AN ANALYSIS

OF THE

MINERAL WATER

OF

TUNBRIDGE WELLS,

&c. &c.

Price Three Shillings.

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To the Medical Society
From the Author.

AN ANALYSIS

OF THE

MINERAL WATER

OF

Tunbridge Wells,

WITH SOME ACCOUNT OF ITS

MEDICINAL PROPERTIES.

By CHARLES SCUDAMORE, M.D.

Member of the Royal College of Physicians,
Of the Medical and Chirurgical Society of London, &c. &c.

TO WHICH ARE ANNEXED

SOME OBSERVATIONS ON THE WATER

WITH WHICH

TUNBRIDGE WELLS IS CHIEFLY SUPPLIED

For Domestic Purposes.

By THOMAS THOMSON, M.D. F.R.S.L. et E. F.L.S. &c.

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PREFACE.

Twenty-three years having elapsed, since an analysis of the mineral water of Tunbridge Wells was offered to the Public; and an apprehension having subsequently arisen, that the water might have suffered some accidental deterioration, in consequence of the building of the baths erected near the Spring, I was induced to submit it again to a chemical examination.

The results of my labours (in which I was assisted by my friend Mr. J. G. Children) possessing some novelty, and especially in the most important particular, the proportion of iron in the water, and its variation according to the season of the year; I flatter myself that a publication of this investigation may not be altogether unacceptable to the Profession, and to general notice; and the more especially, as the former Analysis* has long been out of print.

I have also ventured to offer some observations on the medicinal properties of the water,

* "An Analysis of the Medicinal Waters of Tunbridge Wells, London, 1792."

as far as my opportunity enabled me to obtain a judgment on this important subject, during a residence at the Wells of one season.

It being often imagined, that the chalybeate spring, situated behind the Sussex Hotel, possesses a stronger impregnation of iron than that near the Parade, I was led to make a comparative examination; the account of which, together with the contrasted statement of the proportion of iron, in a water of a similar description near Tundridge town, I have added.

The properties of the water which is in principal *domestic* use at the Wells, being a consideration of much local interest, I take the present opportunity of annexing the statement respecting it, with which I am obligingly favoured by Dr. Thomson.

Holles Street, Cavendish Square,
May 1st, 1816.

AN ANALYSIS,

&c. &c. &c.

OF THE SPRING.

THE Chalybeate Springs of Tunbridge Wells are so well known to the Public in their general history, that any preliminary statement of this kind would be superfluous. It may be mentioned that formerly, several large iron founderies were established in this neighbourhood. They have ceased working for many years; but rather from the want of fuel than of ore.

The Spring, which is now the only one in use, rises into a large marble basin. The water overflows through an aperture into a channel connected with the Chalybeate Cold Bath, depositing in its progress a reddish-brown precipitate.

INTRODUCTORY EXPERIMENTS.

Exp. 1.—The temperature of the water as it issues from the Spring, is, in different seasons of the year, uniformly 50° Fahr. In the coldest winters it has not been known to freeze in the basin. On the 8th of February 1816, when the atmosphere was at 24°, the water in the basin was still at 50°. In the month of April, when I found some neighbouring springs yielding common water, and considered to be deep in their source, as low in temperature as 46° and 47°, this Spring was still at 50°. In summer, the temperature of the water in the basin, near the surface, was raised a few degrees, in consequence of its free exposure to the sun's rays.

Exp. 2.—In examining the Spring at different periods of the year, to ascertain its strength of supply, I derived the following results. In August 1815, it yielded in a minute, one quart, two ounces, and five drachms. In the beginning of November, one quart. The summer had been unusually fine and dry. In October the season was wet. In the beginning of March 1816, the supply was increased to two gallons and a half in a minute. At the end of this month, the quantity was lessened to one gallon and seven pints. Much rain had fallen in the preceding months, but the winter had passed away with very little snow.

In the analysis of 1792, the specific gravity of the water is described "as exceeding that of distilled water, in the proportion of 713 to 712;" or as 1·0014 to 1·0000.

Exp. 3.—In several examinations of the water in the month of August, immediately fresh from the basin, and at its natural temperature 50°, I found its specific gravity compared with that of distilled water at 50°, as 1·0007.

PHYSICAL PROPERTIES OF THE WATER.

The fresh water is perfectly transparent, and does not send forth air bubbles. It exhales a smell which is distinctly chalybeate. Its taste in this respect is strongly marked; but is neither acidulous nor saline. It has an agreeable freshness, and is by no means unpalatable.

Exp. 4.—I put some small fish into the fresh water, and found that their respiration was immediately much distressed. One of them, a lively trout, was the most visibly affected, and died in three hours. The others, which were chubs, survived and recovered.

SPONTANEOUS CHANGES OF THE WATER.

Exp. 5.—The water, fresh from the Spring, was exposed in a large glass vessel, in an apartment of the temperature of 68°. It quickly exhibited a few air bubbles. In an hour a precipitation had begun, appearing in the form of a delicate white pellicle on the surface. This pellicle became thickened and shining in a few hours. In about six hours the water was faintly milky, and in twenty-four hours a slight brownish sediment had fallen to the bottom. In forty-eight hours the water became transparent; the pellicle was increased and beautifully iridescent. A brown precipitate was deposited, partly on the sides of the vessel, and partly appearing in diffused flakes. The water suffered no further visible change on longer exposure to the atmosphere.

Exp. 6.—Both the pellicle and the brown precipitate dissolved in muriatic acid, without the slightest effervescence.

Exp. 7.—The water contained in a corked vessel, received the before-mentioned spontaneous changes very slowly.

Exp. 8.—In a vial almost filled with the fresh water, and immediately sealed, no loss of transparency appeared during two days; but at the end of six days, the brown flakes were abundant. Both in this and the preceding experiment, the pellicle on the surface was very slight. A transparent glass bottle, in which the water has been frequently kept, though carefully washed, retains a strong iridescent stain.

Exp. 9.—Under the exhausted receiver of an excellent air pump, the spontaneous changes of the water took place much more slowly than when openly exposed.

CHANGES PRODUCED IN THE WATER BY HEAT.

Exp. 10.—I immersed a thermometer in a flask containing the fresh water, and applied heat by means of a lamp.

At a temperature of 58°, the water did not suffer any apparent change.

At 60°, air bubbles became visible, and increased rapidly as the temperature advanced, but no other kind of change appeared until the water became heated to near 150°, its transparency till then not being affected.

At 160°, a faint milkiness was distinct.

The temperature increasing, air bubbles were still disengaged, and the whole liquor assumed a brown turbidness. Together with the brown flakes, which, on the cooling of the water, coalesced and subsided, minute vegetable fibres were very apparent.

ACTION OF TESTS.

Exp. 11.—Tincture of galls dropped into the water, instantly produces a light purple hue, which in a few minutes becomes very deep. This, after an exposure to the air for two or three weeks, acquires almost the darkness and opacity of ink.

Exp. 12.—Prussiate of Potash in a few seconds strikes a light blue, which in a few minutes becomes azure, and on longer standing, a fine Prussian blue is precipitated.

Exp. 13.—The water concentrated by boiling was not affected by either of the preceding re-agents.

Exp. 14.—Tincture of litmus added to the fresh water, instantly produces a light pink red colour ; which hue gradually escapes, and in a day or two changes to a lilac. Litmus paper is slightly reddened, but on drying, returns to its natural blue.

Exp. 15.—The boiled water did not change the colour of the litmus tincture.

Exp. 16.—Syrup of violets, after a few minutes, causes a greenish tint, which gradually deepens, and at the end of twenty-four hours becomes a deep grass green. Violet paper is not instantly affected, but on drying assumes the green colour. No effect is produced on turmeric paper.

Exp. 17.—Oxalate of ammonia produces no immediate change, but in two or three minutes, the transparency of the water is impaired, and it gradually becomes turbid.

Exp. 18.—Muriate of barytes produces an immediate slight cloudiness, with a few air bubbles, and a precipitate slowly subsides, which does not re-dissolve by nitric acid.

Exp. 19.—Nitrate of silver occasions blueish white streaks, and an abundant precipitate.

Exp. 20.—A solution of soap in alcohol, scarcely renders even the fresh water turbid.

Exp. 21.—Lime-water instantly produces a faint milky hue; and a light-brown turbidness immediately succeeds.

Exp. 22.—Nitro-muriate of gold, and nitrate of lead, occasion a slight disengagement of air-bubbles, without impairing the transparency of the water.

Exp. 23.—A few drops either of nitric, muriatic, or sulphuric acid, hasten the appearance of air bubbles; and this is so remarkable with the sulphuric, that it resembles effervescence.

Exp. 24.—A current of sulphuretted hydrogen gas being passed into the fresh water, no discoloration is produced; but if the experiment be made after it has been a short time exposed, it is rendered instantly black.

Exp. 25.—An infusion of tea, in a few minutes, strikes a purplish lilac.

Exp. 26.—A clear infusion of coffee is rendered of a blackish hue. With cocoa or chocolate, no change of colour appears to be produced.

INFERENCES.

From the preceding experiments we derive the following conclusions:—but it should be remarked, that with regard to the effect of reagents, the indications can seldom be considered to possess more than general presumptive evidence.

1. It is certain that the Spring rises from a great depth, *Exp.* 1.

2. That the state of the Spring is considerably influenced by the seasons of summer and winter, *Exp.* 2.

3. The near approximation of specific gravity which the water possesses, to that of distilled water, is alone a proof of a small proportion of foreign ingredients, *Exp.* 3.

4. That the water contains iron, and probably in no very slight proportion, *Exp.* 10, 11, 12, 25.

5. That the iron is combined with carbonic acid, appears from the deposition of the reddish-brown precipitate in the basin, and along the channel through which the water flows, and from *Exp.* 5, 10, 13, 14, 24.

6. That the carbonic acid is the only solvent of the iron in this water, *Exp.* 13.

7. That the iron which exists in the water as a carbonate, falls down, in its spontaneous separation, in the state of oxide, *Exp.* 6.

8. That free carbonic acid is contained in the water, *Exp.* 10, 14.

9. That the water contains a carbonated earth, is proved by the effect on the colour of violets, (*Exp.* 16); which substance, as was suggested by Dr. Saunders, requires separation from the iron with which it falls down, in order that the

proportion of this metal in the water may be accurately estimated.

10. That a carbonated alkali is not present, is indicated by the colour of turmeric remaining unchanged, *Exp.* 16.

11. That lime is present, *Exp.* 17.

12. That the water contains combined sulphuric acid, *Exp.* 18.

13. That it contains a muriatic salt, *Exp.* 19.

14. That it is a soft water, is deducible from its low specific gravity, *Exp.* 3, and also from *Exp.* 20.

15. That the water is free from animal matter; and that the slight putrescence which it was found to acquire from confinement, when the pump was formerly in use, is referable to the vegetable matter which it contains, *Exp.* 22.

MISCELLANEOUS EXPERIMENTS.

Exp. 27.—To the boiled and filtered water, pure ammonia being added, after a few hours, a whitish flaky precipitate, very minute in quantity, is seen slowly subsiding; which, after remaining exposed two or three days, acquires a reddish-brown colour.

Exp. 28.—This precipitate being collected and dried, was fused with glass of borax, and the violet hue was produced;—being fused with pure nitre, a beautiful grass-green appeared. Prussiate of potash being added to a solution of the precipitate, a white precipitate instantly ensued. These results therefore were distinctive of the presence of *manganese.*

Exp. 29.—A portion of the ferruginous precipitate collected from the channel, and carefully dried at a very moderate heat, was heated with cold muriatic acid. It did not dissolve; whence it follows, that the iron thus separated from its solvent, and exposed to the atmosphere, is in the state of *peroxide.*

In the former Analysis it is stated, that "the whole ochre collected by the filter proved, when dried, to be strongly *magnetic.*"

Exp. 30.—I found that no effect could be produced by the magnet upon the ferruginous precipitate, either after being dried by a moderate heat, or being heated before the blowpipe; but, if heated with *wax*, it became strongly sensible.

ANALYSIS OF THE SOLID INGREDIENTS.

Four gallons and 12 oz. (wine-measure) of the water were reduced by evaporation to three pints, and the ferruginous precipitate was separated. The remaining fluid was then evaporated to dryness. The solid matter, dried at 220°,

		grs.
was	Ferruginous	11·9
	Saline	19·6
		31·5

Or, per gallon .... 7·68 grs.

EXAMINATION OF THE SALINE MATTER.

A. 1.—The 19·6 grs. of saline matter were digested in 80 grs. of alcohol of the specific gravity of 805·72. After standing about eighteen hours, the spiritous solution was separated from the insoluble matter, and the latter washed with a little fresh spirit. The solution and washings were then evaporated, and the solid matter dried at 220°* weighed 2·85 grs. The solution was slightly tinged yellow, from a little vegetable matter taken up by the alcohol.

* The apparatus used for drying the precipitates, by means of heated air, consisted of a double cylindrical vessel of cast iron, with an intermediate space all around, and supported on legs, so as to receive a lamp under the bottom. A hole was perforated in the middle of the lid, to receive a thermometer; and the precipitate being placed on a stand conveniently adapted to the vessel, the heat of the inclosed air was easily regulated by the adjustment of the lamp.

2.—The 2·85 grains were decomposed by sulphuric acid, and evaporated, and the heat was raised towards the end, to expel the superfluous acid. The sulphate of magnesia was then carefully dissolved in a small quantity of cold water, and the solution separated from the sulphate of lime, which was again washed with a fresh portion of water. In this way a pretty complete separation of the two salts was effected, and the sulphate of magnesia being evaporated to dryness, and heated to 220°, weighed 1·6 grs.; which was found by a separate experiment, made expressly for the purpose of comparison, to be equal to 1·22 of muriate of magnesia. This being deducted from 2·85 grs. leaves 1·63 grs. for the muriate of lime.

B. 1.—The saline matter, insoluble in alcohol, was dried at 220°, and weighed 16·75 grs. It was digested in 134 grs. of distilled water in the cold for several hours, and frequently stirred. The solution was separated, and the residuum washed in fresh portions of cold water. The washings and solution being evaporated to dryness, and heated to 220°, weighed 11·3 grs. and was common salt. On examination, however, it was found that some sulphate of lime was mixed with the muriate of soda. It was therefore re-dissolved, and muriate of barytes was dropped into the solution, as long as it produced any effect. When the precipitate had subsided, the clear liquid was separated, and the sulphate of barytes, which had formed, was well washed and dried at 220°. It weighed 2·15 gr.=1·25 for the sulphate of lime; which being deducted from 11·3 grs. leaves 10·05 of muriate of soda.

2.—The matter insoluble in cold water being dried at 220°, weighed 5·1 grs. This was boiled with 5 oz. of distilled water, which dissolved the whole of the sulphate of lime, leaving only a small residuum, weighing ·6 gr. This almost wholly dissolved with effervescence in diluted nitric acid, and the solution gave an abundant precipitate with oxalate of ammonia. It was therefore carbonate of lime. The portion not dissolved by the nitric acid, weighed ·02 of a gr. and was chiefly vegetable fibre, with some very minute particles of quartz sand.

EXAMINATION OF THE FERRUGINOUS PRECIPITATE.

A. a. 1.—This precipitate (11·9 grs.), dissolved by the application of heat, in muriatic acid, with the exception of 1·8 gr. of a dark-coloured matter, which was found to consist of vegetable fibre, silica, and alumina. The two last substances probably arose from some particles of dust accidentally blown into the basin from the walks, and mechanically suspended in the water.

a. 2.—The muriatic solution was diluted with more than a pint of distilled water, and pure ammonia, cautiously dropped in*, till the solution very slightly restored the blue colour of litmus paper, which had been reddened by vinegar. A copious precipitate of oxide of iron ensued. This was separated after standing some hours, and when dried at 220°, weighed 9·4 grs.

a. 3.—The clear liquid of the last process was evaporated to dryness, and the muriate of ammonia sublimed. When the volatile salt was quite driven off, and no more fumes arose on the application of a strong heat, a small portion of matter remained, weighing about half a grain, which consisted of carbonate of lime, and a slight trace of manganese.

The 9·4 grs. of oxide of iron being examined, by fusing a portion with pure potash, gave also indications of containing some manganese, but in quantity infinitely too minute to be estimated. The results of the foregoing analysis, therefore, appear to give,

* This method was adopted for the purpose of attempting the separation of the manganese from the iron, according to the ingenious method recommended by Mr. Hatchett (Thomson's Annals, vol. ii. p. 343), which appears to me the best that has been proposed.

Of saline matter, 19·6 grs. consisting of,

A. 2.	Muriate of magnesia............	1·22
	.... lime..................	1·63
B. 1.	.... soda	10.05
B. 1 & 2.	Sulphate of lime	5·75
2.	Insoluble	·02
	Carbonate of lime............	·58
		19·25

Of ferruginous precipitate, 11·9 grs. consisting of,

		grs.
A. a. 2.	Oxide of iron	9·4
a. 1.	Insoluble	1·8
A. 3.	Carbonate of lime, &c......	·5
		11·7
		19·25
		30·95

	19·6
	11·9
Total	31·5
Ditto, by processes, ..	30·95
Loss................	·55

From these data, one gallon of the water appears to contain 7·68 grains of solid contents, in the following proportions,

	grs.
Muriate of soda	2·46
——— of lime...........	·39
——— of magnesia......	·29

Sulphate of lime...........	1·41
Carbonate of lime	·27
Oxide of iron.............	2·29
Traces of manganese, insoluble matter, (vegetable fibre, silex, &c.).........	·44
Loss in processes.........	·13
	7·68*

Or, stating the results according to the mode of computation of Dr. Murray†, assuming, as data, the proportions laid down by Dr. Wollaston in his valuable Scale of Chemical Equivalents, the following estimate will appear:

* The whole contents of a wine gallon, according to the former Analysis of 1792, are stated as follows:

	grs.
Of Oxide of iron....	1
— Muriate of soda	0.5
— Muriated magnesia	2·25
— Sulphate of lime...............	1·25
	5

	Cubic inches.
Of Carbonic acid gas	10·6
— Azote	4·
— Atmospherical air	1·4
	16·

† See his ingenious and very valuable paper of the "Analysis of the Mineral Waters of Dunblane and Pitcaithly," Thomson's Annals of Philosophy, vol. vi.

	grs.
Muriate of soda	1·25
Sulphate of soda..........	1·47
Muriate of lime..........	1·54
——— of magnesia.......	·29
Carbonate of lime.........	·27
Oxide of iron	2·29
Traces of manganese, insoluble matter..........	·44
Loss, &c.................	.13
	7·68

EXAMINATION OF THE GASEOUS CONTENTS OF THE WATER.

A flask which, with its ground-bent tube, contained exactly four ounces and a half of the fresh water, was completely filled by immersion in the basin. This water was gradually heated by means of a lamp, and the gas received over mercury. The boiling temperature was continued until no more gas came over.

The mean of three experiments, performed in this manner, the necessary estimates and corrections being made for barometrical pressure, assumed at the standard 30°, and for thermometrical temperature at 60°, gave, for the total quantity of gas, per gallon,

Cubic inches, 13·3

For the separation of the constituent gases, the usual methods* were adopted, and, as the mean of the several examinations, the following results were obtained:

	Cubic inches.
Carbonic acid, per gallon, ..	8·05
Oxygen	·50
Azote	4·75
	13·30

Or, stating the two last gases differently, according to the proportions† into which they enter to compose atmospherical air, it will be,

	Cubic inches.
Azote	2·75
Atmospherical air	2·50

It has already been shewn, by *Exp.* 10, that the water may be heated to a very high temperature, without the smallest separation of the iron. Being further desirous, with a view

* For the separation of the carbonic acid, lime water was the agent employed. The oxygen was separated by means of a solution of green sulphate of iron impregnated with nitrous gas. The residual gas was submitted to the power of the electric spark, and was proved by its negative properties to be azote.

† See these proportions stated in an excellent paper (the author Dr. Prout), "On the Relation between the Specific Gravities of Gaseous Bodies and the Weight of their Atoms." Thomson's Annals, vol. vi. page 321.

to medical considerations, to ascertain what influence should be produced on the proportion of the carbonic acid gas of the water, by the exact temperature of the Bath water, 114°, being applied to it, the following examination was made.

The fresh water was heated by the lamp to 114°, and was then immediately transferred to the flask already described, it, and the tube, being filled. The remaining process was conducted as in the former experiments with the fresh water.

The mean of two experiments, the due estimates and corrections being made, gave for total gas, per gallon,

Cubic inches, 9·14

The carbonic acid being separated in the usual manner, afforded as the mean per gallon,

Cubic inches, 6·32

The following comparison, therefore, appears from the whole results.

The mean of three experiments on the water at its natural temperature, gave of

	Cubic inches.
Carbonic acid gas, per gallon	8·05
The mean of two experiments on the water previously heated to 114°	6·32
Loss by heat..	1·73

In reference to the variations in the quantity of supply, which is yielded by the Spring at different periods of the year, I have now to offer the results of comparative examinations of the proportion of iron in the water, at the following respective intervals.

	grs.
In August 1815, a dry summer preceding, and the supply of water in a minute being one quart, two oz. five drachms (*Exp.* 2.), of oxide of iron, per gallon . .	2·29
In the beginning of November 1815, much rain through October, and the supply in a minute being one quart (according to the analysis which has been detailed),	2·29
On March 26, 1816, the supply in a minute being one gallon, seven pints, . . .	1·63

It is hence shewn, that the strength of the Spring, both in regard to its quantity of supply, and the degree of its chalybeate impregnation, is not connected with occasional changes of the season ; but is to be referred to the gradual influence of the summer and winter upon the earth, which extends even to great depths.

EXAMINATION OF THE CHALYBEATE SPRING BEHIND THE SUSSEX HOTEL, WITH REFERENCE TO ITS PROPORTION OF IRON.

Tincture of galls, dropped into this water, immediately produces a slight effect, but much weaker than on that of the Parade Spring. Making the comparison, I found, that in a few minutes, with the latter, the purple tint was very strong, but even at the expiration of half an hour, it was faint only in the former.

A similar distinction of result occurs from the prussiate of potash. No immediate effect is produced, and, after many minutes, only a very faint light sky-blue appears; while, in the Parade water, the change is instantaneous, and in a very few minutes a deep azure blue is produced.

One gallon of the water, procured in Sept. 1815, being evaporated, and the ferruginous precipitate being separately obtained, and dried at the temperature of 220°, its weight was found to be 1·1 gr.

ESTIMATE OF THE PROPORTION OF IRON IN A CHALYBEATE SPRING NEAR THE TOWN OF TUNBRIDGE, CALLED THE TILE HOUSE SPRING.

One gallon of this water, procured in the beginning of November 1815, was evaporated, and the ferruginous precipitate was separately obtained, and dried at 220°. It weighed 1·77 gr.

In conclusion, I shall exhibit in one view a comparison of all the results which have been mentioned, with respect to the proportions of iron.

	grs.
Parade Spring, Analysis of 1792, of oxide of iron, ... per gallon,	1
Ditto .... ditto ..... Aug. and Nov. 1815	2·29
Ditto .... ditto .... March 26th, 1816	1·63
Spring behind the Sussex, ditto, ... Sept. 1815	1·01
Tile House Spring, near Tunbridge, ditto, Nov. 1815	1·77

ON

THE MEDICINAL PROPERTIES

OF THE

WATER.

It has with truth been observed by Dr. Saunders, in his General Treatise, that "the most noted of the simple chalybeates in this country, is that of Tunbridge Wells*."

It may with equal justice be added to this character of the water, that the mildness and salubrity of the air, joined with the remarkable beauty of scenery in the surrounding country, render Tunbridge Wells a situation of resort for the invalid at once valuable and delightful.

When it is considered how very minute a proportion of iron is contained in this water, in a quantity so large as a gallon of the fluid; and that the utmost portion thus taken by the patient falls so far short of the dose which is constantly administered in the preparations of phar-

* A Treatise on the Chemical History and Medical Powers of some of the most celebrated Mineral Waters, &c. 1800, p. 237.

macy, it becomes a natural and interesting inquiry to determine, whether its powers as a medicine have all the pretensions which it claims; and how far the imagination may have contributed to the credit which it has acquired. I wish to meet this question fairly, and to apply the conclusions which may result from the discussion.

Some persons, I know, when in perfect health, have made trial of the water; and not finding from it any notable effect, have most unjustly undervalued its power, which ought not to be expected to act in any very marked manner, unless on the invalid. An exception, however, presents itself to this observation, as I can assert from experience, that all persons in full health cannot make free use of the water with equal impunity. A plethoric habit, with vessels easily excited to strong action, might find it to be a very injurious stimulant.

It is admitted universally, both by medical and chemical writers, that the most active form in which iron can be administered as a medicine, is in the state of solution by carbonic acid. I have already shewn in *Exp.* 10, that in this water, the iron continues in perfect solution at a temperature a little beyond 140°, a heat full forty degrees higher than that of the human stomach. We may conclude, therefore, that in this state of perfect chemical activity, it exerts its agency in a very direct manner, over the whole of the surface of the stomach to which it is applied. It is also probable from the speedy and active diuretic power of the water, that the iron may partly find its way into the circulation, in its entire state of solution.

To the carbonic acid gas itself, a considerable and very useful influence may justly be assigned. The very small proportion of the solid ingredients in this water, which detain the carbonic acid in union, enables it to exert its effects more directly and actively upon the stomach; and for the same reason, namely the remarkable purity of the water, we may further explain why its virtues as a chalybeate are so remarkable as they are found, with relation to the actual quantity of iron.

The manganese which is present may probably, as a tonic astringent, deserve some consideration; but from any particular speculations on this question, I shall forbear.

The saline ingredients, existing in the water in such minute proportions as I have stated, appear, with the probable exception of the muriate of lime, scarcely deserving of regard as medicinal substances.

It is obvious, therefore, that this water is distinguished by the remarkable purity in which it possesses a solution of iron, in carbonic acid gas; and the investigation of its properties as a medicine, and the methods of its employment, I have now more distinctly to consider. It may be conceived that the most considerable, as well as the most immediate agency of the water is upon the stomach itself; and that its impressions are secondarily communicated to the heart and arteries through the medium of the brain and nerves. Hence the powers and good effects of the water will be felt, according to the judicious preparation, and fit condition of the stomach. This important point of attention is too much overlooked: and from this cause, from general erroneous management, and misapplication of the remedy on the part of the patient, many of the visitors of this Spring experience injury rather than benefit. Some instances of this kind have come under my own observation; and many have been related to me on the best authority. It is equally true on the contrary, that this water judiciously employed, is a powerful and very successful remedy in many diseases.

A single dose of half a pint will contain, according to the Analysis which has been given, and the statement made agreeably to Dr. Murray's views, of solid ingredients, about $\frac{14}{100}$ of a gr. of oxide of iron; $\frac{2}{100}$ of a gr. of muriate of lime; $\frac{8}{100}$ of a gr. of muriate of magnesia; $\frac{8}{100}$ of a grain of muriate of soda; $\frac{2}{100}$ of a gr. of sulphate of soda; $\frac{2}{100}$ of a gr. of carbonate of lime, and a minute portion of manganese; and of gaseous ingredients, half a cubic inch (or a quarter of an oz. in bulk) of carbonic acid gas; $\frac{17}{100}$ of a cubic inch of azote, and about the same quantity of atmospherical air.

On all occasions, on entering on the use of this water, some aperient medicine should be premised. If more than such simple treatment be necessary, it constitutes a case in which further medical consideration would be useful. The patient being favourably prepared, should take the first dose of the water at seven or eight o'clock in the morning; the second at noon; and the third about three in the afternoon. However small the total quantity may be which is first employed, I am induced to recommend this frequency of repetition, upon the same principles that we employ any diffusible stimulant in successive portions, where it is our object to render its effects permanent. The exact quantity to be taken daily, must of course be varied, according to the several circumstances of the age and constitution of the patient, and the nature of the disease;—but above all, according to the effects which it is found to produce on the individual. The directions of the women in attendance (who are named the *Dippers)* can cnly be of a general, and obviously not of a medical nature; but certainly as far as relates to the *quantity*, they are always on the side of security, supposing that the case is not unfit for the employment of the water.

It is very correct that every one should begin, and continue with a small quantity, for three or four days; after which, if it perfectly agree, the total daily amount should, I apprehend, be larger than is most commonly employed.

As a general statement, I would say that half a pint daily, is the extreme smallest quantity, and that two pints daily is the extreme largest amount, to found a just expectation of benefit; and further, in the way of general outline of direction, I conceive, that half a pint, a pint, a pint and a half, and two pints, should form the progressive ratio of the total daily quantity to be taken at the three intervals. As the patient arrives at the larger proportions, they may with advantage be subdivided, with the interval of a quarter, or half an hour, which should be occupied in exercise.

Those who consult their health in the best manner, should take exercise in the open air of the common, rather than in the sheltered parade, when the weather is favourable. I need not expatiate on the kind and degree of exercise, which must be entirely relative to the convenience and strength of the invalid.

An attentive regard to diet is strictly necessary. Tea at breakfast should be avoided, on account of the combination which its astringent principle forms with the iron in the water, as demonstrated in *Exp.* 25; and for the same reason in a degree, the use of coffee also is not very correct. In the evening, however, either of these refreshments may be taken without disadvantage, as the water will long since have quitted the stomach. Bread and milk, or cocoa, or chocolate, may be taken at breakfast with propriety. The hour of dining should not be later than four or five*: and with this arrangement, very slight refreshment only can be required in the middle of the day. It is hardly necessary to observe, that more than ordinary prudence should be pursued in the general diet, in order to give the best opportunity of efficacy to the water; and as a part of this plan, as little drink as may be convenient should be taken at meals. A want of caution in this particular, in addition to other bad effects which it may produce, will serve to weaken the stomach by over-distension.

In many cases the coldness of the water will have a salutary influence on the stomach. It is almost always judicious to allow it a fair trial at its natural temperature, and with its complete properties just fresh from the basin. If however after a sufficient trial, it should sensibly disagree, or should fail in producing the

* I would advise that not less than an hour should always elapse between the taking of the water, and a meal.

stimulating effects which are desired, its powers on the system may be found much increased, by giving to it an addition of temperature. The failure in question will happen more especially in those constitutions, where the circulation is languid; where the skin, and feet and hands, are remarkably cold; and where a great defect of nervous energy is altogether apparent. It is true that by raising the heat of the water, rather less of carbonic acid will be taken in the dose; but this loss will most probably be more than compensated, by the increased stimulant power which the chalybeate receives from heat. This observation will appear more consistent, when we refer to the former position, that beyond 140°, the iron does not escape from solution. By the *Exp.* p. 19, determining the loss of free carbonic acid, which the water sustains from the heat of 114°, the practitioner is enabled to determine the question for his patient, according to his own judgment. The agency of free carbonic acid is certainly not to be disregarded; and as being the solvent of the chief active principle which is administered in this water, its properties are more especially important. In some cases, I have seen a very superior benefit produced from the water, when taken cold from the basin, where I should have feared that it would disagree, while in others, its active and useful operation has been much assisted by heat. Dr.

Saunders, in his valuable Treatise, commenting upon the activity of the oxide of iron as a medicine, when held in solution by carbonic acid, and assisted by high temperature, as in the Bath water, in which the greatest estimated proportion of iron is not more than $\frac{1}{5}$th* of a grain in a gallon, remarks, "May we not therefore conclude, that Bath water is indebted for its powers on the human body (independantly of those of mere water at a high temperature) principally to the circumstance of a chalybeate impregnation, minute in itself, but much exalted in all its properties by a heat superior to that of most chalybeate springs?" He adds, "that waters of the description of Tunbridge Wells are best heated by being put into a bottle well corked, and immersed in hot water."

It does not appear to me that any advantage is gained by corking the bottle,—an operation both tedious and liable to accident. It could not be completely filled and then exposed to heat with safety; and when a free space is left in the bottle, as necessarily must be, the withdrawing of the cork allows the escape of all the free carbonic acid extricated by the increased temperature, as completely, as if its temporary confinement by the cork were neglected.

* Analysis of the Hot Springs at Bath, by Mr. Richard Phillips.—Phil. Mag. vol. xxiv. p. 342. 1806.—This is the latest Analysis, and doubtless the most accurate.

I recommend therefore as the most favorable mode, a *thin* glass flask, almost filled with the water, in which a small thermometer may be immersed, to be dipped in boiling water (which may be always kept ready for the purpose in the apartment adjoining), and immediately that it has received the desired temperature, as indicated by the thermometer, it is to be poured out for drinking.

The dippers would soon acquire a dexterity in executing this plan; and if increase of temperature be the object desired, it is important, both that the degree should be adapted to the medical direction in the particular case, and also that it should be constantly uniform; an advantage not to be insured in any other way, than as I have now stated.

On the first employment of the water, either cold or warm, some inconvenient sensations very commonly arise, such as flushing of the face, slight fulness of the head, with drowsiness, and an uneasy distension of the stomach, together with continued flatulence. In general these effects are not of importance, either in degree or duration; and are much to be prevented by previous attention to the stomach and bowels. If, notwithstanding this care, and the correct observance of general rules, the symptoms abovementioned continue, the necessary inference is, either that sufficient preparation has not yet been made, or that the remedy is not suited to the case. Dr. Saunders expresses himself in the following words: "The simple chalybeate produces no action on the bowels. When these are foul and loaded with sordes, the water often purges pretty briskly at first, but this operation ceases, when the intestines are restored to their natural state."

I am disposed to affirm, that in the occurrence of this faulty state of the bowels, the use of the water should not be begun; or if taking place afterwards, that its continuance should be suspended, until suitable medicine has produced its proper effects. I may mention the following symptoms as certain indications of the necessity of some preparatory treatment;—a furred tongue, with heartburn, and occasional nausea; unnatural discharges from the bowels; and a turbid state of the morning urine, which in a faulty state of the digestive organs, commonly deposits, more or less copiously, a reddish or pink sediment, or one that is chrystallized, and commonly denominated gravel. As a general statement, it may be added, that the employment of this water is improper in a very plethoric state of the circulation, and especially when this is connected with any degree of inflammatory action. Also, when there is an inflammatory determination to any particular organ, or even when local congestion exists without inflammation. In cases of simple debility of the constitution, the water promises to produce its happiest effects. The proofs of its immediately agreeing with the patient, are, increased appetite and spirits; and these auspicious symptoms are followed by a gradual improvement in the general energy and strength. The taking of active exercise immediately after the water, produces with most persons a degree of general glow of warmth, occasioned by the increased circulation, which may be a consequence very much of a re-action succeeding to the impressions made on the stomach by the *coldness* of the water. The increased action of the kidnies is also a very favourable indication of the salutary action of the water; and this effect is much promoted by an adherence to the proper rules of diet and exercise.

To speak again of the importance of immediate exercise, in the praise of which too much cannot be said, it helps the water to sit lightly on the stomach, to quicken its absorption, and, in a word, to promote powerfully all its good effects.

The bowels usually become constipated, and require the assistance of medicine. It appears to me preferable for the most part, not to join purgative medicines in mixture with the water, lest the stomach be nauseated, but to give it at bed-time in the form of pills. Those containing aloetic compound (as for example, the pulvis aloes compositus formed with the decoctum), I have found to be the most beneficial. In some instances, it may be found adviseable to add a small quantity of sulphate of magnesia to the water, it being previously dissolved; and if taken with each dose of the chalybeate in a very small proportion, its effects may be secured, without the nausea that would arise from an occasional and larger quantity. I must repeat, however, that the conciliation of the stomach to the water itself, should seldom be hazarded by the addition of any nauseous combination. Also, the admission of the water into the circulating system, which is probably a consideration of importance, would be much opposed by any purgative admixture. This practice therefore appears to me correct, only in some cases of unfavourably astringent action of the water, together with a sensibly heating effect on the system.

The propriety of employing warm or cold bathing, in co-operation with the chalybeate, must be entirely relative to the individual case, and cannot form a part of a general outline of instructions. Dr. Saunders observes, " It is frequently of eminent service to employ the warm bath occasionally: and the propriety of this practice, warmly recommended by Hoffman, is amply proved by daily experience."

I cannot presume to offer an abstract of all the diseases, in which the water might probably be found a remedy; but a few remarks, partly deduced from my own experience, and in part collected from authors, may not be unacceptable.

In dyspepsia, depending on debility of stomach, and accompanied with general languor and nervousness, a course of the water is remarkably restorative; and it deserves a similar recommendation, in the debility which often follows a course of Cheltenham water, or other analagous treatment, for bilious complaints.

In uterine debility, its tonic powers are very successful, both in improving the general functions of the organ, in lessening painful irritation and general irritability, and in restraining that inordinate action of the vessels which depends chiefly on their want of tone. Dr. Saunders, in reference to this point, and to the different forms of local debility, thus connected, very sensibly argues, that as they are "a very frequent cause of abortion or barrenness, these mineral Springs have often been the means of removing such unpleasant circumstances."

In chlorosis, as might be expected, the water is eminently useful; but from the languor of the system which so often accompanies this form of complaint, its employment requires much auxiliary management. It is here principally that its powers will often be much assisted by giving to it the Bath temperature of 114° ; by joining the occasional use of the warm bath, employed so as not to produce its relaxing effects; by acting on the bowels with aloetic pills; and by enforcing a strict observance of the rules of diet and exercise ; of which last article of attention, the patient in these cases is generally too unmindful. It sometimes happens that in this complaint, a feverish irritation exists, accompanied with cough and pain of the side ; and certainly such symptoms demand removal, before the water can be entered upon with prudence.

As a remedy in cutaneous diseases, I have not had any sufficient opportunity of seeing its effects. Dr. *Willan* concludes the mention * of Tunbridge Wells water, amongst others, " as having been at all times particularly commended for their utility in the lepra, scaly tetter, and other cutaneous affections." He observes also †, " Chalybeate medicines are perhaps occasionally useful by removing states of the constitution, with which the scaly tetter seems to be connected." It is I think just to add my opinion, that the sulphureous waters, or even the saline carbonated chalybeates, as of Cheltenham and Scarborough, promise a greater effi-

* On Cutaneous Diseases, p. 111. † *Ibid*, 182.

cacy in cutaneous diseases, than this simple carbonated chalybeate; although where superior convenience for its employment does occur, it may deserve considerable confidence.

In scrophula, *the sea*, in its different modes of employment, possesses a much higher claim to our choice than a chalybeate water: yet, after a long trial of its powers, a change may on many occasions be usefully made, to the mild invigorating air of the Wells, when the water also may be employed with great propriety, and with a prospect of much benefit. I am informed by a medical friend, of one very satisfactory example of the kind, in which, taken internally, and also applied externally to an ulcerated surface, it was useful.

As a stimulating diluent and diuretic, in addition to its tonic influence on the stomach, it bids fair, in conjunction with other treatment, to be useful in gravel, of which disease, an unhealthy condition of the digestive functions is the foundation. I have had some convincing proofs of its beneficial influence, under these circumstances. At the same time, the action of the bowels, and the state of the secretions should receive due attention. The acid matter which continually forms in the primæ viæ in this disorder, should be naturalized by appropriate medicines.

The employment of the water for young children, is a much more questionable consideration than for adults. From the observations which I have attentively made, I am induced to draw a *general* conclusion, that under six years of age especially, it is not a favourable remedy. The diseases of very young children are for the most part of a nature to require a distinct attention to the bowels; to the progress of dentition; and a sensible arrangement of diet, exercise, and sleep, with cold or tepid ablution, or bathing; and do not, so far as I have seen, come within the useful influence of a chalybeate water.

In respect to the necessary duration of a course of the water, it may in general terms be observed, that a shorter period than three weeks scarcely justifies the expectation of any material advantage; and that a longer one than two months, or at the utmost three, is not required, to produce all the good effects of which it is capable; so that its employment has been fairly and judiciously managed.

When after considerable trial, the water, although it has quite agreed, has appeared deficient in power, I have been induced to recommend an additional dose of steel from the *Materia Medica.* Two or three grains of sulphate* of iron, formed into pills with five or ten

* It appears to me that in the medicinal exhibition of iron, it is preferable to make choice of the most soluble preparations

grains of extract of bark or gentian, taken with each dose of the water, I can mention from experience to be very useful; and I may add another preparation, the tincture of ammoniated iron, in doses of twenty, thirty, or forty drops, mixed with warm water, as being a very successful auxiliary.

It remains for future experience to determine and record, to what extent more complicated curative intentions may be effected, by joining the connected or peculiar influence of other medicines, to the given range of action, belonging to this carbonated chalybeate.

In conclusion of my present subject, I may observe, that the most favourable period of the

of this metal, which may accordingly be esteemed the most active. The rust of iron (Rubigo ferri, Pharm. 1787) does not afford the least effervescent action with muriatic acid, and may be considered a red oxide, very insoluble, and little capable of being acted upon by the stomach. The ferri sub-carbonas of the present Pharmacopœia has a weak action on the addition of the acid, and may be viewed as a carbonated oxide. The precipitate which subsides from a mixture of a solution of sulphate of iron, and of carbonate of potash, exhibits a strong effervescence with the acid. Hence it may be stated as a conjecture, that so long as the iron remains in the state of black oxide, it retains more in proportion of carbonic acid, and parts with it, as it approaches to the state of red oxide. If a pharmaceutical preparation therefore of a carbonate of iron, on which the stomach may act with least difficulty, be attempted, Griffith's mixture (mistura ferri composita), if used when recently prepared, claims our preference.

year for the visit of the invalid to this fountain of health, is from May to November; both because this season affords the best opportunity of enjoying the very material adjuncts of regular exercise, of early rising, and of the full influence of the air; and because it gives the important advantage of drinking the water, in its highest state of impregnation.

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SOME OBSERVATIONS

ON THE

WATER

WITH WHICH

TUNBRIDGE WELLS

IS CHIEFLY SUPPLIED

FOR

DOMESTIC PURPOSES.

BY THOMAS THOMSON, M.D. F.R.S.L. ET E. F.L.S. ETC.

TUNBRIDGE WELLS, so celebrated for its Chalybeate Spring, is situated in a valley surrounded on all sides by gently sloping hills. It stands upon a clayey sandstone, dipping both from the north and south into the valley, and alternating with beds of clay iron ore, both of which I consider as lying over the chalk. In consequence of this situation, most of the wells in its neighbourhood are more or less impregnated with iron, and have a chalybeate taste, which renders them unfit for domestic purposes. Good water was so scarce, that the visitors who resorted to this very fashionable watering place, were under the necessity of purchasing it at a considerable price; and this had long been complained of as a grievance. There is an excellent spring of very fine water, which rises about a quarter of a mile to the south of the village, bursting out of a field on the side of the hill.

About two years ago, Mr. Taylor, a plumber in Tunbridge Wells, conducted this water to the village in leaden pipes, and distributed it to all the different houses that wanted water. Many hundred individuals have since been in the constant habit of drinking this water, without experiencing any ill effects from it whatever*.

It is collected in an open reservoir constructed of brick work, at the place where the spring rises. From this it proceeds in leaden pipes to the village. In those houses that are situated at the bottom of the valley, the pipe is merely terminated by a stop cock: but those that are in a higher situation, upon the side of the hill, have leaden cisterns, into which the water flows chiefly during the night; the height of the reservoir above these houses not being sufficient to afford a constant supply.

The water is quite transparent, without any particular taste, and possessing all the qualities of the best water; its specific gravity is only 1·00023: that of distilled water being 1·00000. I evaporated 60 cubic inches of it, or 15,163·2 grains, to dryness, and obtained a residue which

* It is to be observed, that this water has been for a long course of years in use by the inhabitants living near the Parade, with entire approbation of its purity. It has also always been conducted through a considerable extent of leaden pipe; and one of the cisterns which has served as a principal reservoir of the water, bears the date of more than one hundred years. The older pipes in this situation were removed a few years ago, and larger ones substituted; but at that period no consequent suspicion fell on the purity of the water.

weighed only 0·4 grain. Thus the foreign matter in this water scarcely exceeds 1 part in 38000. This residue is chiefly common salt. So far as I was able to determine the nature of so small a quantity of matter as 0·4 grain, it consisted of

Carbonates of lime and iron..	0·07 grs.
Sulphate of lime.............	0·06
Common salt..................	0·27
	0·4

During the autumn of 1815, which was uncommonly dry and warm, some bowel complaints occurred at Tunbridge Wells, as they did likewise in other parts in that neighbourhood. It was conceived (I do not know by what process of reasoning) that these complaints were owing to the agency of lead; and Mr. Taylor's leaden pipes were fixed upon as the source of that deleterious metal. This opinion gaining ground, and causing great alarm, the proprietor ran a considerable risk of being ruined, by the whole inhabitants refusing any longer to make use of his water; when Dr. Scudamore, who was at that time engaged in a chemical analysis of the Chalybeate Spring, benevolently, and for the satisfaction of the inhabitants, undertook to examine the suspected water. He affirmed, in consequence of the experiments which he made, that in his opinion the water either contained no lead whatever, or at least only so truly minute a quantity, and so insoluble in its nature, as could not produce injurious effects upon the most delicate constitution. This opinion of the minuteness of quantity, and its state of insolubility in the water, was fully confirmed by J. G. Children, Esq. of Tunbridge (well known to the chemical world by his celebrated experiments with the most magnificent galvanic battery that ever has been constructed). This gentleman being in possession of all the requisite means, undertook to determine, not merely the presence of lead, but to ascertain the quantity of that metal which was in it. He made no fewer than eight experiments, all of them on a large scale, sometimes evaporating no less than 27 gallons of the water. The result of his trial was this: "The water never contains any lead in solution; but there is always a little mechanically suspended in it. This quantity varies slightly at different times; but its average amount has not exceeded 1 grain of lead in 600,000 grains of the water, or 1 grain of lead in 10 gallons of the water."

In consequence of this discovery of lead by Mr. Children, I was requested to try whether I could detect any lead in the water; and considerable quantities of it were sent to Town for that purpose. I made all the requisite experiments with sufficient care, and even evaporated three gallons of the water to dryness, and digested the dry residue in diluted nitric acid; but all my efforts to discover the presence of lead were unsuccessful. Nor was Dr. Wollaston more fortunate; though he had the goodness to examine a portion of the water (from the same bottle, and which had been sent by Mr. Children himself) at my request. This want of success in London led me to suspect that some of the re-agents employed by Mr. Children might have contained lead. But Mr. Children assured me that all his re-agents had been prepared with the greatest care. He was even so good as to repeat his experiments again, no less than twice, with the very same results as he had formerly obtained.

This want of agreement between Mr. Children and myself was sufficiently puzzling. No satisfactory explanation offered itself. There was no other method of obtaining complete satisfaction, but by going to the Wells, and examining the water on the spot. Accordingly, Dr. Scudamore, Dr. Prout, and myself, went to Tunbridge Wells on Friday the 5th of April, carrying with us all the re-agents necessary to determine the point. The result of our examination was a general confirmation of the accuracy of Mr. Children. We found a sensible quantity of lead, not only in the water that had flowed through Mr. Taylor's pipes, but in all the waters at Tunbridge Wells, that passed through leaden pipes or a leaden pump. Nor could we perceive any sensible difference between Mr. Taylor's water, and any of the others which we tried. The quantity of lead present in the water was rather less than one millionth part, or almost exactly 1 grain of lead in 20 gallons of the water. The lead is in the state of carbonate, and is only mechanically suspended in the water. After filtration of the water through paper, the presence of lead can no longer be detected by the nicest examination.

There cannot be a doubt that the opinion which was entertained respecting the noxious properties of this water is altogether erroneous: and in proof of this assertion it is surely sufficient to mention, that the inhabitants and visitors have been in the constant habit of drinking the water, during the whole period since last autumn, with perfect impunity.

Those who have adopted an unfavourable opinion of this water, do not seem to be aware, that it is precisely in the same circumstances with every other water which passes through leaden pipes, or is kept in leaden cisterns. Small quantities of lead may be detected in all such waters; but not in sufficient quantity to produce any injurious effects on the constitution. That lead is a poisonous metal is sufficiently established; but before it can produce any deleterious effects, it must be present to a certain amount; and it is well known to all medical men who have attended to the subject, that lead will not act upon the human body, unless the quantity of it in water greatly exceeds what has been stated in this instance. About ten years ago, I was very much in the habit of examining Edinburgh water. It always gave unequivocal symptoms of containing lead; and the quantity of that metal present, I believe to have considerably exceeded what we found in the water at Tunbridge Wells. Yet nobody in Edinburgh ever heard of any complaints from the water. The lead colic was quite unknown in that city; or only a single case occurred, now and then, among those persons who were employed on substances containing lead, or consisting chiefly of that metal. At that time the Edinburgh water was conveyed for nearly six miles in leaden pipes. These pipes have been recently removed, from motives of œconomy; but as the water is still conveyed through the city in small leaden pipes, it is highly probable that lead might still be found in Edinburgh water, if the requisite experiments were made.

I have likewise found fully as much lead in Hampstead water as in that at Tunbridge Wells.

Mr. Dalton informed me, several years ago, that he had found lead in Manchester water. But the most striking example with which I am acquainted, of the presence of lead in water, which was used with perfect safety, is the following. When Dr. Wollaston was a practitioner of medicine at Bury St. Edmonds in Suffolk, he was consulted by a man who laboured under symptoms which bore some resemblance to those produced by lead. Soon after, he was consulted by a second man, labouring under the same complaint. On inquiry, he was informed, that both of them were supplied with water from the same place, a well belonging to the Coach and Horses public house. He procured a quantity of this water to ascertain whether it contained lead. He compared it with the water of his own house, which he had been in the habit of using for years, and which he knew from experience to be perfectly innocent. The result of the examination was, that he could not detect any lead whatever in the water from the Coach and Horses; but the water from his own well gave unequivocal symptoms of the presence of that metal. Edward Howard, Esq. has informed me that he has examined a great many waters, with a view to ascertain whether or not they contained lead. He found, in every case, that when a leaden pump was employed, the first drawn water in the morning always contained lead. I have kept distilled water for years in a leaden cistern, and have frequently detected the presence of lead in it, by means of albumen, which I consider as one of the most delicate tests of that metal.

Mr. Children found the same quantity of lead in the water of Summer Hill as in Mr. Taylor's of Tunbridge Wells. I am informed, that this water of Summer Hill has passed through the present leaden pipe, of about half a mile in length, for a hundred years past; that it has been the only water in domestic use, in a very large family; and has been invariably esteemed as perfectly pure and salubrious.

These examples I consider as quite sufficient to establish the fact, that minute quantities of lead may be detected in all waters which pass through leaden pipes. I only know one exception to this general law; and it is an exception by no means favourable to the purity of the water which constitutes it. I allude to the water of the River Thames, in which I have never been able to detect any lead, though it had been allowed to flow in leaden pipes. Whoever will consider the situation of this river, and the immense population along its banks for so many miles, must at once perceive the prodigious accumulation of animal matters of all kinds, which must be constantly making their way into it. These matters are, no doubt, the cause of the putrefaction, which it is well known to undergo at sea; and of the carburetted and sulphuretted hydrogen gases which are evolved from it. These animal matters prevent it from dissolving lead, or from holding the carbonate or oxide of that metal in mechanical suspension; because they have the property of combining with it, and forming with it a bulky insoluble precipitate. If you add nitrate of lead to Thames water, you will find, that it becomes milky, and that a white powder falls to the bottom, which dissolves without effervescence in nitric acid. It is therefore a combination of oxide of lead with some animal matter. Thus it is the impurity of Thames water that prevents it from containing lead. Probably hard waters containing sulphate of lime in solution, may also be free from lead. But with these exceptions, we may lay it down as a general fact, that all waters which pass through leaden pipes, or which are kept in leaden cisterns, contain small particles of carbonate of lead. But it is evident from Edinburgh water, Hampstead water, Bury St. Edmonds water, &c., that these particles are present in too small quantities to be in the least injurious to the human constitution.

I shall conclude these Observations with a few remarks on the re-agents commonly employed, in detecting the presence of lead in water.

1.—Sulphuretted hydrogen gas is the re-agent most commonly employed, and chiefly trusted to. When water contains lead, if a current of sulphuretted hydrogen gas be passed through it, a brown colour is produced, more or less intense according to the quantity of lead present. I find that by means of this re-agent, a sensible discolouration is produced in distilled water, containing only one 200,000th part of its weight of oxide of lead in solution. But the use of this re-agent requires considerable precautions; otherwise it acts only ambiguously, or may mislead altogether. Tin, silver, and various other metals, are thrown down dark-brown by this gas, as well as lead. When the water contains any iron, the discolouration by this gas is much greater than it ought to be, from the minute quantity of lead which it contains. This is the case in a very remarkable degree with the Tunbridge Wells water. If the precipitate thrown down from this water by sulphuretted hydrogen gas, be dissolved in nitric acid, and the solution be evaporated to dryness, a yellowish white matter remains, which is insoluble in water, but dissolves in nitric acid with great facility. I conceive this effect to be owing to the presence of a little iron in the precipitate, which seems to act upon the nitrate of lead, when assisted by heat, and decompose a portion of the acid. At least I do not see how the insolubility can be explained in any other way.

2.—The alkaline sulphurets have been employed as favourite tests for lead; but when there is any possibility that the substance which is to be examined contains iron, they are objectionable, as they have the property of forming a dark precipitate with that metal, which might be very readily mistaken for lead. For example, they would lead to a fallacious inference, if employed in the case of this water of Tunbridge Wells; for although the proportion of iron which it contains is exceedingly minute, and so much so as not to affect its properties as a pure domestic water, still, after being much concentrated, it discovers the presence of iron, by these and other re-agents.

3.—The hydriodate of potash, which has been recently recommended as a re-agent to detect the presence of lead, is too ambiguous to be in the least depended upon. It sometimes precipitates lead, orange, and sometimes white. If there be the least excess of acid present, the iodine itself is thrown down, and bare exposure to the atmosphere for some time occasions a red tinge, which is sometimes even yellowish. Iron and tin are thrown down yellow, as well as lead; and I have sometimes produced a yellow precipitate by means of this re-agent, when no metal whatever was present. Hydriodate of potash, then, though a good negative proof of the absence of lead, cannot be employed with safety to ascertain its presence.

4.—I consider the sulphuretted chyazate of potash of Mr. Porrett, as one of the most delicate re-agents for lead with which I am acquainted. It occasions a white precipitate, consisting of small brilliant scales of considerable lustre, and quite peculiar in their appearance. I have procured this precipitate by means of this re-agent, from water left standing in leaden cisterns; though neither sulphate of soda nor carbonate of potash produced any effect on it.

5.—Sulphate of soda or potash produces a precipitate in water containing $\frac{1}{100000}$th of its weight of lead. The precipitate is a fine dense powder, which speedily falls to the bottom, and is not re-dissolved by nitric acid. I consider it as the most unequivocal re-agent of lead that we possess. No other precipitate can well be confounded with it, except sulphate of barytes; and there is no chance of the presence of barytes in solution in water. It was by means of this re-agent, that we formed an idea of the quantity of lead in Tunbridge Wells water. One part of nitrate of lead was dissolved in 10,000 parts of water. A portion of Tunbridge Wells water, to which a few drops only of nitric acid had been added, was condensed by evaporation to $\frac{1}{100}$th part of its original bulk. Both of these liquids yielded a precipitate, when mixed with sulphate of potash; but the artificial lead water yielded a much denser precipitate than the Tunbridge Wells water. Hence it is obvious that the quantity of lead in the Tunbridge Wells water is less than one millionth part of its weight.

6.—The alkaline carbonates are useful re-agents of the presence of lead. I can detect the presence of a smaller quantity of lead in distilled water, by the carbonates, than by sulphuretted hydrogen; but this does not hold with respect to Tunbridge Wells water. The carbonates produce no precipitation whatever in that water, though it is much discoloured by sulphuretted hydrogen. The alkaline carbonates must be cautiously employed as re-agents for lead, as they throw down lime and magnesia; one or other of which is very likely to be present in most waters.

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