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XX. *An experimental Inquiry into the Nature of Gravelly and Calculous Concretions in the Human Subject; and the Effects of Alkaline and Acid Substances on them, in and out of the Body.* By THOMAS EGAN, M.D. M.R.I.A.

[Concluded from p. 36.]

Experiment XI.

As children are such frequent sufferers, Mr. Richards suggested the propriety of ascertaining whether the alkaline influence might be weakened by the addition of sugar. One-half of a calculus, of the uric acid kind, weighing $185\frac{1}{4}$ grains, extracted by my friend Mr. Richard Dease, and (though under the most unpromising circumstances) with a dexterity and success not to be exceeded by his late father, was suspended in a lixivium consisting of eight ounces of distilled water and twenty drops of weak *aqua kali puri* (partly aerated), and scarce imparting an alkaline taste. To this were added thirty-six grains of sugar, which were found adequate to sweeten it sufficiently. After remaining forty-eight hours in a temperature varying from 55 to near 100 degrees, or a medium one of 74 degrees, being dried and weighed, it was found to lose ten grains three quarters. The addition, then, of saccharine matter cannot diminish, but may add to the alkaline energy.

Experiment XII.

Ten grains of very pure crystallized carbonate of potash were dissolved in four ounces of distilled water. In this filtered lixivium was suspended a fragment of calculus, of the uric acid kind, weighing seventy-two grains and a quarter, for forty-eight hours, on a sand-heat, varying from 50 to 100 degrees (for the fire was not kept up during the night). Being taken out, dried, and weighed, it was found to have lost seven grains and a quarter. The solution had a yellowish green colour, different from the light yellow tinge of the pure alkaline ones. It also lost its taste, but without becoming sweet. A quantity of flocculent animal matter was separated, and the dissolved uric acid was, for
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the greater part, again precipitated, upon the mixture cooling, to the temperature of the atmosphere.

Experiment XIII.

The crystallized carbonate of potash, being generally prescribed in the proportion of one drachm to four ounces of water; in a similar mixture was suspended an entire calculus, of a very compact, rough, and gritty appearance, weighing forty grains and a quarter. After remaining forty-eight hours in the above temperature, it was taken out, dried, and weighed, and found to have lost three grains three quarters. The solution here more highly coloured than in the former: some spontaneous precipitation; and an immediate one, on the addition of a few drops of weak marine acid. We then find the vegetable alkali in the fullest state of saturation, with carbonic acid, that we can procure it, in the solid form, acting powerfully on these concretions, when assisted by degrees of temperature even much inferior to that of the human body.

Now, as to the mineral alkali, nature presents us with similar, nay, more extraordinary results, in the mild mineral alkaline impregnation of the waters of Carlsbad, in Bohemia. Here are several springs, varying in temperature from 114 degrees to that of the Brudel at 165 degrees. According to Elliot, they contain, in the gallon, of aerated lime 36 grains; muriate of soda 48; aerated soda 102; vitriolated soda 6 drachms; some minute proportion of iron, and a considerable carbonic acid impregnation. But Klaproth rates the proportion of mineral alkali still higher.

Of the lithontriptic effects of these waters, Springfield gives us a very surprising account indeed: founded, however, upon numerous experiments, instituted upon the spot, by the immersion of many calculi in the sources themselves; where they were either entirely dissolved, or acted upon with an energy that must appear incredible, if we did not consider the nature of the menstruum, its high temperature, and constant renewal by the flowing of the stream. Nay, the urine of patients who used these waters for a few days was found to possess powerful lithontriptic effects, as appeared by the

immersion of many calculi in it. For an account of these highly interesting experiments, too numerous for insertion here, I must beg leave to refer to his Treatise *De Prerogativa Thermarum Carolinarum, in dissolvendo Calculo Vesicæ, præ Aqua Calcis vivæ*.

From these experiments, as well as the highly beneficial effects of these waters, taken internally, by the numerous calculous and gravelly patients who frequent Carlsbad, he establishes their superiority over the different alkaline and other remedies hitherto in use, not excepting Whyte's oyster-shell lime water. Now, the lime in these being carbonated, and only kept in solution by their highly aerated state, we can be at no loss, in those days, to attribute their superior agency to the alkaline impregnation, assisted by so high a temperature. Klaproth affirms, that a person who drinks these waters, in the usual quantity, for twenty-six days, takes of mild mineral alkali 3913 grains, or 8 ounces 1 drachm and 13 grains; which amounts to two drachms and a half per day, besides the other saline ingredients.

Doctors Rutty and Smyth, who gave us a valuable extract from this publication, in the Memoirs of the Medical and Philosophical Society of this city, (now in the library of the Royal Irish Academy, but which, we have sincerely to regret, were never published, and are now discontinued,) conclude their account by the following query: "May not some alkaline lixivium be contrived by art, that would possess similar effects with these waters?" And has not this partly taken place in the instance of our soda waters? But may we not make a nearer approximation by a solution of the above specified proportion of mineral alkali in the relative quantity of water, with the addition or omission of the carbonic acid, and the other saline ingredients, as may be thought proper, afterwards heating, however, each separate dose to 160 degrees?

We find, then, the alkaline carbonates, in the great laboratory of nature, as well as in our experiments, exerting considerable solvent powers upon these animal concretions contrary to what has been hitherto supposed.

Experiment

Experiment XIV.

Into a filtered solution of ten grains of salt of tartar, in four ounces of distilled water, were introduced two fragments of calculi, weighing seventy-four grains and a quarter. The mixture was set aside for forty-eight hours in a cool room; temperature varying from 47 degrees at night, to 55 degrees in the day. After twelve hours it began to be coloured, and continued to be more so, until the temperature fell to 51 degrees, when a precipitation took place, and continued during the night; so that it appeared to deposit at the temperature of 47 degrees, what was taken up at degrees somewhat exceeding 51°. These fragments, on being taken out, dried, and weighed, were found to have lost three grains and three quarters; the laminæ disposed to crack, and the strata to separate and crumble. This weak lixivium, then, exerted much energy, even in a very low temperature.

Experiment XV.

A fragment of calculus, weighing seventeen grains three quarters, was immersed in a lixivium of similar strength; but now exposed to a temperature varying from 51 degrees at night to about 95 degrees in the day. After forty-eight hours, it was found to lose five grains and a half: a prodigious quantity, when we consider the small surface presented by this fragment, weighing only seventeen grains three quarters. The solution, upon cooling, became turbid as before, and precipitated a large proportion of the dissolved uric acid.

Experiment XVI.

A fragment of calculus, weighing forty grains three quarters, was immersed in four ounces of soda water for forty-eight hours, and exposed to a temperature varying from 55 to about 100 degrees. Its loss amounted to one grain. A repetition of this experiment afforded nearly the same result; and demonstrates, that though the soda, in this supercarbonated state, still exerts some energy on concretions of the uric acid kind, yet it is but feeble; and that these waters appear more capable of preventing their formation than ef-

fecting their solution, when they once acquire the aggregate state. The same fragment, in a similar quantity of soda water, in the temperature of from 50 to 55 degrees only, sustained no loss, after forty-eight hours. And here we have another proof of the necessity of seriously attending to the degree of temperature in all researches of this kind.

But it may be observed, as to the internal use of alkaline substances in particular, that their effects must be considerably weakened upon their immediate admixture with the urine; as the small quantity that can be conveyed there must, in the first place, neutralize the uncombined phosphoric acid in all urine, the benzoic in children's, and decompose the ammoniacal and magnesian phosphates in that of every period of life. It must be acknowledged its efficacy is partly counteracted by these circumstances, which should never be overlooked, and always taken into account in practical application. Referring to Fourcroy's instructive essay on this subject, *Memoirs of the National Institute*, and *Connoissances Chimiques*, let us here once more appeal to the test of experiment.

Experiment XVII.

A fragment of calculus, weighing eighteen grains one quarter, of the uric acid kind, was suspended, for forty-eight hours, in an alkaline lixivium, consisting of four ounces and a half of recent urine, and twenty drops of a very weak, and partly aerated, caustic lixivium; medium temperature about 74 degrees. On being taken out, and dried, it was found to have lost one grain three quarters; a considerable quantity from so small a specimen. To the filtered solution were added a few drops of dilute marine acid, which, after a few minutes, precipitated a reddish crystalline matter in a triple proportion of what generally occurs in the natural state of urine.

From the above experiments, therefore, it appears no longer doubtful; first, that pure lime, even in the small proportion contained in lime water, and the pure alkalies, in an extreme state of dilution, in temperatures even somewhat inferior to those of the human system, exert an active solvent power on calculi of the uric acid kind: secondly, that
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the alkaline carbonates, under similar circumstances, are possessed of similar powers, though in an inferior degree: and thirdly, that, by our having ascertained this point, we have removed a long established error, substituted a discovery highly interesting to animal chemistry, and likely to be productive of a more enlightened and successful practice in the treatment of these diseases.

In these expectations we shall appear to be the better founded, when it is considered, that, for want of entire specimens (preserved here like the oriental bezoars of old), we were obliged to operate upon fragments presenting small surfaces only to our solvents: that these last were never renewed during the course of the experiments, which would not have occurred in their application in the form of injections; as they should, in that case, be so often repeated, and act, of course, with renewed energy; that, either taken internally, or used in form of injection, the smallest proportion of alkaline matter, in a great state of dilution, assisted by the human temperature, answers our purpose; and that the temperature in our experiments was never permanent, and might be rated at the medium one of 74 degrees.

Having now fulfilled the second object of this essay, I would no longer presume to trespass on the indulgence of the academy, if I were not actuated by the sanguine hope of turning the attention of my surgical friends to the humane consideration of obviating, as much as possible, the most dangerous of operations by the prudent application of a few safe solvents injected into the bladder. How far they may succeed with calculi of the uric acid kind, may be already conjectured from the preceding experiments; but with those of the next most frequent occurrence there is much less difficulty to encounter, and every reason to hope for a speedy and safe result. The ammoniaco-magnesian phosphate is partly soluble in water, highly so in the carbonic acid (as we have already seen); and, consequently, more so in the weakest possible acid impregnations that can be devised; nothing more being necessary than the addition of as many drops only of weak muriatic acid as will scarce impart an acid taste. But as precept should, in every instance, be as

much as possible assisted by experiment, I shall, for the encouragement of the young practitioner, exhibit a few on this very soluble species the more willingly, as he has no assistance to expect from his professional books; these subjects being only treated of in Philosophical Transactions, Memoirs of the National Institute, and a few other foreign chemical publications, if we except Whyte's Treatise on Lime Water, to which we would willingly refer him.

Experiment XVIII.

An entire calculus, of a reddish, gritty appearance, externally, proved to consist of ammoniaco-magnesian phosphate, weighing forty-six grains one quarter, was suspended, for forty-eight hours, in a mixture consisting of four ounces of distilled water and ten drops of weak marine acid. After being taken out, and dried, it was found to have lost six grains three quarters. The mixture was whitish, lost its acid taste, and precipitated, on the addition of a few drops of fixed alkali, the ammoniaco-magnesian phosphate, under that beautiful crystalline form so accurately described by Dr. Wollaston.

We may readily conceive how much more the loss would have amounted to in this case, in the short space of forty-eight hours, if the menstruum had been frequently repeated under the regular influence of human temperature.

Experiment XIX.

A fragment of the same species with the above, weighing twelve grains, was immersed, for forty-eight hours, in three ounces of distilled water, without addition: temperature from 60 to near 100 degrees. After being taken out, and dried, it was found to have lost one grain three quarters, became so friable as to crumble, and the solution to precipitate with a few drops of pure ammonia. This species of calculus, therefore, is soluble in water, at temperatures even inferior to that of the human. It is unnecessary I should enter into a further detail of experiments made upon calculi of the mixed kind, having the uric acid, phosphate of ammonia, and sometimes, though rarely, phosphate of lime, intermixed

intermixed in their strata. Suffice it to say, that the very dilute marine acid speedily takes up the earthy phosphates, leaves the laminæ of the uric acid bare and distinct, ready to crumble, and of easy solution in the weakest alkaline lixivium, and still more so in lime water:—a most important consideration in a practical point of view.

It would be trespassing too much on the already tried indulgence of the academy, to go further into the detail of the circumstances necessary to be attended to, and acquainted with, to ensure success in the application of these principles. These are already tolerably well detailed in the *Connoissances Chimiques*. To the gentlemen professors in the school of surgery it more particularly belongs; and from the zeal and talents now in full activity there, what may not be expected? Created only the other day, by a Clegghorn, (a name as deservedly as universally revered;) fostered, afterwards, by the anxious care and talents of Mr. Dease; we find it already arrived at a state of perfect maturity, and holding out to the student advantages no where to be rivalled, if indeed equalled: and that nothing may be wanting to a complete medical as well as surgical education, establishing a chair of botany, supported by the acknowledged abilities of Dr. Wade, both as a botanist and teacher. From the above experiments and observations we may presume to draw the following conclusions:

That acids, and acescent drinks of all kinds, give rise to gravelly and calculous affections, by causing a separation and precipitation of the native uric acid of urine within the body. That all acids, vegetable or mineral, nay, the native phosphoric acid of urine, in excess, are equally productive of this effect; the tartaric, perhaps, somewhat more so. That, on the other hand, we find lime, both the fixed alkalies, pure as well as aerated, (even in the smallest proportions,) serviceable in these disorders, by uniting with, and keeping in solution, this acid substance. That they also, in the smallest proportions, and diluted state, exert strong solvent powers on this acid in its aggregate form of calculus, provided their action be favoured by degrees of temperature approaching to the human. That, under the

same

same circumstance, contrary to what was generally supposed, the carbonated, sub-carbonated, nay, the super-carbonated, exert similar influence, though in an inferior degree. That lime, even in the small proportion it presents itself to us in lime water, is a most active and safe solvent of calculi of the uric acid kind, and its various combinations; as has been long since ascertained by Whyte. That, weight for weight, it exceeds even the caustic alkali in any state of dilution that the latter can be applied to the living body. That, finding four ounces of lime water, containing only two grains three quarters, take up, or detach, seven grains three quarters from a very compact calculus, we may be led to suppose this may arise from its action on the agglutinating medium, its affinity to, and energy on, animal matter being so well known; and, if so, may we not expect something from its power on the mulberry calculus, our most formidable enemy? For, though it cannot touch the oxalate of lime, it may the cementing medium, with which it peculiarly abounds.

For the application of these established facts to useful purposes, I must refer to my surgical friends, being all now possessed of the necessary degree of chemical acquirement; and I am happy to find this career already entered on by my friend Mr. Crampton, who has favoured us with an analysis of a pulmonary calculus in the *Philosophical Transactions*, and from whose professional as well as scientific talents we have every thing to expect in fulfilling (even on this occasion) his duties as a teacher.

Having now endeavoured to accomplish the chief object of this essay, which was, to establish experimentally a more clear and comprehensive view of the nature of these maladies, and the remedies employed to combat them, than we hitherto possessed, I should not have trespassed further on the time of the academy, were it not properly suggested, by my friend Dr. Clarke, that it would be of importance to ascertain how far the facts and notions, brought forward in it, may stand confirmed or contradicted by the result of our practical application of them in Simpson's Hospital; an establishment affording the best and most extensive field of
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observation, of this kind, of any in Europe, that of Lunenburg, perhaps, excepted.

The benefit of this charity extends equally to the blind and gouty. In the year 1795 I found it to contain thirty-two of the latter; and since that period thirty-four have been admitted: in all, sixty-six gouty patients. Of these, the greater number have either complained of gravel, or passed it without any previous or concomitant inconvenience: a circumstance which I had every day occasion to observe, whilst attending to the state of gouty urine. Among the blind and gouty, however, we may count about twenty-two as specifically more afflicted, having occasionally complained of marked and distinct symptoms of this disorder. Of these, we find sixteen among the gouty, and six only among the blind. Now, as the severity of gout is uniformly diminished, nay, in many instances, the disease entirely removed, by a residence of a few years only in the house, we must expect to find the same take place with respect to gravel, to which it is so strongly and nearly connected. And this singular alleviation of both diseases we can only attribute to the influence of temperance, and the manner of living, very opposite to that of their former habits. The diet in our house consists of bread and milk for breakfast and supper; beef, or mutton, with table beer, for dinner; all of the best quality, and administered with the greatest propriety and regularity; whilst the introduction of ardent spirits is prohibited, and sobriety enforced, by the strict discipline of the house. On the other hand, we find that, previous to their admission, they were either addicted to intemperance, or in the habit, at least, of muddling in public-houses, where, after a libation with porter, they indulged in the free use of acidulated punch (the constant nocturnal practice of our middling tradesmen and shopkeepers, who furnish the greatest proportion of our patients). The keeper of a porter-house of considerable resort informs me, that, to please the generality of his customers, he finds it necessary to add the juice of an entire lemon to about two quarts of punch; and that, from this circumstance, he would have experienced a considerable di-

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minution of his profits, if he did not occasionally substitute cream of tartar, or the dilute sulphuric acid : an innocent and safe practice, in his opinion. Now, so satisfied are our patients of the pernicious effects of acids of all kinds, that we find many of them refuse to make use of our table beer during the summer months, through the apprehension of its acescent quality (as was before observed), and which continued to be the practice of Hewson, Khensk, Clapham, and others, for years back : nor do our present two greatest sufferers, Sing and Cox, venture on it at any season but with the greatest caution.

To a removal, then, from the former occasional causes we may attribute no small share of the alleviation of those diseases which takes place with us : a practical observation, that cannot be too generally known. But to return to my subject :—On the slightest appearance of gravelly symptoms, unconnected with fever, or inflammatory tendency of the urinary system, our patients have recourse to an alkaline medicine, the gravelly pills (as they term them), which consist of desiccated soda, in the most convenient form for hospital practice, as well as most suited to gouty stomachs. Of this (as first advised by Beddoes,) one drachm, with the addition of a few grains of capsicum, or drops of essential oil, and the necessary quantity of hard soap, or extract, is made into twenty pills. Of these, from three to six, or more, are taken in the twenty-four hours ; and are found sufficient, not only to alleviate or remove these complaints, but even to render the interference of the physician but seldom necessary. We have had also occasion to remark, that several of our patients, induced by their marked beneficial effects, carried these pills about them, so as to have occasional recourse to them, without much attention to either dose or number.

To this practice, then, we would be disposed to attribute the very pleasing and interesting consideration, that, among so many gravelly patients, there has not occurred, in the course of ten years, a single operation of lithotomy ; nor has the catheter, even in the hands of our expert and able surgeon, Mr. Macklin, been able to discover the smallest occasion

occasion for it. We could therefore have no opportunity of ascertaining the efficacy of injections into the bladder, as recommended by Whyte, Fourcroy, and myself.

I shall conclude by observing, that it would be interesting to have it in our power to extend these researches to the urine of those who live habitually on different aliment and drinks, particularly of the acescent kind, as well as to that of those who drink waters with mineral alkaline impregnations. But this desirable object can be only obtained by the concurrent exertions and attention of gentlemen of the faculty in different countries and situations. In private practice it is not to be expected; for here, wherever experiment is surmised to be the object, mistrust and suspicion take place of professional confidence. The use of the nitric acid in our venereal hospital, I hoped, would afford some useful facts as to its effects upon the saline contents of urine; the uric acid in particular. But I had not, as yet, sufficient leisure for that inquiry; nor could I, hitherto, obtain the urine of those using it, with all the circumstances necessary to enable me, at this moment, to draw any direct conclusions from my examination of it. In many instances, a morbid state of the urinary system (the urethra in particular) took place. In others, the combined effects of mercury interfered: and in all, no certainty of its not being blended with the urine of others not using this acid. I could not, however, help observing, that the few specimens, sent to me, agreed in one particular, viz. their exceeding very little, if at all, the usual healthy standard of acidity. This circumstance must excite our attention the more forcibly, when we consider, that two drachms of nitric acid, nay, sometimes three, diluted in the proportion of one pint of water to each drachm of acid, were taken daily; whilst, on the other hand, a few drops of the acid elixir of vitriol, or tincturæ martis in sp. salis, nay, the weak vegetable acids, and cream of tartar, persevered in for a few days, impart an additional degree of acidity to the urine. Would not this observation (if founded), conjoined with the easy decomposable nature of the acid itself, and its action on animal matter, induce us to lean to the opinion of those who have already asserted that this acid

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is partly decomposed in the system, imparts its oxygen to it, and that, perhaps, to a degree capable of annulling or destroying its properties as an acid?

And it may be here further remarked, in confirmation of such notion, that those gentlemen most conversant with it here, as well as most capable of judging, entertain strong doubts of its supposed diuretic effects, allowance being made for the necessary quantity of its watery vehicle. If it be, then, truly deoxygenated in the system, why be deterred by its failure, as a radical cure of siphylis, from extending our trials with it here, to other chronic diseases, as they have already done in India?

XXI. *Extract of a Memoir of Messrs. FOURCROY and VAUQUELIN upon Guano, the natural Manure of the South Sea Islands near the Coast of Peru. Read before the National Institute. Drawn up by A. LAUGIER*.*

AMONG the vast number of objects worthy of the attention of naturalists which M. Humboldt has observed and collected during his late travels, *guano* is one of the greatest importance. In making us acquainted with this singular substance, one of the principal resources of agriculture in the countries he has visited, this celebrated naturalist has furnished the authors of this memoir with an opportunity of confirming a discovery which they had made at the very moment of M. Humboldt's return. The perusal of their memoir upon the existence of uric acid in the excrement of birds, created the idea in Humboldt that the guano, found in the islands on the coast of Peru frequented by a great number of birds, might be of the same description. It belongs to chemistry alone to decide the degree of credit to which this conjecture is entitled. Messrs. Fourcroy and Vauquelin have undertaken the examination of this substance, and we purpose laying before our readers the results of their labours as inserted in the Memoirs of the National Institute.

* From *Annales de Chimie*, vol. lvi. p. 258.