediately follows delivery, with a view principally to the prevention of puerperal fever, or other disease, may form the subject of a future communication.

Note.—Page 159, line 18, read *fatal* puerperal convulsions, &c.

Contributions to Chemistry, No. 1. By JOHN GORHAM, M. D. Professor of Chemistry in Harvard University.

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1. *Indigogene.*

THE investigation of the properties of this substance seemed to promise something interesting, from the two facts announced by Brugnatelli, that indigo, when exposed to

heat, produces a vapour of a fine purplish red, by which it would appear to be assimilated to iodine, and that the substance constituting this vapour is capable of forming an amalgam with quicksilver, and is, consequently, possessed of one property peculiar to metals.*

In order to obtain indigogene, so called by Brugnatelli, from ten to fifteen grains of powdered indigo are exposed in a glass capsula to the heat of a lamp. A small quantity of water is first vaporized, after which there follows a bluish smoke of an offensive odour, the mass swells and is apparently fused, and a beautiful purplish red vapour is observed to play over its surface; the lamp is then withdrawn, indigogene condenses in crystals, and it may be easily detached from the mass beneath, by a small and thin spatula. One hundred grains of the best indigo will yield from fifteen to eighteen grains of this substance. If the indigo be of an inferior quality, the quantity obtained is not only smaller, but it is separated with more difficulty, in consequence of the softness or powdery state of the scoria. Even in its best state, it is more or less contaminated with the ashes, if the residue may be so termed, and for nice experiments requires a second sublimation.

When thus procured, it appears as an aggregate of small and delicate prismatic crystals, interlaced, of a purple red colour, and slightly iridescent. The colour of a single crystal is golden yellow. Its specific gravity is about 2.6. When exposed to the temperature of 360° Fah. it is volatilized, its vapour is dense, and it speedily crystallizes. At this degree of heat it is partly decomposed, a portion of it becoming semi-fluid, and finally concreting in the form of a black, spongy, and shining mass. The crystals of indigogene, which have undergone a second sublimation, are minute, and the mass appears comparatively dense.

It is insoluble in water.

It is dissolved by the acids. One twentieth of a grain will tinge a cubic inch of concentrated sulphuric acid of a fine green; if the proportion amount to three or four grains, the colour of the solution is so intense as to appear black. On exposing it to the air for some hours, this colour is changed to a deep blue, and the same effect is immediately produced by the addition of water. A solution of indigogene in this acid, sufficiently strong to intercept the rays of light, requires for this change one sixtieth of its weight of water.

In order to ascertain, whether the conversion of the colour from green to blue, was the consequence of the chemical

* *Annals of Philosophy*, vol. VI, p. 75.

agency of the water, or, in other words, whether this liquid was decomposed, and the transfer of one of its elements to the indigogene occasioned the change, the following experiments were made:—

Experiment 1. Half a cubic inch of sulphuric acid, which had just been distilled, was saturated with indigogene. Its colour was intensely green; it was introduced into a graduated tube filled with quicksilver, inverted in the mercurial apparatus, and an equal volume of distilled water, which had been recently boiled, was added. When the temperature of the mixed liquids had fallen to that of the air, the tube was examined, and a minute bubble of air was discovered at its upper part. This air had, probably, been introduced with the indigogene, or it might have been disengaged from the materials, by the high heat occasioned by their mixture. It was not more than one twentieth of an inch in diameter, and it can hardly be supposed, that it arose from the decomposition of the water.

Experiment 2. A quantity of the green coloured solution was put into a vessel containing oxygen gas, which had been previously exposed to sulphuric acid, and they were excluded from the air. After some days, no change in colour was perceptible.

Experiment 3. Sulphuric solution of indigogene was exposed, in the same way, to hydrogen, nitrogen and carbonic acid gases, but no obvious effect was produced.

The change of colour, then, from green to blue, when water is added, does not appear to depend on the decomposition of that liquid, and the transfer of one of its constituents to the indigogene, and this fact, therefore, is adverse to the opinion which has been advanced respecting the cause of the change of colour in cloths that have been dyed by indigo. The colour of the cloth, when first taken from the vat, is green, but, on exposure for some days to the atmosphere, it varies to a dark blue; and it has been supposed, that this change is the consequence of the absorption of atmospheric oxygen by the colouring matter of the cloth. But as pure oxygen, and the other gases mentioned above, when in contact with the green solution, are incapable of producing this effect, and as it is immediately rendered blue by the addition of a small quantity of water, which has been freed from air, and which does not appear to be decomposed, the most probable conclusion is, that the cloth owes its blue colour to the absorption of water, and that the effect is rather mechanical than chemical.

When this sulphuric solution is largely diluted with water, and is allowed to remain at rest some hours, it is decomposed,

indigogene is precipitated, the liquid becomes light blue, and, when passed through filtering paper, colourless and transparent. This blue colouring matter is, therefore, merely mixed with the diluted acid.

In its concentrated state, the solution is decomposed by potash, soda, ammonia and lime-water, the indigogene being precipitated of a beautiful violet colour.

By adding indigogene in excess to sulphuric acid, and exposing it to heat, I endeavoured to ascertain the exact degree at which this substance is vaporized; but, although the temperature was raised to the boiling point of the acid, no vapour was disengaged. It was, probably, retained by its strong affinity for the acid. At this temperature, however, the indigogene is soon decomposed, carbon is extricated, and the colour changes to a permanent dark brown.

When nitrous acid is boiled for some time on indigogene, the latter is dissolved, and the colour of the solution is a deep yellowish red. Potash, added to it, throws down a yellowish precipitate, which is re-dissolved by adding the alkali in excess. The nitric solution contains the *bitter principle* of Fourcroy and Vauquelin, but I have not succeeded in obtaining from it the *detonating crystals*.

At a boiling heat, indigogene is dissolved by hydrochloric (muriatic) acid, forming a yellowish green solution. It is also dissolved by alcohol, sulphuric ether, and the essential oil of turpentine, the solutions in the two first liquids being light blue, in the last of a fine green colour.

It is, also, soluble in the fixed oils, but requires for this effect an high temperature, the colour varying according to the degree of heat; at first, it is light blue, then greenish blue, which changes to an amethystine colour, and, finally, to a deep and beautiful purplish red. As the temperature is reduced, the indigogene is precipitated unaltered. Indigogene is decomposed by chlorine.

Experiment 4. Dry chlorine gas was mingled with the vapour of this substance, a dense yellowish cloud was immediately formed, the odour of hydrochloric acid became perceptible, and the receiver, in which the vapour was condensed, was found, after the experiment, to contain two or three drops of a yellow liquid, of an austere, disagreeable taste.

A watery solution of chlorine slowly acts on indigogene, and reduces its crystals to a brownish mass.

Brugnatelli, and after him Dobereiner, have stated, that indigogene is capable of amalgamating with quicksilver, and, consequently, that it must be considered as consisting of, or, at least, as containing a metallic substance. In fact it has been

regarded as such; and Dobereiner has even supposed, that there may exist a number of other bodies, which may be called vegetable metals. "He heated together thirty grains of the finest Guatimalo indigo, with ten grains of mercury in a porcelain dish (constantly triturating the mixture) until the purple fumes of the indigo began to appear. He obtained a solid amalgam of mercury, which, when heated, exhaled the purple fumes of indigo. When digested in sulphuric acid, it communicated a dark blue colour. When put into nitrate of silver, crystals of silver were speedily deposited in the form of an artichoke. These being digested in sulphuric acid, coloured it blue, indicating an alloy of silver, and the metal of indigo."*

The following are some of the experiments, which I have made on this interesting subject:—

Experiment 5. A globule of mercury, weighing about ten grains, was put into a spoon of platina, with a quantity of indigogene, and exposed to the heat of a spirit lamp. When the purple fumes began to appear, the mass was constantly stirred, in order to bring the metal into contact with the vapour. The quicksilver lost, in a considerable degree, its spherical form, and had the appearance of an amalgam. When it was immersed in sulphuric acid, a deep green colour was developed, and the metal reassumed its globular form.

Experiment 6. A globule of mercury, treated as above, was well washed in repeated portions of water, in order to remove any crystals of indigogene adhering to it, was afterwards dried and thrown into the acid. No change of colour was perceptible.

Experiment 7. Quicksilver, which had been exposed to the vapour of indigogene, until its form and fluidity were impaired, and afterwards washed and dried, was put into solution of nitrate of silver. After forty-eight hours the precipitated silver was immersed in sulphuric acid, but it communicated no colour.

Experiment 8. A globule of the metal, which had been exposed to indigogene, was viewed through a microscope. Its surface was uniformly covered with a thin film of the substance, exhibiting a golden yellow colour, but no distinct crystals. When added to solution of nitrate of silver, the film collected in different parts, in distinct masses, leaving the surface of the mercury beneath highly brilliant. After twenty-four hours, the precipitated silver, taken from the surface and thrown into sulphuric acid, occasioned no change of colour, nor was any

* Annals of Philosophy, vol. VII, p. 37.

effect produced on the acid until some of the silver, which had indigogene adhering to it, was added, then the acid became green.

Experiment 9. A quantity of the supposed amalgam was put into a glass tube, bent in the shape of a retort, and connected with an inverted jar, filled with quicksilver, in the mercurial apparatus. Heat was applied to the part containing the materials; the mercury boiled, a small quantity of indigogene sublimed, but no gas passed into the receiver. The quicksilver, which had thus been vaporized, was exposed to the action of sulphuric acid, but no change of colour could be observed.

Experiment 10. Protochloride of mercury (*calomel*) was sublimed through indigogene; the upper part of the receiver contained the salt, and the lower part, the indigogene. They did not appear to have acted upon each other.

Experiment 11. Perchloride of mercury (*corrosive sublimate*) and indigogene, were intimately mixed by trituration in a mortar; the mixture was put between two watch crystals and exposed to the heat of a spirit lamp. The internal surface of the upper crystal soon became covered with a light green coloured film, a whitish vapour escaped by the sides of the glasses, but the purple fumes of the indigogene were not, at any time, during the experiment, visible. On separating the glasses, the upper one was found covered with a crystalline substance, of an uniform light green colour. This substance exhibited the following properties. Under the microscope, it appeared to be composed of crystals, in the form of flattened prisms. A portion was boiled with alcohol, which acquired a fine green colour: from this solution nitrate of silver and ammonia threw down a white, and potash a deep yellow precipitate. Some of it was gently concentrated in a watch crystal; its colour gradually heightened, and it deposited minute green coloured crystals. Water, which had been boiled on the portion left undissolved by the alcohol, and which still retained its colour, was not affected by the addition of potash or ammonia. When thrown into solution of potash, this substance remained unchanged; and they were even boiled together, without producing any obvious effect. Added to sulphuric acid, it formed a green coloured solution, which was changed to blue on the affusion of water. Exposed to heat on platina, purple fumes, succeeded by a white vapour, were produced, and the whole mass was speedily dissipated. From the phenomena, exhibited by this saline substance, it can hardly be considered as a mixture of indigogene with the perchloride. May it not rather be regarded as a triple compound of indigogene, chlorine, and metallic mercury?

Experiment 12. Indigogene and cyanide (*prussiate*) of mercury were intimately mixed; the mixture was put between two watch crystals, and heat was applied. A strong odour of hydrocyanic acid was perceived; and when the glasses were separated, minute globules of mercury were found adhering to the upper crystal, and indigogene, mixed with quicksilver, occupying the lower. The result of this experiment is interesting, as it appears to demonstrate the presence of hydrogen in indigogene, and, at the same time, to afford another proof of the nature of the salt, formerly called prussiate of mercury.

Experiment 13. A mixture of indigogene and the sub-sulphate of mercury was exposed to heat, in the way above mentioned; the result was the decomposition of the salt, and the separation of quicksilver in its metallic state. Some of the globules were dropped into sulphuric acid, but they had no effect in communicating colour.

Attempts were also made to ascertain, whether alloys of indigogene and some of the other metals could be obtained, and the following are some of the results.

Experiment 14. A small mass of *fusible alloy*, mixed with six or eight grains of quicksilver, was melted; indigogene was added, and they were triturated together while hot. They adhered to each other with much pertinacity. A small portion of the mass tinged sulphuric acid green; the remainder was put into a retort of the capacity of one cubic inch, connected with a mercurial apparatus, and exposed to heat. No elastic fluid passed over, but a fine crimson vapour filled the retort, and a very small quantity of a light blue powder sublimed. The compound metal, after the experiment, was white, and did not colour sulphuric acid.

Experiment 15. Indigogene was mixed with melted tin, into the substance of which it could be readily pressed, and be made to divide it into a number of distinct masses. Some of these, added to the acid, tinged it green; but the others, which were previously washed and carefully wiped, produced no such effect.

Experiment 16. Metallic arsenic, and indigogene were mixed in fine powder, and exposed, in watch crystals, to a subliming heat. During the experiment, the violet fumes were very apparent. On separating the glasses, the arsenic was found sublimed, in its usual octoedral form, and very brilliant. It neither gave purple vapours on exposure to heat, nor tinged sulphuric acid green or blue. Antimony and bismuth were also treated in the same way; but there was no evidence, that either of them existed after the experiment, in the form of alloy.

Indigogene is an inflammable substance. Its vapour takes fire by the approach of a flame, and it burns with a dense and

red flame, exhaling a thick smoke. It decomposes the metallic oxyds, when exposed to heat together, and the salts, which contain a large proportion of oxygen, by percussion. Mixed with chlorate of potash, and struck forcibly on an anvil, it explodes, but not violently, and the mixture deflagrates brilliantly on exposure to a strong heat. The results of its combustion are, carbonic acid, carbonic oxyd, and aqueous vapour. Hence I conclude, that the elements of indigogene are carbon and hydrogen.

In the experiments detailed, there does not appear to me to be sufficient evidence of the truth of the opinion stated by Brugnatelli, that indigogene is capable of forming an amalgam with mercury, and, therefore, is to be considered as metallic in its nature. Even supposing the amalgam to be actually produced, this property alone is not to be regarded as decisive that the substance itself is metallic. But the appearance of the quicksilver may be explained in another way. The indigogene, I believe, is kept in contact with the metals by cohesive attraction alone; for it may be mixed with melted tin, and when the solid mass is broken, its crystals may be observed in the substance unaltered; and a globule of mercury in this state, when viewed by the microscope, seems to have merely its surface covered with a film, exhibiting the colour of indigogene, which may be removed by washing, and will leave the metal in its pure and simple state. Dobereiner supposed he had obtained a solid amalgam, by the long triture of mercury with heated indigo; but it is possible, that it appeared solid, merely in consequence of the great division of the metal by the interposed substance, as quicksilver is extinguished, as it has been termed, by oily and viscid bodies. If indigogene, as a whole, be metallic, or if it contain a metal, we must admit either, that this metal is compound, of which there is as yet no example, or that it is the basis of carbon or of hydrogen. With respect to the metallic nature of carbon, no one, but Dobereiner, I believe, has ventured to affirm it; but there is some probability, that this is the case with regard to hydrogen, at least, the phenomena which take place, when mercury is negatively electrified in contact with water, by the voltaic apparatus, appear to favour the idea. But the facts, connected with the mutual action of indigogene and the metals, do not warrant any conclusion of this kind; for the supposed amalgam, when exposed to heat, gives out purple vapours, and tinges sulphuric acid green, which colour, being the same as that which is produced in the acid by indigogene alone, is a strong argument in favour of the mechanical mixture of the two substances.

[To be continued.]