ANALYSIS
OF A SPECIMEN OF
CUTANEOUS PERSPIRATION.

By J. BOSTOCK, M.D. F.R.S.

WITH

AN ACCOUNT OF THE CASE

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Read 11th March, 1828.

IN the month of March last, I received from Dr. Bright about four ounces of a fluid, which he informed me was the cutaneous perspiration of a patient, at that time under his care in the wards of Guy's Hospital, and I gladly embraced the opportunity thus afforded me, of examining the properties of a substance, which we are seldom able to procure in so considerable a quantity.

It was of a dingy brown colour, was somewhat opake, without odour, and did not appear to be either viscid or tenacious : its specific gravity was 1·0117; it was very slightly alkaline. After standing at rest for twenty-four hours, it began to deposit a flocculent precipitate, which appeared to consist

principally of fibres of wool or cotton, derived, as we may presume, from the clothes or bedding on which the perspiration had been deposited; after the separation of this substance the fluid was left nearly transparent, although the colour was not much changed: 500 grains of the fluid were exposed to the atmosphere in a shallow capsule; it underwent no perceptible change for several days, but at length the colour became deeper, and a small quantity of a brown matter adhered to the sides of the glass; at the same time it had acquired a slightly putrid odour. As the evaporation continued, a mass of crystals was gradually formed, which in the centre were well defined cubes, nearly without colour, surrounded by an imperfectly crystallized margin, mixed with a portion of extraneous matter. The capsule was then kept for some time at a temperature of 200° ; the residuum, when completely dried, amounted to 8.4 grains, indicating very nearly 1.7 per cent. of solid contents in the fluid. A second portion of the fluid, without previous exposure to the atmosphere, was evaporated at a temperature of 200° , until it appeared to be completely dried, when the amount of the residuum was found to be 1.32 per cent.

Portions of the fluid of two drachms each were subjected to the following re-agents:—1. No change was produced in the appearance of the fluid by exposing it to the heat of boiling water; 2. the solution of bichloride of mercury produced a slight

opacity, and when the mixture was heated, a very small quantity of a dense precipitate was thrown down; 3. the ferro-prussiate of potash produced no effect until heat was applied, when the fluid became opaque, and a very small quantity of a flocculent precipitate gradually subsided; 4. a more dense precipitate was thrown down by the oxalate of ammonia; 5. a minute precipitate was thrown down by the muriate of barytes; 6. a very copious precipitate by the nitrate of silver; and, 7. a precipitate, which appeared still more copious, by the sub-acetate of lead. From these results we may conclude, that the substance contained in this fluid was principally muriate of soda, with a portion of uncombined or carbonated alkali, a small quantity of a salt of lime, a still smaller quantity of a sulphate, together with some animal matter, of which a very small portion may be regarded as a species or modification of albumen.

In order to ascertain the proportion of the saline to the animal matter, the residuum obtained by evaporation was strongly heated in a small platina vessel, until the combustible matter was gradually carbonized, and at length consumed. By this means the weight of the residuum was diminished in the proportion of 24·9 per cent.; hence we may conclude, that the saline and animal matter existed in the fluid in the respective proportions of 1·37 and ·46 per cent.

With respect to the nature and composition of the saline matter, both the action of re-agents and the appearance of the crystals indicated that it existed almost entirely of muriate of soda with a small quantity of an uncombined alkali. That this alkali originally existed in the fluid in the uncombined state, I concluded from there not being the slightest perceptible effervescence upon the addition of an acid. The usual tests, as well as the aspect of the crystals, indicated that this alkali was soda, or at least, that if any potash were present, it was in the most minute quantity only*. For the purpose of ascertaining the respective proportions of soda and the muriate of soda, two methods were employed. The first consisted in neutralizing a portion of the saline solution with acetic acid, the strength of the acid having been previously ascertained by the quantity of crystallized sub-carbonate of soda which was required to saturate a known weight of it, and estimating the quantity of soda by the quantity of acid necessary for saturation†. The second method, probably the most

* The substance that was employed to detect the presence of potash was tartaric acid. I found by a direct experiment, that when a solution of tartaric acid is added to an equal volume of a solution containing $\frac{1}{360}$ of its weight of bi-carbonate of potash, which is nearly equivalent to $\frac{1}{1636}$ of potash, very distinct crystals of bi-tartrate of potash are formed.

† I found that by employing an acetic acid of the specific gravity of 1019, it was easy to ascertain, with great accuracy, the quantity of the acid necessary for the neutralization of a

accurate, but by far the most operose, was by ascertaining the quantity of muriate of silver, formed by adding nitrate of silver to a quantity of the saline solution*. By these means I found that the uncombined soda amounted to about one-twelfth of the residual mass, which will be $\cdot 114$ per cent. of the entire fluid. The quantity of the phosphates and sulphates, either as indicated by the appearance of the crystals, or by the effect of the tests that were employed to detect their presence, would appear to be very minute. From the above experi-

fluid, which contained no more than $\frac{1}{360}$ of its weight of crystallized sub-carbonate of soda, equivalent to about $\frac{1}{360}$ of pure soda. It is necessary, towards the end of the experiment, to suffer some time to elapse between the addition of each minute portion of the acid, to admit of its diffusion through the fluid, and of the escape of the carbonic acid. The test papers that I employed were litmus and litmus reddened by acetic acid.

* The method usually employed for measuring the quantity of muriatic in a fluid, by the intervention of the nitrate of silver, is to collect and dry the resulting precipitate of muriate of silver. But I believe it will be found, that a very much easier, and an equally correct mode is to ascertain the quantity of nitrate of silver, which is necessary to combine with the muriatic acid in the fluid under examination, having previously learned, by direct experiment, what quantity of the nitrate of silver that was employed is requisite to decompose a given quantity of dried muriate of soda. I found that it required $26\cdot 5$ grains of my nitrate of silver to decompose 1 grain of muriate of soda dissolved in 50 grains of water. Hence it will appear, that by adding the nitrate of silver drop by drop, so as to observe the effect of each portion as it mixes with the fluid, we may ascertain the quantity of the muriates in a solution with great precision.

ments we may conclude the composition of the fluid to be as follows :—

Water		981·7
Animal Matter		4·6
Muriate of Soda		12·56
Soda		1·14
Phosphates and Sulphates, a trace		
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		1000·00
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The next point was to ascertain the nature of the animal matter; for this purpose a portion of the entire fluid was slowly evaporated nearly to dryness, when a number of distinctly formed cubical crystals were formed, which were carefully removed, and the remainder was then completely evaporated, and heated until it indicated the commencement of the process of carbonization. The residuum was then digested for some time in tepid water, by which it appeared that very nearly all the saline matter was removed, and the residuum being then exposed for a short time to a temperature of 200°, I obtained a brown viscid mass, which had an acrid taste, and an odour, which I thought bore a considerable resemblance to that of urea, after it has been strongly heated. The addition of nitric acid to the residuum produced an appearance, which might be conceived to depend upon a tendency to crystallization, but I

could not pronounce it to be similar to the pearly scales of the nitrate of urea. The brown colour of the residuum was changed by the nitric acid to a bright yellow, but no further change of colour took place by saturating the nitric acid with ammonia. The residuum was disposed to deliquesce by exposure to the atmosphere.

A portion of the residuum was digested with alcohol at a temperature of 150° . The alcohol acquired a brown tinge and became slightly opake, but a considerable part of the substance seemed to be insoluble. The alcohol was evaporated; and a brown viscid residuum was obtained, which both in its sensible properties, and in the result of the action of nitric acid upon it, manifested a certain degree of resemblance to urea, and may be characterized as intermediate between this principle and osmazome, or perhaps a combination of the two. The proportion which it bore to the part insoluble in alcohol was nearly as one to four, or more exactly as twenty-eight to one hundred. The part insoluble in alcohol, in its sensible and chemical properties, seemed to approach the most nearly to the substance which forms the principal ingredient of the serosity of the blood. Besides these, the fluid, in its entire state, contained a very small quantity, which was scarcely appreciable, of albumen, but it gave no indication of the presence of jelly.

Upon comparing the above analysis with the account that is given us of the composition of the serum by Marcet and Berzelius*, we find that the fluid of perspiration, in this case, differed from the serum of the blood, in the smaller proportion of the solid contents generally, and especially in the almost total absence of albumen; while it agrees with it in containing a considerable quantity of muriate of soda, a portion of uncombined soda, and a quantity of animal matter, which is similar to that contained in serosity. Notwithstanding the absence of albumen, it must therefore be considered as essentially belonging to the class of serous fluids, such as contain the same kind of salts with those in the blood, along with the peculiar animal matter in the serosity, and nearly in the same proportion as in this fluid, generally combined with a quantity of albumen. This last ingredient however varies in its quantity, from one-ninth of the weight of the whole, as is sometimes the case in the serum, to the gradually decreasing quantity which is found in the fluid of ascites, of the spina bifida, or of hydrocephalus, of which it occasionally constitutes no more than one-hundredth part, until we arrive at the substance now under examination, where the albumen is barely discoverable by the most delicate tests.

* Med. Chir. Trans. Vol. II. pp. 370, 1., and Vol. III. p. 230.

The account which I have given of this fluid may be considered as agreeing essentially with those of M. Thenard* and Professor Berzelius†, except in one particular, that they both of them found the cutaneous perspiration to contain an uncombined acid. I should feel much distrust in any experiments of my own, which were in opposition to those of chemists of so much eminence, were it not that the point in question is one on which it was impossible that I could be mistaken, while, at the same time, I had the accidental advantage of operating on so large a quantity of the fluid. It is, however, by no means improbable, that the cutaneous perspiration may differ in the nature of its ingredients according to the state of the system, a circumstance which takes place in a remarkable degree with respect to the urine, a fluid to which the cutaneous perspiration bears some analogy, and with which it possesses some well known physiological relations.

I have obtained from Dr. Bright the following account of the symptoms of the patient from whom the fluid was procured.

J. BOSTOCK.

Upper Bedford Place,
Feb. 16, 1828.

* Chimie, Tom. III. p. 712.

† Med. Chir. Trans. Vol. III. pp. 256, 7; see also my Physiol. Vol. II. pp. 333, 4.

“ MY DEAR SIR,

“ You have expressed a wish to learn some particulars respecting the case of the patient, from whom I procured the specimen of perspired fluid which I sent to you early in March 1827. He was at that time under my care in the Clinical Ward of Guy’s Hospital ; but as he had been transferred to me with the ward, I had not conducted the treatment from the commencement. I had however frequently seen him, and think it necessary to make what statements I am able respecting the previous history and progress of his ailments, in order that you may better understand his condition at the time I collected the fluid.

“ Robert Healas, a sailor, aged 64, had been admitted into the Clinical Ward of Guy’s Hospital, Jan. 3, 1827, under the care of Dr. Cholmeley. He was a robust man, who had enjoyed good health, but stated that he had formerly suffered some attacks of gravel. Having slept in damp sheets about six days before admission, he was seized with shivering, eructation, hiccup, and vomiting, and most violent pain in the abdomen, which continued more or less urgent up to the time when he was admitted into Guy’s, and the symptoms were attended with a constipated state of the bowels. He had been previously bled without relief, and taken purgative medicine which had failed of producing stools. There was tenderness on pressure of the abdomen ; a yellow furred

tongue ; pulse eighty-four, with considerable action. He was bled, put into the warm bath, had three grains of calomel, and half a grain of opium every four hours, and injections with castor oil were administered frequently.

“ The blood was slightly buffed ; the bath produced no perspiration. Copious feculent dejections were procured during the two following days, and on the 9th, six days after admission, he was considered convalescent ; but it was observed about this time that his stools had become of a light colour and were apparently deficient in bile, and he complained of occasional griping pains. On the following day it was remarked that the urine was unusually pale ; and on the 12th it appeared that the quantity of urine was unnaturally increased ; and his legs became somewhat oedematous towards the evenings ; his bowels were very freely opened, but the stools were still of a very light colour. It was about this time that he came under my care.

“ On the 14th he complained of pain round the umbilicus and over the pubes, particularly when passing water or on pressure ; and the urine voided in twelve hours was found to amount to ten pints.

“ On the 16th the urine did not coagulate by the application of heat, nor had it any sweetness of taste, but as it continued very abundant, I had

him weighed, intending to see whether he lost weight from the unusual flow of urine. Attention was paid to his bowels, and different forms of mercurial alteratives were administered, the stools still continuing of an unnaturally pale colour.

“ On the 26th, in consequence of his having suffered severe pain in the abdomen and epigastrium, he was cupped on the pit of the stomach, and was bled at the arm on the following day; and some dysenteric symptoms having shewn themselves, he was put on the use of ipecacuanha with the hydrargyrum cum creta.

“ On the 2d of Feb. he was cupped on the loins to sixteen ounces in consequence of the great irritation going on in the urinary organs, leading to frequent calls to pass his water, so that he was disturbed every twenty minutes during the night. The condition of the stools improved as his mouth became gradually affected by the mercurial preparation, but it was continued till the 20th of Feb. In the mean time the urine still remained very inordinate in quantity, seldom less than eight or ten pints in twenty-four hours. He was on the 14th of Feb. ordered to go to the warm bath twice in the week. This produced the most profuse perspiration I ever witnessed; the perspiration running completely through the bedding and forming streams upon the floor. It was on an occasion of this kind that I collected, as it fell to the ground, in a clean

glass, the fluid I sent to you. In spite of the profuse perspiration he gained weight, and the urine gradually diminished in quantity. He left the hospital on the 13th of March, still passing about six pints of urine in twenty-four hours, but well in other respects. He immediately resumed his occupations, and I heard a few days ago that he continued perfectly well.

“ Yours very faithfully,

“ RICHARD BRIGHT.”

“ 14, Bloomsbury Square,

“ Feb. 9, 1828.”