**A complete treatise on the mineral waters of Virginia : containing a description of their situation, their natural history, their anaylsis, contents, and their use in medicine / by John Rouelle, M.D.**

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A COMPLETE

# TREATISE

ON THE

# MINERAL WATERS

OF

# *VIRGINIA:*

CONTAINING

A DESCRIPTION OF THEIR SITUATION, THEIR NATURAL HISTORY, THEIR ANALYSIS, CONTENTS, AND THEIR USE IN MEDICINE.



BY JOHN ROUELLE, M. D.

*——when I thoſe alpine mounts aſcend*
*I ſit me down a penſive hour to ſpend.*

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*No. 29.*

District of PENNSYLVANIA, to wit:

BE it remembered, that on the eighteenth Day of January, in the sixteenth Year of the Independence of the United States of America, John Rouelle, of the said District, hath deposited in this Office, the Title of a Book, the Right whereof he claims as Author, in the Words following, to wit:

" A complete Treatise on the mineral Waters of
" Virginia: containing a Description of their Situ-
" ation, their natural History, their Analysis, Contents,
" and their Use in Medicine. By John Rouelle, M. D.
" ——*when I those alpine Mounts ascend*
" *I sit me down a pensive Hour to spend.*"

In Conformity to the Act of the Congress of the United States, intituled, " An Act for the Encouragement of Learning, by securing the Copies of Maps, Charts and Books, to the Authors and Proprietors of such Copies, during the Times therein mentioned."

SAMUEL CALDWELL,
Clerk of the District of Pennsylvania.

# PREFACE.

*THE treatiſe on mineral waters, which I now offer to the public, however conciſe it may be thought, will be of ſome utility, not only to invalids, but alſo to mankind in general, on account of the variety of obſervations it contains, which may be employed in many other reſearches.*

*Water, whether it be conſidered* in general *as an element, according to the old opinion, or as a compound fluid, as it has been proved by recent authors, offers itſelf as a ſubject very deſerving the attention of philoſophers. In this treatiſe I ſpeak of it in combination with different* heterogeneous *ſubſtances, which do not enter into its conſtitution as a fluid, but are foreign to it.*

*Every one knows the great importance of common water in the different functions of the animal œconomy; this ſubject is much more neglected at this time than it was by the* Greeks. *That nation, in general very good obſervers of nature, never founded towns, houſes, &c. without having previouſly well examined the natural hiſtory of the place, the kind of waters, &c. as much as the ſtate of ſcience in their time permitted. Theſe circumſtances are plainly deſcribed by* Hippocrates, de aere et locis. *The*

Romans

Romans, *great imitators of the* Greeks, *were very cautious upon the ſame ſubject, as it appears by the accounts of their* architecture *preſerved by* Vitruvius, *ſo that among the precepts of that art, after the ground is explored, it is recommended to attend particularly to the water, as a neceſſary point for the comfort of human life.*

*Men in their undertakings of this nature too often neglect theſe objects, and it is only when large cities are built, that the water becomes a ſubject of thought and reflection. So it has happened with the ſeveral towns in Europe, where all theſe conveniences have been neglected, &c.*

*It is nevertheleſs very eaſy to make a good analyſis of the waters intended to ſupply any city, whether they are taken from a river, run, ſprings or wells, and each of theſe waters often has different qualities in different places.*

*Theſe differences, ſometimes, depend on the various ſubſtances they contain, ſometimes, on the difference of their proportions. There are ſome of them which are improved by expoſure to the open air; ſome others require different precautions to retain their active principles for the advantage of the animal œconomy. We have a ſtriking inſtance of this in* Philadelphia, *where very few wells can be accounted good, and this is generally the caſe with all the towns*

*in*

*in* America. *Such inconveniences are not to be met with ſo frequently in the old towns eſtabliſhed by the Romans; for they were ſo attentive to this point, that* aqueducts *were built even for very ſmall forts, where a legion or ſmaller body of troops was to be quartered; hence epidemical diſorders rāged much leſs with them. We attribute to the air many great effects upon the body of which we cannot give any good account, but it ſeems very probable that the corruption or alteration of waters at different times may alſo have a ſhare as a cauſe of epidemical diſorders.*

*Such is the human mind in a ſtate of ſociety! In our different inquiries, we direct our ſtudies to unneceſſary objects, while we neglect thoſe, which have an immediate connection with our exiſtence.*

*The mineral waters were formerly as much neglected by us as the common. The ancients left no kind of inquiries or experiments upon the ſubject; they were, however, perſuaded of their efficacy, and* Celſus, Galen, *&c. recommend them ſometimes, as uſeful and even neceſſary in different caſes. However, nothing intereſting was publiſhed before the time of the learned* Hoffmann, *and mankind is much indebted to him for having introduced them properly into the practice of medicine.*

*If we compare his analyſis with thoſe made by different late authors, we may ſee what an extenſive*

*field*

*field was opened to the inquiries and* genius *of philoſophers; how many errors were committed upon the ſubject until this day; and how* neceſſary, curious *and* uſeful *theſe inquiries muſt be. Any body may conceive from what I have obſerved above, my inducements for engaging in that branch of philoſophical reſearch. Being very converſant in it, I thought that my obſervations on the waters of America might be agreeable to the public as well as uſeful, eſpecially as the difficulties of inveſtigation are ſo great, that they will hinder many from attempting it.*

*I begin with the waters of* Virginia, *becauſe in travelling through that part of the country where theſe waters are, I obſerved the errors of the public, and thought it was time to introduce good principles upon the ſubject inſtead of prejudices, which are already too much diffuſed through the public's mind.*

*I hope during the courſe of another year to be able to publiſh an analyſis of ſome of the waters ſuppoſed to be good in the other ſtates, as I intend to give an account of all the mineral waters of America which are eſteemed at this time, ſo that our preſcription of them may be founded on a knowledge of their real properties, and the public may have better information reſpecting a curious part of natural hiſtory which is ſo uſeful to mankind.*

INTRO-

# INTRODUCTION.

AMONG the advantages of the ſoil and climate which nature has beſtowed on Virginia, ſhe has not neglected to ſupply this ſtate with every thing that is neceſſary to procure to its inhabitants *health*, which is often diſordered by different natural cauſes. But reſearches into theſe cauſes requiring much time, I ſhall leave the ſubject for another place, where I intend to ſpeak of the different methods of reſtoring health, according to the nature and the products of each of the MINERAL WATERS.

THE mountainous part of Virginia, or *High Virginia*, being under a cooler climate, affords to the inhabitants of the lower parts a comfortable difference, according to the heat and dryneſs it occaſions. Hence all the different kinds of diſorders, occaſioned by the rarefaction of the fluids, and by atony, which occur in this country. Theſe conditions of the body are the cauſes of a great many different fevers, eſpeci-

ally the Non-humoral Intermittent*, the Double Quartan, &c. which are ſo common about the end of ſummer. It is to avoid this dryneſs that the inhabitants go up the country, to find a cooler air to breathe, and a more nouriſhing food, which, together with the uſe of mineral waters that are adviſed by the learned phyſicians of the different towns, conduce, more or leſs, to the reſtoration of their health, according to their conſtitution, &c.

To acquire a true knowledge of theſe waters, and to form a proper opinion of their uſe in medicine, a good analyſis of them by a phyſician and a chymiſt was wanted. But the difficulties attending ſuch an analyſis were very numerous, and there was no kind of encouragement for it. Hence the many errors which have attended the uſe of theſe waters. Phyſicians could not recommend their uſe, not being well acquainted with their properties by experiments. The public opinion, therefore, was followed, and uncertainty

* This is a kind of fever peculiar to the low part of Virginia, and which I never did obſerve in Europe: I look upon it as a ſymptomatic diſorder, if the patients are attentive to have it cured; but it degenerates into a double quartan, or a quartan, according to the complexion and diet which theſe patients follow. There is no humoral matter at firſt, but the fever going on, brings more than is neceſſary for a natural *criſis*.

ty was the baſis of the whole matter. Every phyſician was ſenſible of the importance of an analyſis; but no one would leave his buſineſs for a little time to examine the place, and to ſtay there to make the preliminary experiments, which would have enabled them to eſtabliſh ſome certain opinions on the ſubject.

The learned author* of the *Notes on the ſtate of Virginia*, ſeems deſirous, for the good of mankind, as well as for the happineſs of his country, that theſe waters ſhould be analyſed by ſome chymiſt, accuſtomed to experiments of this kind: and this has alſo been the wiſh of the learned in general. No perſon, however, undertook the taſk, becauſe the analyſis of waters is the moſt difficult part of chymiſtry, and that with which a chymiſt is generally leaſt acquainted, as it reſpects the ſcience of medicine; and yet experiments of this kind were chiefly inſtituted by authors for the purpoſes of practice.

Beſides the difficulties which I have mentioned, there are ſome others no leſs important, ſuch as the expence of tranſporting an apparatus through a country very diſagreeable to travellers. Of theſe difficulties I was unmindful,



* Mr. Jefferson.

when, at the ſolicitation of ſeveral gentlemen of merit, I undertook the taſk; and indeed, I muſt confeſs, that I received every kind of encouragement, from the politeneſs of different gentlemen, and from the hoſpitality captain Gurney, of Philadelphia, honored me with, during my ſtay there.

Physicians and the learned have never entertained any doubts of the different virtues and of the efficacy of ſome mineral waters. The ancients, who were much better obſervers of nature than we, took notice of different virtues and properties in ſuch and ſuch waters; but not being able to give any account of their different actions, owing to their want of a ſufficiency of philoſophical experiments, they explained theſe actions according to the principles which were received in natural philoſophy.

Several authors, after the late celebrated Frederick Hoffmann, examined mineral waters; but their experiments being difficult, little light was thrown upon the ſubject, in compariſon of what we have derived from more modern authors, or from the new diſcoveries which have been made both in natural philoſophy and chymiſtry. This ſcience which, in the preſent century, has arrived to ſuch a degree of perfection,

could

could not fail to throw new light upon the ſubject of mineral waters, which had been much neglected; artiſts not being fond of operating upon ſmall quantities, and not finding the ſame ſatisfaction here as in the other parts of the ſcience, viz. metallurgy, &c. At length the new diſcoveries of different kinds of airs, opened a new field in chymiſtry, paved the way to the explication of a great number of phænomena, which had not hitherto been unfolded, and more and more encouraged philoſophers to purſue the ſubject, in ſuch a manner, that it is now as complete as any other in the ſcience.

Dr. Brownrigg and Mr. Cavendiſh in England, and other chymiſts, both in France and in Germany, about the ſame time obſerved, that there was a kind of air in mineral waters, ſuch as *Spaw*, *Pyrmont*, &c. After this, the mineral ſpirit of the old authors, which Paracelſus, Van Helmont, and Becher had called *Gas*, excited the curioſity of the learned in Europe. They now began to apply themſelves, and to pay more attention to the ſubject, which they had formerly looked upon with indifference.

Hales, a learned Engliſh philoſopher, upon making new experiments on the air contained in all animated bodies in nature, diſcovered ſo

many

many new ſubjects of curioſity, that he gave riſe to an emulation for reſearches of the kind. The learned excited by theſe new diſcoveries, attempted a variety of experiments. Dr. Brownrigg publiſhed in the *Philoſophical Tranſactions*, that Spaw water and a great many others contained a mineral ſpirit, but without aſcertaining of what nature it was. About the ſame time two authors, Meſſrs. Venel and Roüelle travelled through ſome parts of Germany, and diſcovered that Pyrmont water contained air of a new kind. Venel, one of theſe gentlemen, publiſhed a reſult of their joint experiments, without having mentioned his operating companion.

In this ſtate the diſcovery and opinions remained, until M'Bride and Black publiſhed ſomething curious reſpecting the air produced by putrefaction, and that obtained from burning lime. Theſe two authors formed a theory founded on new experiments, and then Fixed Air began to be better underſtood by the learned world.

This new phænomenon, after it became well underſtood, excited a better method of inquiry. In conſequence of theſe diſcoveries, Prieſtly began his immortal experiments upon this ſubject, and the learned of all nations were ambi-

tious

tious to have a ſhare in ſuch important diſcoveries. Among all theſe new and curious experiments nothing was tried concerning mineral waters, if we except Cavendiſh's analyſis of the pump-water of London. He demonſtrated that there was an aerial acid in the pump-water, and likewiſe other contents. Theſe experiments were the firſt, and the beſt that had hitherto been inſtituted upon waters in general, and are a rule for any perſon who wiſhes to follow this line of philoſophical inquiries.

Bergmann, in Sweden, illuſtrated this method much farther; and his way of operating may be looked upon as one of the beſt among all the recent authors, who have followed this kind of reſearches, ſo uſeful in medicine, and ſo neceſſary to the human ſpecies in the diſordered ſtate of health.

All thoſe inquiries were a great help to phyſicians to arrive at a certain knowledge upon the matter and to judge better of the virtues and application of mineral waters in different caſes, where their patients may be in want of theſe ſalutary natural remedies.

Whatever may be the opinion of ſome people about the matter, and their doubt reſpecting

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the properties of waters in general, it is by analyſis alone that all theſe doubts may be removed, becauſe what falls under our ſenſes, is a demonſtrative proof againſt incredulity.

The medical obſervations which were made centuries ago, proved the contrary. We have therefore a right to conclude upon the ſubject, after a good analyſis, by which we diſcover the different principles of any body whatever; and if the chymiſts do not always pronounce directly upon the application of ſuch or ſuch waters, their compound being explained, they acquire a ſufficient authority to do it, eſpecially when they are practiſing medicine at the ſame time. To deny that authority to chymical reſearches, which are known to be ſo uſeful and neceſſary, ſince medicine follows the laws of natural philoſophy, would induce the incredulous to ſhake the foundation of the beſt theory, and refuſe that certainty to a ſcience ſo able to illuſtrate by its own knowledge all the different branches of ſociety, and introduce ignorance inſtead of learning.

The incredulous, in vain, exclaim that there is no compariſon between the ſmall quantities of ſome parts of a ſaline ſubſtance and their action upon the animal œconomy: daily experience, however,

however, will convince them fully of the contrary, if they are not obſtinate. If philoſophers had ſooner applied themſelves to the ſubject, and had reflected upon the different mixtures of ſalt contained in waters, their diviſion, the large quantity of them drunk by patients, before they found any relief from them: if phyſicians, after theſe obſervations, had adminiſtred the ſame ſubſtances, in proper doſes, with the ſame patience, in the ſame caſes; if patients were not anxious to be cured in a ſhort time of a ſickneſs of long ſtanding, then it would be more eaſy to come to a good rule reſpecting the uſe of the ſame ſubſtances, and that would lead us to diſcover a new method of curing, ſooner and quicker, ſuch diſorders which would otherwiſe reſiſt the common way, uſed even at this day.

These obſervations were made by ſkilful phyſicians, who were deſirous to find out the ſame ſalts, the action of which they found more powerful; but *ignorance*, contrary to their view, always oppoſing her ſiſter *incredulity*, together *they* overturned the beſt ways and plans which were propoſed to ruin *their* dominion over the greateſt part of the world.

Every body knows that as ſoon as a new diſcovery is publiſhed, it is directly oppoſed by

ignorance and incredulity. I hope, this will not be the fortune of this eſſay. I am not afraid of critics. I have attempted to find out a truth uſeful to *mankind*, and inquiries after truth are my *object*. If I have been miſtaken ſometimes, others, upon new experiments, will diſcover my faults, and rectify them for the ſake of the human ſpecies.

That I might be better acquainted with theſe waters and their principles, I examined with care the place in which they run; becauſe the natural hiſtory of their ſituation aſſiſts us in forming a concluſion, determined by various experiments, neceſſary for that purpoſe. All the contents of theſe waters exiſt near them, or a very little way off; and even a naturaliſt could almoſt conclude upon their nature, if chymical experiments were not the only way to prove the exiſtence of what the naturaliſt has only a ſuſpicion of.

All theſe ſeats of ruined mountains, one upon another, are very curious: their irregular formation, their new materials, afford a good many reflections to the obſerver who chooſes to pay ſome *attention* to them. *

In

* Theſe obſervations will be publiſhed in a treatiſe on the natural hiſtory of the United States.

In order to come to a better idea of the different ſubſtances contained in theſe waters, I followed the proceſs formerly uſed; afterwards I tried thoſe employed by recent authors, who uſe the new theory of airs: the reſults were pretty nearly the ſame. I ſhall only relate here that method which I followed a long time ago, as being at once the moſt concordant with the new theory, and more certain in practice. The *aeriform* fluids being ſome of their moſt curious contents, I demonſtrate that ſuch waters contain ſuch and ſuch ſpecies, but without aſcertaining the quantity, for want of a proper *apparatus*; and as it belongs much more to natural philoſophy, I leave it to the care and ingenuity of learned gentlemen in this country, who will make addition to what I have begun, only with a view to public utility.

I began by expoſing each water to a gentle evaporation, in glaſs veſſels or in earthen ones, and repeated the ſame in better ones at home. *Balneum mariæ* was the degree of evaporation, and whatever might be the error attributed by certain authors to *analyſis* by fire, when it is properly managed, there is no difference perceptible; and the ſuppoſed errors are more in opinion than in fact. However on proceeding in this way, I found no decompoſition, no al-

teration, and the products were the ſame; I muſt confeſs too, that great care is to be taken to keep a conſtant graduation, and the *balneum* ſhould always have the ſame quantity of water boiling. By theſe means the water evaporates ſlowly, and you may obtain the earthy products about the middle of the evaporation.

THE difficulty of carrying ſo far, by *bad roads*, proper inſtruments, is a great obſtacle to a multiplicity of experiments; and of thoſe I had along with me, I was obliged to uſe what I could, ſometimes for one thing, ſometimes for another. As for the degrees of heat, &c. I refer the reader to the learned Jefferſon's *Notes*, and the learned *biſhop* Maddiſon's paper, publiſhed in the *American Philoſophical Tranſactions*, vol. II.

THAT gentleman, on his tour, had a very good thermometer, &c. and mine being one of Reaumur's, I rather chooſe to follow Mr. Maddiſon's; obſerving that hot water and *warm water*-ſprings are not different in ſo great a degree as is thought by every body.

THE method of collecting products by precipitation, as propoſed by ſome gentlemen in Europe, I have often tried; it would not ſucceed, or elſe it would have ſaved me a great trouble:

trouble: that method will do only for earthy precipitates, and I rather choſe to collect them by evaporation, than by any active precipitant, the ſeparation being afterwards difficult and uncertain; and if this method were to be adopted, it can not be but upon large quantities, which is ſtill more difficult. To be certain that there was no error, they have been obliged to repeat the ſame experiments many times, becauſe ſometimes there are accidental products with the natural ones; theſe waters being ſubject to alterations, according to the ſtate of the atmoſphere, as in damp, rainy, ſtormy or cold weather, and when the heat is more or leſs moderate. Theſe obſervations remain to be made, and are worth the attention of a good philoſopher.

In general, ſome waters follow the temperature of air, ſome others not, as ſulphurous ſprings; but thoſe which contain a calcareous earth, combined with *aerial acid* alone, are rather cooler than thoſe which contain another kind of air, mixed without aggregation: I obſerved, a good many years ago, theſe differences; but this is not the place to ſpeak of them, for fear of being too long.

Waters which contain inflammable air, with *aerial acid* in combination, are rather

warm

warm in proportion to inflammable air, which alone makes the difference between the *ſweet ſpring* and the *red ſpring*: the firſt contains aerial acid and *inflammable air*; the ſecond, aerial acid combined with iron in two different ſtates, to be explained in its place.

The firſt of theſe waters is by ſome degrees of heat warmer than the other, loſes its principles a good deal quicker, and is more difficult to be exported from the place; however all of them may be exported by taking ſome precaution.

The other method I uſed was by *re-agents*: this is the common way of attempting to acquire ſome idea, reſpecting the contents of any kind of waters; but it is more advantageous in trying common waters than mineral ones. I did not obtain as much ſatisfaction by re-agents in general as I thought I ſhould: therefore, I never tried but ſeven of them, which I found to be the only neceſſary ones for preliminary experiments. Authors do not entirely agree, which to prefer: every one has his own to which he is uſed, and extols it; but, in truth, I do not find more than ſeven re-agents, which may deſerve that name; and all of theſe are not neceſſary at the ſame time: however, as they are uſed all in the common way of analyſis; I employed them

on

on this occaſion for want of ſome other things, which I could not find on the place.

THE way of analyſing *liquids*, as waters, by *re-agents*, has been introduced in chymiſtry, as all errors are, ſlowly: chymiſts thought they could diſcover a great deal directly, under a kind of myſtic operation; but it is nothing more than a conjecture. The learned in that ſcience fixed upon ſome experiments, as the action of galls diſſolved in water or ſpirits, to know if there was any iron or not contained. The theory of airs brought lime-water to be a certain teſt of the preſence of *aerial acid*; and at laſt the learned Bergmann brought in the *acid of ſugar*, to aſcertain the ſmalleſt quantity of lime contained. Theſe *re-agents* do not always give a true reſult; but they aſſiſt us in diſcovering, that there may be ſuch a ſubſtance to be tried by other ways, uſed and known in chymiſtry.

I FOUND, by a great many analyſes, the uncertainty of theſe experiments, and how neceſſary it was to diſcover a better way; and all experiments in chymiſtry having different reſults, they ought to be tried by all the different methods known in the ſcience. For inſtance, it is not enough to be perſuaded, that a water contains an alkali, it is not enough that a liquor

be

be turned to green, or any other color, according to the re-agent I may employ: ſome other methods are neceſſary to determine, whether there is an alkali, or not, and to diſcover of what kind that alkali is, &c. It is not enough, neither, for a water to turn yellow by pouring the ſolution of a metal into it, to believe that there is ſome vitriolated ſalt, if by different experiments I do not prove of what nature the ſaid ſalt is.

In general, I look upon re-agents as being almoſt uſeleſs and unneceſſary for analyſing of mineral waters; and I think they are merely amuſing experiments, affording no knowledge of the compound, unleſs the chymiſt is particularly uſed to experiments in chymiſtry. It is on account of this difficulty, that mineral waters were that part of the ſcience which was neglected, till the modern authors began to bring in a new light.

From the numerous experiments made by the learned of different countries, it appears, that chymiſtry has a better method, and more certain experiments upon the ſubject. There will always be very difficult points to determine, eſpecially when the chymiſt himſelf can not go to the place, and try there ſuch experiments, as are fruitleſs and uncertain any where elſe, &c. Every body knows the conſequence of this, be-

cauſe

cauſe there is a great difference between a water carried away to a great diſtance, on account of accidents of all kinds. The patient, however, does not regard theſe little differences, provided he is ſure of finding a relief to his pains, and a certain action upon himſelf, to bring about a cure, either complete or palliative.

It is, then, the duty of phyſicians, in general, to obſerve the patients to whom they have preſcribed waters, and to judge from them, what kind of alteration their uſe has made, and they will then be enabled to determine, by the compoſition, how to direct themſelves in a great variety of caſes, on beginning a cure at home, which is to be finiſhed by waters. The practice of medicine will enlarge a great deal, upon enquiring into the different kinds of diſorders to be cured, and knowing, by obſervation, the various effects produced. Then, theory, having obſervation and practice, would be grounded upon a ſolid bottom. For the benefit of mankind, it would be even neceſſary, for ſome time, to ſettle there a good obſerver, to reduce into tables all the diſeaſes coming there, and to note the effects of the waters, to direct the patients to ſuch or ſuch, and to follow conſtantly the direction of nature. Such an eſtabliſhment, for three years, would be more uſeful to ſociety than twenty

battles; the art of ſaving one being more neceſſary than that of killing a thouſand.

All the indications, which I offer to the public, in this book, are not only made upon obſervations, and reflection, but are founded upon the natural compoſition of each water in particular: hence, after the analyſis of each water, I intend to give its way of operating in medicine, and its indication in different diſorders. Phyſicians will then order theſe waters, according to the peculiarities to be met with in the courſe of their practice.

The diet to be followed on uſing mineral waters, is a matter not to be neglected by phyſicians. It often happens that diſorders very eaſy to be cured at firſt, turn out differently for want of a proper diet; and as it is frequently in deſperate caſes that patients go to waters, the leaſt fault in diet is very prejudicial, and deſtroys entirely all the benefit produced by the waters. A moderate diet is the only which is proper; high living will never render a conſtitution healthy, much leſs on uſing mineral waters.

The chronic diſorders are much more frequently to be cured by mineral waters, becauſe theſe diſorders require ſomething particular in living

living, and being in general left to nature for their end, the drinking of the waters often completes a cure, which was begun by the common remedies in medicine.

THE hiſtory of each water will form a chapter of this work, that the reader, who wiſhes to be acquainted with one or the other, may find it apart, and ſatisfy himſelf by acquiring a perfect idea of it.

A COMPLETE

# TREATISE

ON THE

# MINERAL WATERS OF *VIRGINIA.*

## CHAPTER I.

### *Analyſis of the acidulous Water, (commonly called Sweet-Spring.)*

THE ſituation of this ſpring is between two ſmall mountains, in a little valley in the county of *Bath*, and ſtate of *Virginia*: the water ſprings out of the ground in great plenty, and makes a ſtream ſtrong enough to move a ſaw-mill and griſt-mill. A little way from its ſource, it may be conſidered as a ſmall river, falling into one of the branches of James-river. The ſituation being quite low, makes it liable to be mixed with a run of water which ſpoils it; and there being no baſon, the walking about

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it makes the mud fall into it, to the great inconvenience of thoſe who drink the waters. The ground is ſoft and tremulous, incumbent upon a marſhy mud; which is the cauſe of its being not very clean: another cauſe is this, that the bath is quite in the middle of the ſpring, and people drink the waters, whilſt others bathe in them; ſo at leaſt it was when I was there; things, however, I hope, are altered. A very ſmall expence would put up the place in good order; If this is not done, the great number of inconveniences will turn it into diſcredit, ſhould the public be well acquainted with them.

ALL the different ſubſtances, compoſing the ſoil, are an indication to the naturaliſt, that he is in a country formerly altered by great revolutions. The mixtures of old and new revolutions are preſent; whether they have been rolled about by ſea, or made by it; at leaſt it is certain from the nature and compoſition of the earth, ſtones, foſſils, &c. that this part of the mountains is older than any of the adjacent ones. Each ſide of the mountains is covered by *free ſtone (cos communis)*; ſome other parts are a kind of *jaſper*, variegated with white lines; and the baſis of the whole mountain is a hard earth, compoſed in general of *clay* and *limeſtone* in different proportions, mixed with iron and colored by it. There

is a conſtant obſervation to be made here, viz. where we find the loam *argilloſo-calcarious*, the waters are much more impregnated with aerial acid; and on the contrary, where the waters come out of a *free ſtone*, *cos* or *quartz*, they are cooler, and contain leſs of this acid; becauſe they run through, or over, ſubſtances, which alter them.

THE whole valley becomes wider, in conſequence of the acceſſion of the waters of the ſpring, and the waters being almoſt upon a level, ſtagnate there. A good many ſmall ſprings are adjacent, and being moſtly upon the edge of the principal ſpring, receive at once the waters of the marſh and mountains, by natural declivity. The ſediment of the waters has partly filled up that valley, and it is full of *ſelenites*, cryſtalliſed like *ſtalagmites*, and underneath it forms crevices or ſmall caves, which extend a good way under the ground, and ſometimes break and ſink down, as I have obſerved near a place called *Beaver-dam*. There is no ſafety in building upon theſe places. The cryſtalliſation being in a confuſion, there is no identity but only a *juxta poſition*, and the rain-water coming through carries away ſomething, and divides each cryſtal in ſuch a manner, that in ſucceſſion of time, the falling of trees cauſes the excavations to break.

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THE reader will conceive that formation better, when he ſhall be aquainted with the quantity of earth theſe waters contain, which they loſe on running down. Aerial acid being the diſſolvent, and having more affinity with atmoſpheric air, leaves the earth, which ſettles upon all other ſurrounding ſubſtances; as ſtones, leaves, branches of trees, which is a great curioſity. All theſe ſingularities are to be ſeen at the mill, and at the *Beaver-dam*, (upon *Spaw-ſpring*-ground) a mile off. The falls of water at theſe places are delightful and very curious; and the ſediment is a proof of what is loſt by evaporation in the ſpace of two miles. There is another dam, lower down, much larger; but its products are not ſo fine, becauſe the whole waters of the valley unite there in a fall, and form a branch of a river: the water then becomes ſoft, diſſolves ſoap better than before, on account of the quantity of earth which was diſſolved by the aerial acid being now diſengaged, which makes the water better for any uſes of human life, &c.

IF we dig in any part of the *marſh*, we ſhall find the water impregnated with the ſame principles, and directly a great quantity of bubbles of air riſing at the ſurface, and ſucceding one another very rapidly. They are aerial acid, mixed with a little inflammable air produced by the

putre-

putrefaction of vegetables in the marſh. This ſmall portion of inflammable air gives to the waters that putrid taſte, ſuſpected by the public to be owing to *brimſtone*. This taſte ſoon diſſipates, if we let the water ſtand a little while; the want of a proper apparatus here hindered me from aſcertainig the exact quantity of theſe two kinds of air, eſpecially the *marſh-air:* but the diſcuſſion of this point would be too long for this book, and theſe inquiries belong more to natural philoſophy. Others will do it after me, a man being not able to do all at once; therefore I hope the reader will excuſe that omiſſion, till a new edition, my intention being only to ſpeak of ſuch properties as are uſeful in medicine, and to the health of mankind.

THERE are two ways in chymiſtry to proceed to a good analyſis; one by re-agents, which are different compounds we add to water to alter the aggregation of other bodies, and the other is fire, which by its gentle heat evaporates all the liquid, and leaves behind all the ſolid ſubſtances diſſolved in the ſame.

BY the firſt we may (being accuſtomed to ſuch experiments) gueſs that there is a ſubſtance of ſuch and ſuch a compound nature: by the laſt, the compounds, when they are not

volatile, may be collected together and afterwards divided by other proceſſes known in that ſublime ſcience, by which we may find out the ſmalleſt parcels of bodies in nature.

THESE are the two ways which I uſed in this analyſis of the acidulous water; if I have not attained the whole knowledge of it, ſome philoſophers, after me, can make an addition to what I could not have diſcovered, or what I have neglected.

I NEVER uſe more than *ſeven* of the re-agents mentioned by all the chymical authors; the others being too numerous, uncertain and uſeleſs. Theſe ſeven are, a *blue infuſion* of flowers, no matter which, provided it is good (that of violets is what I uſed) the two fixed alkalis; ſolutions of mercury and ſilver in the nitrous acid; the tincture of galls; and lime-water.

THE water is whitiſh and clear; has a taſte acidulous and *ſulphureous* after it is drunk; its temperature is warm, and in ſummer it follows the temperature of the atmoſphere; a great quantity of an elaſtic fluid is continually eſcaping through it in bubbles. The learned Mr. *Maddiſon* collected ſome in a bladder, and upon agitating it in water, found it was fixed air; the taſte was acidulous,

dulous, which is a proof; but he took no notice of the ſmall quantity of inflammable air produced by the putrefaction of vegetables, &c. It does not feel heavy in the ſtomach, whatever action it may have upon that organ; ſometimes it occaſions a light head-ach after it is drunk, a property common to waters in general, containing either *hepatic* or *inflammable air*. But the headach ſoon diſſipates, eſpecially when any function of the body is beginning to operate, as *ſweat* or *urine*. It is proper to obſerve that very week ſtomachs feel a heavineſs at firſt; but if the patients are moderate in the uſe of the waters, and their diet, this heavineſs ſoon goes off.

THIS water ſometimes brings on a looſeneſs, which is more beneficial than diſagreeable: thoſe who are affected with coſtiveneſs will be obliged to make an addition of ſalts to help nature to perform her functions, becauſe a good digeſtion depends a great deal upon a proper ſtate of the inteſtinal tube.

I SAW at the ſpring ſome gentlemen drinking an exceſs of the water, who in conſequence were ſeized with an atony of the ſtomach, to ſuch a degree, that they were a whole week in repairing the ſtrength and the tone neceſſary to the functions of that viſcus. Hence it follows

that we ſhould not make too great an uſe of them, but drink them moderately, and uſe a middle diet, then a patient is ſure of recovering very eaſily.

## EXPERIMENTS BY REAGENTS.

1. ON pouring a few drops of the tincture of galls, in a little time I obſerved an iris-like pellicle; and the water was only tinged with a light purple colour.
2. THE mineral alkali being mixed with the water, formed a granulous precipitate, compoſed of an earthy ſubſtance.
3. LIME-water precipitated a white ſubſtance, which carefully collected, ſeemed to be lime that was before diſſolved by aerial acid.
4. VITRIOLIC acid made a great many bubbles of air come out.
5. A SOLUTION of mercury in the nitrous acid, afforded a yellow precipitate.
6. A SOLUTION of ſilver in the ſame acid, formed a whitiſh precipitate, which ſoon after aſſumed a purple hue.
7. THE tincture of violets was ſometimes altered to a red colour; this, however, was not conſtantly the caſe.

THESE

THESE are the principal reſults of the experiments which I attempted by re-agents: a great many others I omit here, as unneceſſary in this publication; all theſe experiments I repeated many times, in order to diſcover if they were conſtantly the ſame; and however conſtant they were, I could not be certain of the contents, had I not employed the other way, of fire, in proceeding to a kind of decompoſition or ſeparation of the whole.

FOR this purpoſe I evaporated, in a proper veſſel, in *balneo mariæ*, two and twenty quarts of the ſaid water. The fire being put under and the *balneum* being half boiling, common air firſt came out in *bubbles*; but when the water grew hotter, more of an aeriform fluid came up. Upon collecting this air, it proved to be aerial acid, by all the common experiments uſed ſpoken of before, and when the *balneum* was boiling, there came out much more, till at laſt a thick pellicle was formed on the ſurface of it, and very little air eſcaped afterwards. This pellicle commonly breaks of itſelf in ſcales, and falls to the bottom of the veſſel. The evaporation being carried on until it was reduced to a quart, there then appeared a yellowiſh colour which was probably owing to iron. The water being evaporated to this degree, ſtill retained an

acidulous

acidulous taſte; and on continuing the evaporation, it went off entirely; this laſt portion of aerial acid is in a true combination with iron and a little earth. This is the reaſon why it appears a little turbid, and whitiſh. Beſides the white pellicle forming at the top of the liquor, there is another part of it which falls to the bottom, and ſticks very hard to the glaſs veſſel: ſome experiments prove it to be rather the *calcarious mephite* and a very little *ſelenites*.

THE evaporation being carried to a ſufficient point, I put the whole into a bottle well corked to take along with me, and try ſome more experiments at home. On opening the bottle it ſmelled a good deal of rotten eggs, (or what is called *hepatic,)* ſtronger than it was at the ſprings: and a bottle of the ſpring-water had hardly any ſmell, but was acidulous. The reſiduum of the firſt evaporation was quite black, the end of the cork of the ſame color and covered with ſmall cryſtals.

I EXPOSED this water to a new evaporation: ſome bubbles came out, which were ſwimming upon it: the ſmell ſoon went off, and the whole being reduced to dryneſs, I attempted the ſeparation of ſalts, to know them better one from another. I poured on the whole a portion of diſtilled water, and repeated it till the water

ſeemed

ſeemed to diſſolve nothing more. Then I collected theſe lotions, and proceeded to a new evaporation, till it was brought to the degree of cryſtalliſation: I took it out and left it to cryſtallize: the liquor was of a brown color, making no kind of effervescence with acid or alkali, and forming no precipitate, which were proofs that the ſalts were perfectly neutraliſed. On following the evaporation, a ſaline ſubſtance adhered to the glaſs veſſel, and was ſpreading over it, a ſign that there were ſalts of an earthy combination preſent. All being dry, and the cryſtalliſable ſalts a-part, if we add an acid there is an effervescence and ſomething remains untouched. With the *vitriolic acid* there is a ſolution of calcarious earth; and what remains is a little of vitriolated tartar, and ſiliceous earth.

THE cryſtals obtained are evidently *epſom ſalt*, or *vitriol of magneſia*, and ſome cryſtals of marine ſalts; this is the reaſon why the reſiduum of evaporation had a ſaltiſh taſte. After the whole evaporation the marine *calcarious ſalt* remains in the waters. This is the cauſe of the attraction for dampneſs when it is left by itſelf in the open air.

HAVING diſcovered the different ſaline ſubſtances contained in the water, I am next to explain what kind of earth there is which could

not

not be diſſolved by the diſtilled waters, and remained upon the filter.

I FOLLOWED the way of diſtilled vinegar to diſſolve the calcarious earth, and make a *foliated earth* or *coralline* ſalt of a ſcaly figure. The liquor being evaporated, afterwards gave no cryſtals, and is thick. Then on precipitating it, it is found to be magneſia, which was in the water in a perfect combination with aerial acid. On entirely drying up the *reſiduum* left by the acid of *vinegar*, there remains a quantity of earth which is not acted upon by acids: it is ſiliceous earth, ſometimes mixed with a little of clay. As for the iron contained, I ſeparated it by the filter, and found it to be from 1 gr. to $\frac{1}{2}$ gr. according as the water was taken in clear weather or not.

HENCE it follows that the acidulous ſpring in Bath county, contains in the quart:

| | |
|---|---|
| Of ſaline ſubſtances in general, | 12 to 15 gr. |
| earthy ſubſtance, - - | 18 to 24 |
| iron, - - - - | 1 to $\frac{1}{2}$ |

IT is ſurpriſing to find in this water ſuch a quantity of contents, but on conſidering its ſituation, in a valley where rain-water carries all kinds of things, adjacent to a marſhy place, where putrefaction yields a large quantity of acid

air

air fit to diſſolve theſe earthy ſubſtances, where ſulphur, ſpread in pyrites, as well as in rotten wood, is conſtantly operating new compoſitions and decompoſitions, with all the ſubſtances it has attraction to, it will not be difficult to find out from where all thoſe contents are derived. How they are produced will be very eaſily known to any philoſopher accuſtomed to obſervations on mountains.

THE inflammable air being obliged to make its way through the water, impregnates it with the ſame hepatic ſmell, which is ſometimes produced in putrefaction, as in that of eggs. However, I would not perſuade myſelf that there is no hepatic air, becauſe ſulphur is to be found there in plenty enough to give ſuſpicions of it. But theſe particulars belong more to other reſearches. This uncertainty reſpecting the preſence of hepatic air, appears much greater upon examination of another ſpring cloſe by. In the ſelenitous ſediment of this ſpring, where putrefaction has no communication, the water is *acidulous*, and has no hepatic taſte. Its ſituation is ſomething higher, out of any run of rainy water, in open ground, more expoſed to the ſun. This expoſition makes the water ſomewhat *white*; hence it was called *buttermilk*. A good deal of the aerial acid eſcapes into the atmoſphere; the

calcarious earth being deprived of it, ſwims in water, and gives it the white appearance. Being tried by re-agents, it afforded the ſame reſult, and is the ſame with the other in every reſpect, except in the quantity of acid and in taſte.

Now if we recollect the bottom ground of the whole valley filled up by the ſediment of waters or *calcarious mephites*, or ſelenites, it is not ſurpriſing to find the ſame ſubſtances in water as the baſis and ſome other accidental contents, which are produced by all the ſurrounding ſubſtances of different natures. The preſence of ſulphur in putrefying vegetables and its re-action in other ſubſtances, give the aerial acid and inflammable air, which make new compounds, &c. in ſuch a manner that there is a conſtant action and re-action of ſubſtances and new compounds appearing, the formation of which is eaſily accounted for by a learned obſerver.

IF we receive the inflammable air coming out of the marſh without croſſing a large ſpring, we ſhall find aerial acid in a ſmaller proportion, but at the ſame time it does not ſmell ſo much of ſulphur. This experiment naturally accords with the new theory of the compoſition of water, ſo much ſpoken of ſome years ago; and I think I ſhall ſoon demonſtrate the daily formation of

waters

waters in the mountains of Europe, and in thoſe of America: ſome few more experiments upon the ſubject will bring the demonſtration to a concluſion.

BEING now acquainted with the natural and chymical hiſtory of the acidulous waters, and being certain of their principles, it will be eaſier to aſcertain their uſe in medecine in general. I leave it to phyſicians and experience to determine more particularly in what kinds of ſickneſs they may be better applied, after knowing in general the conſtitutions of the perſons, who want to make uſe of them.

ALL ſaline or earthy ſubſtances have pretty nearly the ſame effect and tendency. They are in general laxatives, promoting ſome ſecretion, either that of perſpiration, or ſtools, ſeparately, or ſometimes two ſecretions at once. Conſequently, there will be a good evacuation, according to the fulneſs or *plethora*, eſpecially if we conſider the quantity of earthy and ſaline ſubſtances which theſe waters contain. The contrary happens, when there is no rule obſerved by the perſon uſing of them, becauſe if the ſtomach does operate well, the bowels follow the ſame laws. But many times, inſtead

of having a tonic effect, they induce a general relaxation.

I OBSERVED two or three cases of this kind when I was at the springs. I saw a gentleman in a very desperate situation, from a weakness of the whole body, proceeding from a general relaxation of the system; he was in the use of these waters, beginning with a few glasses, and drinking no tea afterwards. At last he drank about two quarts in a day, and recovered entirely, and went home satisfied: but now and then he took some gentle remedies to assist nature and the operation of the waters.

THE excessive use of this water produces the opposite effect; and when drunk after meal, it works differently, because a remedy that is innocent, when taken on an empty stomach, produces a bad effect when that organ is full, &c.

THE kind of salts of which I spoke before, are the substance upon which chiefly depend all the virtues and activity of this water: it will be enough then, to explain in general, in what kind of sickness it is necessary.

AMONG all the different disorders to which mankind is liable, there are none of longer continuance

tinuance, and more tedious than what are called chronical diſorders. That extenſive claſs of diſorders is more the object of mineral waters than any other; acute diſorders cannot be cured by them, except by the inhabitants of the place, becauſe theſe diſorders are ſeldom of long duration. It follows from thence that all kinds of *languiſhing* ſituations, remaining after fevers, whether acute or intermittent, may be relieved by uſing this water, and following exactly the direction of a good phyſician. If there are any obſtructions of the viſcera, they muſt firſt be attended to, in order to prepare nature for a revolution neceſſary to accompliſh a complete cure, without any danger.

ALL diſorders having a vice of the humors, as, a viſcoſity of the lymph, *king's evil*, ſimple or complicated, may be begun with ſucceſs, and be finiſhed by other waters, the acidulous being not able to complete the cure. All kinds of ſwelling of any of the viſcera without ſcirrhoſity, as, ſwelling of the liver, ſpleen, pancreas, meſenteric glands, may receive great relief, ſome be cured, ſome others not, according to the duration of the ſickneſs, the hardneſs and the bulk of the ſwelling, which many times, for want of action, hinder phyſicians from undertaking a ſolid cure.

PERSONS

PERSONS ſubject to an extraordinary heat of body, as of the bowels and different parts, may be cured, and eſcape great accidents, which always follow theſe diſpoſitions. In theſe caſes, a proper uſe of the water and of the bath, relieve them entirely. Some patients require now and then to be aſſiſted by remedies, of a kind, ſuitable to their ſickneſs, as *purges*, *tonics*, &c. or elſe they remain weak after uſing the waters.

THIS great phenomenon of the human œconomy deſerves great attention; becauſe if the heat is too great, the body remains weak. All the ſyſtem of nutrition is ſuffering, if not ſufficient in proportion, there happen more accidents, as heavineſs, languor, till that function is reſtored, or the critical matter is carried off by another ſecretion in a larger quantity.

THE firſt part of this obſervation is more applicable to the people of the ſouthern ſtates, where the perſpiration being great, and the body weak, nutrition has hardly time enough to be operated, ſo as to ſupply what is neceſſary to the ſtrength of the body. This is the reaſon why they are in general, thin, weak, very often ſick, and fall into conſumptive diſorders, &c. The contrary happens in the northern ſtates to the greateſt part of the people, nutrition being there

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in proportion more than the body has occaſion for; hence very fat perſons, and very frequently acute fevers almoſt as dangerous as in Europe.

THIS theory being well known, nobody will think it extraordinary, why the Virginians on going up the mountains, will ſoon repair more ſubſtance, and be fatter there, than they can poſſibly be lower down. They ſoon repair their weakened ſtomachs, hence all the ſtrength of body: they recover as ſoon as they have entered the mountains, where they find exactly the oppoſite of their native places, in which the ſurrounding things have a propenſity to deſtroy all the bodies living by fluids; the rarefaction of blood, heat, hot winds, &c. all have a tendency to evaporation. In the mountains it is quite otherwiſe: all has there a tendency to keep freſh and cool: hence, their better health, becauſe there is little or no ſweat, perſpiration being moderate and equal, and the organic functions better: then the harmony of organized beings is more complete, and conſtitutes health, eſpecially when the people join to it that fine virtue, *frugality*.

THE people of the mountains, however, are very often ſick, and as often as any, becauſe of their way of living: I obſerved among them a great

great number of caſes of rhumatiſm, obſtructions, eruptions of different kinds; and acute diſorders more frequent; I infer from thence, that there are pretty nearly as many patients there as any where elſe; but I repeat it, their way of living is the cauſe of it. The Germans who live in a better way are not liable to ſo much ſickneſs, their induſtry preſerving them better, however liable they may be to the infirmities incident to mankind.

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## CHAPTER II.

### *Analyſis and natural hiſtory of the ſpring called Red-Spring, but which would be more properly called Spaw.*

THIS ſpring comes out of a kind of *rock* of the *argilloſo-calcarious* kind, ſpreading from the mountain down the valley, which produces acidulous waters all over. This ſtone is ſheeted like, compact, but is ſoftened a great deal by expoſure to air, and breaks eaſily afterwards: the interſtices are often filled up with an *ochreous* earth, left behind by the waters and the loom between the crevices: it is of a *marl* nature and *ferrugineous*.

THE

THE water going through all theſe interſtices containing aerial acid, carries along parcels of the iron, which precipitate as ſoon as there is any contact with the atmoſphere, when another part remains in water in a ſolid combination with the acid. The ſuperfluous iron ſettles upon any ſurrounding bodies under its native color of a fine red *crocus*. This appearance was the cauſe of the name given to this water of *red chalybeate water*; but it does not contain, in fact, more *chalybs* than any other; the difference is in the two ways the aerial acid diſſolves iron, as it has been publiſhed by Mr. *Lane* and *Roüelle* in the *Philoſophical Tranſactions* for the year 1770.

AMONG the variety of waters which I tried, I found none that comes nearer to *Spaw-water*, conſequently, as it is a well known name I thought it better than that of *Red-ſpring* which in itſelf is accidental, and not founded upon its nature. This water, when drank at the ſpring, has a very light, acidulous, chalybeate taſte, mixed with ſomething putrid; which taſte is frequent in all ſprings containing iron, and is owing to a phænomenon, the explication of which would require more time than I can devote to the ſubject in this place. I believe, however, it depends upon a reaction of the two airs upon iron, &c.

THE waters leave no kind of aſtringency upon the tongue, and do not diſſolve ſoap. Cloſe by in the marſh, coming out of the hill, are other ſprings of the ſame nature, and ſome exactly like the acidulous water, ſpoken of above.

## EXPERIMENTS BY RE-AGENTS.

1. ON pouring into this water ſome drops of the tincture of galls, it produced a purple hue, which became a little more colored upon ſtanding four and twenty hours.
2. THE vegetable fixed alkali precipitated a white powder, and air was obſerved.
3. MINERAL alkali produced the ſame effect.
4. A SOLUTION of mercury turned the water yellow; which renders it probable that there are ſome vitriolic ſalts preſent.
5. A SOLUTION of ſilver diſturbed the water very little: after a long ſtanding it looks only a little pale, but gives no ſediment. This ſeems to be a proof of the preſence of a very ſmall quantity of muriatic ſalts.
6. LIME-WATER produced a white precipitate; which is a proof of the preſence of aerial acid, diſengaged from its baſis.
7. IF ſome drops of an acid are poured into the water, there is no kind of motion. This

leads

leads us to ſuſpect there is no kind of alkali preſent, which experiments will prove to be true.

IT is very eaſy to ſee, from theſe experiments, that there is nothing certain reſpecting the contents of the water; and this analyſis by fire will prove ſufficiently.

I PROCEEDED in the ſame way as before, and expoſed about ten quarts to a ſlow evaporation, in balneo mariæ. A great number of bubbles of air came up, which upon being collected in a bladder, were found to be aerial acid, by all the experiments proper for aſcertaining this point, and which are too long to be repeated here. As it eſcapes from the water, a white pellicle is forming at the ſurface, compoſed of the calcarious earth left behind by the aerial acid: when all of it is diſſipated, the pellicle falls down in fragments of different ſizes.

IN the progreſs of evaporation the water does not change at all its color; this is only the caſe when it is reduced to one half of its bulk; then it turns yellowiſh, and the iron contained begins to ſeparate. This progreſſion ſeems very exact according to the quantity of acid in the fluid; thoſe ſubſtances which contain moſt of the acid,

loſe it firſt, and others afterwards. This obſervation is a proof of what I ſaid before concerning the two ways in which iron is diſſolved in water; namely, a ſuſpenſion by the aerial acid and an intimate combination by the ſame fluid. At laſt, on following up the evaporation, the water aſſumes a deeper color, till all the iron falls to the bottom, or ſwims in it, or till all the water is dried up.

I PROCEEDED, as before, by lotions with diſtilled water, and having evaporated all together to a point of cryſtalliſation, I found, ſome days after, cryſtals of different forms, as ſelenites, vitriol of magneſia, and a very few cryſtals of marine ſalt.

THE earthy reſiduum being dried, I poured into it diſtilled vinegar, and the greateſt part of it was diſſolved; being evaporated to a cryſtalliſation, it was found to be coralline ſalt. The mother remaining after cryſtalliſation being precipitated, gave an earthy ſubſtance, which proved to be a magneſia, which had before been diſſolved by aerial acid. There remained upon the filter that portion of iron mentioned above. Theſe are the proceſſes by which I came to an exact knowledge of the contents. I tried a good

many

many other experiments to come to that point, which it would be tedious to relate, and uſeleſs to the reader.

IT follows that this *Spaw water* contains, by the quart, as follows, viz.

| | |
|---|---|
| Of aerial acid, - - - | |
| calcarious earth or lime, - | 4 gr. |
| aerated magneſia, - - | 3 |
| iron aerated, - - - | 2 |
| ſelenites, - - - - | 1 |
| vitriol of magneſia, - - | 1 |
| cubic muriatic ſalt, - - | ½ |
| iron combined, - - | 1 |

UPON ſeeing this table, no body will be ſurpriſed at the great quantity of ſubſtances contained in this water: and it would be more acidulous than the firſt ſpring if the ſuperfluity of aerial acid was not taken up by the iron; ſuch is the bulk of aerial acid in theſe waters till it comes in contact with the atmoſphere; without this happening, the water would be as acidulous as *Pyrmont*, or at leaſt as *Gronſtein*-water, which is ſent about for Spaw-water. The acidity would be greater, again, in the *ſweet ſpring*, if the inflammable air did not alter it.

BUT

BUT to return, the inferior part of the hill of argilloſo-calcarious ſtone, contains a good deal of martial *pyrites*. Being broke into pieces, and left to *ſlake*, as it were, and put afterwards in any water, it impregnates it with the putrid irony taſte, ſpoken of before. It is not then to be wondered at, how waters, running through theſe pyrites, may contract that taſte, eſpecially on account of their containing airs, very attractive of dampneſs, or fluids, in general.

BEING now acquainted with the principles contained in the *Spaw-water*, I may very well deduce their application to the animal œconomy; and phyſicians, according to different caſes, may adviſe them as ſalutary remedies, either by themſelves, or aſſiſted by other remedies. Active ſubſtances in this water are four in number, namely: aerial acid, magneſia, vitriol of magneſia, and iron. They have all the ſame properties, in general, moderating one another, as *ſtimulants*, *tonics*, and *antiſeptics*. This is the reaſon, why in *weak ſtomachs* and *bowels* they are mild purgatives, and when the tone is reſtored, they become aſtringents. If there is any *acrimony* or *ſourneſs* of the *primæ viæ*, they relax, &c. They prove very effectual from the acid, leaving the earthy ſubſtances to form a new combination. When the aerial acid goes off,

off, then they muſt be applied in caſes of relaxation of the whole ſyſtem of the *belly*, whether it is in the ſtomach, bowels, or other parts. A moderate quantity will operate very well: a too great one will increaſe a ſlow circulation of the meſenteric ſyſtem. Sometimes weakneſs after a long ſickneſs may be altered with great ſucceſs, on drinking a little at once, uſing a moderate exerciſe, and a ſober diet, and no tea, unleſs made with bitter plants, &c. otherwiſe internal obſtructions, &c. will often be the reſult of error.

THOSE patients, who wiſh to drink this water as a tonic, muſt previouſly be purged once or twice, afterwards they ſhould bathe three or four times; then begin with a pint in the morning and one at night, eating no ſupper, drink ſmall glaſſes at once, and conduct themſelves in ſuch a manner, that all the water may be digeſted before any meal. The contents of this water being moſt conſtantly the ſame, I think it ought to be conſidered as the beſt of all. It comes out of the rock, and has no kind of impurities as the acidulous; it is ſomething cooler, and its ſituation is in a place much leſs alterable; the ſame ground contains acidulous waters of the ſame kind, and they might frequently be mixed, either together or ſeparately, in wine, or in any other drink.

THIS

THIS kind of water is more certainly adapted to the conſtitutions of this country, becauſe there is but one kind of *air* contained in it, which cannot be diſturbed by the accidents of the valley, as putrefaction, &c. inconveniences to be found in the other ſpring, as I explained above. It only remains for the owner to provide accommodations as good as poſſible, that every body may find the difference, naturally exiſting between the two waters, but unknown to the public, who are apt to follow what has been before conſidered as rules, that are often very bad, and contrary to the views entertained by patients on ſetting out for the ſprings. There is yet to be obſerved, that this water, when left by itſelf in a bowl, will loſe a great deal of its ſtrength, which ſome ſtomachs can not bear, becauſe iron diſengages itſelf from a great part of the aerial acid, which going off, the water then becomes lighter.

THERE are a great many other experiments which I made, concerning the practical uſe of theſe waters, but they are too long to be mentioned here, and would be too tedious to the reader.

THIS water may be carried any where in the United States, on taking particular care for the purpoſe:

purpoſe: it retains all its taſte. I carried ſome bottles down with me, and one of them, three months after, was as good as when I put it in the bottle, and being analyſed for a point of compariſon, I found in it pretty nearly the ſame quantity of aerial acid. This is a great proof of its more intimate mixture, and of a good aggregation of the whole. This water has, then, over all the others, the rare advantage of being fit to be tranſported any where we may deſire. The others loſe a great part of their aerial acid, and then they become diſagreeable. I believe, however, they could be managed in ſuch a way as to render them tranſportable.

IT is probable, the owner of this place, being a gentleman of fortune in *Philadelphia*, will do all he can for the beſt accommodations, and will eſtabliſh more baths, and a pump or a baſon proper for the people meeting there to drink the waters, and have the benefit of the whole; a little decoration, and more conveniences, ſuch as ſeats, ſteps, &c. are neceſſary to give an eaſy acceſs to this place, to be out of the ſun, rain, &c. which ſpoil water.

PHYSICIANS will afterwards ſettle a proper diet for their patients going up there, becauſe every thing is not to be found in plenty in a country

ſo little inhabited, and where the inhabitants having hardly enough to ſupply themſelves, can not ſpare much for the great number of people reſorting up every year. If the inhabitants of *Green Briar* did not bring their proviſions to the bath, the ſprings would not be ſupplied. I muſt inform the public, that all the waters which come out of the meadow, in different places, are of the ſame nature, and only vary in the quantity of their aeriform fluid. I tried about a dozen of them, in different places, and in the ſame place there are a good many other ſprings, but which do not always contain the ſame proportion of ſubſtances, ſo as to bring them to any compariſon with one another.

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## CHAPTER III.

### *Of the Hepatic-water, called Sulphureous.*

ON croſſing a middle ridge, called by the inhabitants *Alleghany*, there begins the county of *Greenbriar*, ſituated in a valley, which is very large, and very fertile. It is the laſt inhabited country in this direction to *Kentucky*. The waters coming out of this ridge, turn weſt, and fall into *Greenbriar-river*, and this again into

into the *Kannaway*. After having croſſed a great many mountains of different heights, but low; all of them compoſed chiefly of freeſtone of various colours, intermixed with *ſchiſtus lamellaris recens*, and following then a little ſtream coming out of the ſaid Alleghany very low in that place, the brook comes out of a kind of freeſtone mixed with *mica*, which is very fine. The ſtone is in forms of a rhomboidal ſhape, and is cut by the waters into ſteps; it is in ſheets, ſome being thin, ſome thicker.

THIS is very curious to be ſeen, and brings a great many obſervations to the naturaliſt. The top of this mountain ſeems to contain minerals, there being very few trees upon it, and a very poor vegetation; indeed there is none in many places. I found there the *myrica aſplenii folio*, and *hypericum arboreſcens*, very extraordinary ſhrubs for this place. On following this little path, we went in a large baſon ſurrounded by mountains, cut ſtrait, and terminated by different conical tops; three ſmall vallies reunite there as in a cavern. I had, on ſeeing this ſituation, a thought, that there had been a *volcano*, but finding no complete proof, I waited till I ſhould have ſeen the whole place. There is a good farm in the middle of that fine ſpot, &c. About the weſt-end of that place, having the ſhape of a *funnel*,

there is a little hill, in compariſon with others cloſe by; upon the weſt declivity of this hill there is a large place filled up with all ſorts of ſtones, more or leſs worked by fire. The water comes out among all theſe ſtones, and leaves a whitiſh ſediment all round. The ſmell, which is that of the *hepatic air*, may be perceived at the diſtance of half a mile. Very few birds attempt to croſs over the ſprings: to them it is a new *avernus*. Vegetation is very indifferent upon the hill, but lower down it becomes better.

THESE ſprings form a pretty ſtrong ſtream a ſmall diſtance from the bath-houſe. The waters now leave no more ſediment upon the ſtones; they retain very little of the hepatic taſte, and about three miles off there is nothing of it. Then one may ſee more birds flying. In the declivity going to the ſpring, is a run made by the rain-water, which falls into the ſpring, ſometimes ſpoils it, and brings in ſtrange compounds. Upon the oppoſite ſide of the hill is the true baſon of the whole ſpring, which would be a good deal bigger than the *warm ſprings*, if it was cleaned a little for the various uſes of the people, and the benefit of the owner.

THE place has been entirely overturned by ſome great revolution, all kinds of materials of

old

old mountains are mixed with thoſe of new ones; all cemented by fire. A great many ſtones which have evidently been worked by fire, are like *pumices*, very light, full of air-holes, and not ſo heavy as thoſe which have undergone that *torrefaction*.

I BROUGHT ſpecimens of each, to ſhew to any body curious in theſe ſubjects, which were viewed by ſeveral gentlemen there. From all this I infer, that the place I call the large baſon, is an old *crater* of a *volcano*, filled up a long time ſince by the deſtruction of ſurrounding matters. The waters having waſhed away all earthy ſubſtances, there remained only ſtones and their fragments of different ſizes, as may be ſeen upon the ſpot, where, on walking, one ſeems to tread upon old aſhes, ſuch as are round iron works. This creaking ſound is never to be obſerved but where there are volcanic aſhes, pumices, &c. as about the volcanos.

NOBODY will ſuppoſe that there were any iron works or any glaſs houſes there. This obſervation, which is quite new for this country, is not the only very important one made upon the natural hiſtory of theſe mountains, and of the country.

I SAID above, that the large bottom, joined by three narrow vallies, was ſurrounded by the

mountains

mountains, cut ſtrait, and divided by cones of various bigneſs. It is not improbable, that in this place there was the great *focus* of the whole, and that the hill where theſe waters ſpring, was the paſſage of *laves*, and of aſhes, accumulated upon there. This gives a better explanation of the ſtones of the old mountain found there, where there is no limeſtone, and no kind of ſubſtances produced by recent revolutions, becauſe thoſe ſubſtances have been waſhed away. Notice may be taken of it on the whole hill, upon the ſtream cloſe to a high *road*, where the Indians were uſed to come for paint. There I found a *yellow* and *red bolus:* cloſe by there is a kind of black ſubſtance, which has been thought to be *coal*; but it reſembles rather ſome kinds of *manganeſe*, or the *ſchiſtous-ſtone*, which lies at the top of pit-coals. I could not try any experiments upon it, but whatever it is, it gives a new ſtrength to my diſcovery of the volcano. Some people have thought it was a *coal*, becauſe of the appearance of the diſcovered iris between the ſheets on breaking it; but this is not a ſign peculiar to coal, it is not to be met with in any accumulations, which are of another kind. What is againſt this opinion, is this, that being expoſed to fire it does not burn, but turns grey, and keeps its ſolidity, whereas coal would fall into aſhes, more or leſs ſolid, and be very light.

THE

THE hepatic water comes out through all theſe volcanic remains: a great number of bubbles come up at the ſurface, which received in a bladder, prove, by various experiments, to be hepatic air, mixed with a little of aerial acid. The fluid has an action upon the eyes, noſe and breath, and occaſions a head-ach, which ſoon goes off, if you ſtay there. Sometimes, in this water, and in *hepatic air*, vegetables grow very well, even in the ſpring: theſe plants belong, I believe, to the genus of *confervæ*, &c. There is alſo a light white ſediment, mixed with ſulphur, all along the little canal conducting water to the bath-houſe, which is very large, and convenient for the place. There is not ſuch a quantity of ſulphur as a great many perſons believe; on the contrary there is very little, and the vegetables being covered by it, make it appear in greater quantity than there is in reality.

THE natural hiſtory of the place and the ſeat of this ſpring being known, it is now neceſſary, for public utility and the good of mankind, to make inquiries concerning the ſeveral ſubſtances contained in theſe waters, in order to enable us to diſtinguiſh one from another, and to judge of their medical properties, which more deſerve our attention than thoſe that have only philoſophical curioſity for their object.

I USED the ſame way and proceſſes for analyſing this water, that I did in the others, ſome particular experiments excepted, which were neceſſary according to their ſulphurous nature, &c.

THIS water is very cool in ſummer; it has no other taſte but ſulphurous. Some perſons find a little acidulous taſte: it is very clear and white: the ſmell goes off if it ſtands by for a little while; if however it is carried off in a bottle well corked, it retains a long time its vapour, which makes it more eaſy to be tranſported out of the place, to be uſed for different purpoſes, according to the people's deſire.

## EXPERIMENTS BY RE-AGENTS.

1. THE blue tincture of violets was a little changed to a green color, which ſoon went off; this ſeems to be owing to calcarious ſalts.
2. A SPIRITUOUS tincture of gall-nuts gave a very light purple color; which is a proof of a ſmall quantity of iron.
3. FIXED vegetable alkali, produced a white precipitate.
4. A SOLUTION of ſilver turns it black; it is owing to the ſulphurous vapour, or to a little of that ſubſtance contained in it.
5. A PIECE of ſilver put in the ſaid water turns black:

black: this is a full proof of the exiſtence of ſulphur and its vapours.

6. COMMON ſpirit of nitre, pretty ſtrong, formed no precipitate; that is a ſign of very little ſulphur.
7. IT does not diſſolve ſoap.

THESE are the principal experiments which I tried; all the others, which it would be too tedious to relate, are additional proofs of theſe, and help us in forming a concluſion reſpecting the contents.

THAT I might better diſcover what kind of earth and ſalts are contained in this water, I evaporated, in the ſame manner as before, eight quarts, and proceeded to a ſlow evaporation, in order to obtain the eaſier, ſome products apart; the reſult was as follows.

THE *hepatic air* obtained was not inflammable on account of the quantity of aerial acid mixed along with it. After this, ſome aerial acid left its combination with lime becauſe of its attraction to the atmoſphere. This earthy ſubſtance appears in a degree of heat before the water boils, and as ſoon as the air begins to eſcape, it falls to the bottom of the veſſel, in the form of ſcales; ſometimes it is alone, ſometimes it is mixed with

a little of ſelenites, when there is any in the waters. Aerated magneſia ſeparates afterwards, either becauſe it is in ſmaller proportion, or becauſe the combination of air is more intimate. In the progreſs of evaporation to dryneſs the reſiduum ſeems to be rather earthy than ſaline; it has a ſmell of ſulphur, and is black.

ON repeated lotions of it, the whole being filtered to have the ſalts diſſolved in water, and evaporating all theſe lotions to a point of cryſtalliſation, few days after there appeared different kinds of cryſtals, eaſy to diſtinguiſh with a magnifying glaſs. Every time I poured new diſtilled water to the reſiduum, it ſmelled of ſulphur.

THE ſalts obtained by the evaporation of the lotions, were *vitriol of magneſia*, ſelenites, and a little of mineral alkali; the *mother water*, which was brown, upon being examined, was found to contain calcarious marine ſalt and iron. It appears from theſe experiments, and a good many others, too tedious to be related here,

THAT the *earthy* part remaining upon the filter, which was partly combined with hepatic air, partly with aerial acid, is of a calcarious nature. The quantity to the quart is 20 gr. which is a large quantity; but I ſhall immediately explain

in

in what manner this quantity is contained in the water. The other products are iron and a very little of ſulphur.

IT is probable that the two airs contained are the ſolvents of the calcarious earth of the waters, becauſe it ſeems to agree pretty well with the property which ſome authors give to aerial acid of diſſolving ſo much by inches. * As for the hepatic air, nobody has yet aſcertained the quantity it may diſſolve in earthy *hepar*. It is certain, however, that on precipitating it, the *hepatic air* on flowing out, carries away ſome of it, as it is to be obſerved at the ſpring, where having an elective attraction with the atmoſphere, ſome earth ſettles upon the ſtones, as I tried there. As for the formation of hepatic air, whether it comes out of an hepar, or of a volatile *ſulphurous* acid, whether altered by aerial acid and common air, the re-action then is occaſioned, either by a calcarious ſubſtance, or the little quantity of *marine alkali* very common in theſe kind of ſprings. The water contains by the quart as follows, viz.

| | | |
|---|---|---|
| Of hepatic air, | - - - | |
| aerial acid, | - - - | |
| calcarious earth, | - - | 12 gr. |



* See *Bergmann* on the aerial acid and lime.

| | | |
|---|---|---|
| Of vitriol of magneſia, | - - | 5 gr. |
| ſelenites, | - - - | 2 |
| calcarious marine ſalt, | - | 1½ |
| iron, more or leſs | - - | 1 |
| ſulphur precipitated, | - - | ¼ |

THE hepatic air gives a ſtrong impreſſion to water, without yielding much ſulphur. Hence I look upon the hepatic air contained in water to be accidental; it does not conſtitute exactly its nature, but the water coming through volcanic materials meets ſome hepar and a decompoſition is operated: then the water charges itſelf ſo much with the hepatic air, but not always in the ſame quantity; becauſe ſometimes water is ſtrongly impregnated, ſometimes it is leſs, without altering the other contents, and affording another virtue in the uſe of it.

WHAT I ſay is confirmed by experience, and the treatment of different diſeaſes, as, e. g. itch, &c. the cures of which ought to be perfect, but are not. Where real ſulphurous waters are uſed, the cure is complete, the diſeaſe never appearing again, as it does upon many people having uſed of this water. It is very eaſy to ſee, after what I have ſaid above, and from the contents of theſe waters, that their properties are uncertain; this is the reaſon why ſome uſe them as *aperitives*, and

the

the common *idea* is to believe them good for any caſes where the others did not operate any thing upon the patients: as for this, it remains to know if other waters have been taken properly, and with the true application to the caſe.

FROM thence phyſicians will take care of ſtories often in contradiction with the nature of things. This difference of effects leads ſometimes to a diſcovery of a morbific cauſe unknown before. We have now only to determine to what kind of diſorders theſe waters may be applied.

ALL the cutaneous or *ſkin* diſeaſes, as, common itch, all kinds of pimples, red ſpots, whether *ſcorbutic* or not, ſome *fiſtulas* or runnings, and cracks of the ſkin, without an internal vice of the humors, having only the ſkin for their ſeat without complication, may be relieved entirely, on drinking this water and bathing in it now and then the whole body, waſhing frequently in the day. The bath being very cold, it is neceſſary to take care not to be in a ſweat or perſpiration, becauſe it would not ſucceed ſo well on account of the coldneſs of the water.

A QUART in the morning and one at night, eating no ſupper, is the true quantity to drink: ſome may drink three quarts, obſerving that it

muſt

muſt be at leaſt three or four hours before or after any meal.

PERSONS afflicted with any external diſeaſes, muſt be rubbed all over when they are bathing, and this frequently in the day with the water, in order to raiſe a better circulation all over the ſkin. This is a point quite neceſſary for receiving complete benefit of this water, and induce in the ſmall veſſels an oſcillation loſt for ſome time, and to take their primary functions in the ſyſtem. A great part of theſe diſorders is often nothing but a continual error of circulation, cauſed by a *plethora ad vaſa*. All comes in order when the fluids acquire by remedies their natural fluidity, and the proportion to the ſhape of the veſſels; without that, error follows and the fluid breaks out and occaſions all kinds of ſores, more or leſs difficult to cure, according to its nature, whether ſerous, or lymphatic, or mixed.

ALL theſe are much more difficult in the female conſtitution, on account of the laxity of their veſſels, and the tenacity of lymph. Thoſe, on the contrary, of a ſerous appearance are worſt, becauſe the ſerum corrodes the ſmall veſſels by the acrimony of the ſalts contained in the blood. This difference of fluid is the great cauſe of various ulcers, and theſe treated by acids, as

*lemon-juice,*

*lemon-juice*, *vinegar*, &c. may be cured ſooner than by any ointments, as I have experienced for twenty years that I have practiſed the different branches of phyſic.

ALL kinds of the ſwelled glands, having a ſcorbutic origin, whether in ſuppuration or not, being well prepared before, may be relieved by *hepatic* waters; but in theſe caſes there are ſome other remedies to be enjoined by phyſicians, and a proper diet ſuitable to the caſe: then ſuch diſeaſes may be compleated by a criſis aſſiſted by waters. There are ſome other kinds of diſeaſes to be cured by hepatic waters, ſuch are *nodes*, *calloſities* in different parts of the body, which are troubleſome, and painful at certain times. No other remedies will remove them but cold or warm hepatic waters.

IN general, all kind of lymphatic diſeaſes, from accumulation, except thoſe of the venereal kind, may be attempted and cured by hepatic waters, or at leaſt alleviated a great deal.

CHAPTER

## CHAPTER IV.

### *Of the Warm-Springs, or Thermales*

BESIDES the cool mineral waters of different qualities, as I have explained before, nature, always wiſe, has formed ſome other kinds, of a different compoſition and temperature, and they are endowed with virtues, which contribute more or leſs in the cure of the different diſeaſes in which they may be adviſed: they begin cures which the cool waters alone can complete. From the unequal diſtribution of the nervous fluid ariſes a ſlow circulation, or none, in ſome of the remoteſt parts: by the help of *thermales*, diſorders from this cauſe, may be ſooner relieved than by any other means. Irregular motions of the *muſcles* fall under the ſame obſervation.

ALL the waters exciting a hot ſenſation were called *thermales*, after the latin name *thermæ*: as this is generally a known name, I ſhall retain it here, with regard to the two ſprings of which I have yet to ſpeak. The firſt is leſs hot or warm. This wonderful ſpring is ſituated pretty nearly in the middle of the *new mountains*, at the bottom of one tract of the chain called *warm ſpring mountain*, in Bath county, one of the higheſt ridges after the blue ridge: but reſpecting its height,

height, I ſhall ſay nothing, having had no barometer with me to meaſure it, &c.

ALL the ſides of the mountain are moſtly compoſed of freeſtone, lamellated in all kind of ways, but in general inclined to the horizon. This freeſtone ſeemed in ſome places to have been warmed by fire, and ſome parcels which have been ſpread about for a long time, are *ſonorous* upon being touched with iron. Sometimes a white *quartzous vein* croſſes it. On the one ſide there is a *ſchiſtus rufus lamellatus mollis*, which being waſhed away by rain, after it has been broken by injuries of the air, forms the *humus arabilis*, or ground of the vallies, where there is any huſbandry eſtabliſhed. Under this bed is a blue marble inclined to the horizon; this is croſſed by a white vein of cryſtallized aerial *mephites*, or common calcarious ſpar. This marble is very good for lime, and could be worked with advantage for any other uſes. About ſixty yards from this place, is this famous ſpring, contained in a large baſon built in ſtone, of which the diameter may be twenty-four feet, and of an octogonal ſhape: the place is not covered, there is only a wall to keep the *bathers* out of ſight.

THE ſituation of this bath is one of the moſt agreeable in theſe mountains, and it is more eaſy

to find in its neighbourhood, neceſſary proviſions for to be well accommodated. The air is very good there. It would require but little repair to render it one of the moſt agreeable ſpots for ſpending the whole ſummer; but improvements can not ſo ſoon take place. The bath might be divided, ſo as to have cool water when neceſſary, and each patient might have his room and a bath cloſe by, which would particularly ſuit the convenience of rheumatic perſons. The water coming out is in ſuch plenty as to be able to turn mills if they were eſtabliſhed upon it, about half a mile off.

HOWEVER blue the waters may look, it is nevertheleſs as white as all the others: that blue colour proceeds from the fragments of blue marble at the bottom, and the reflection of the ſky.

THE taſte of the water is ſomething acidulous and *fætid* or *hepatic*. The elaſtic fluid eſcaping through the water in bubbles, is no other air but the *hepatic*: it makes ſome impreſſion upon the noſe, eyes and breath, occaſioning a ſmall *head-ach* which ſoon goes off, and ſtill quicker, on moving out of the column of it. This hepatic air is very volatile, and evaporates when expoſed in an open veſſel, before it can be brought to the houſe, when all the taſte is gone, the water being

ing ſtill warm. This is a proof of the incomplete combination between the air and water: however, all its properties depend upon the quantity of air contained, which induces perſons to go to the ſpring and drink there.

THIS water being moſtly recommended as preparatory to the uſe of the others, the bath is the principal object to be conſidered. I took notice of it myſelf, and likewiſe other perſons there, that the water was rather relaxing to the *ſtomach*, therefore in a *plethoric* conſtitution it cauſes a loſs of fluid by ſweat and by bath: care therefore, is to be taken of theſe matters, upon uſing of it. This firſt effect being once over, then it operates as a ſalutary and very agreeable bath. The queſtion now is whether this water owes its properties to *hepatic air*, or *aerial acid*, both being contained in it. As I think there is more *hepatic air*, its properties are rather to be attributed to the latter.

## EXPERIMENTS BY RE-AGENTS.

1. THE water drunk at the ſpring has a ſtrong hepatic taſte and ſmell.
2. THERE is no alteration of a blue tincture after eight and forty hours.
3. IT makes no kind of effervescence.

4. PHLOGISTICATED alkali produces no alteration on it.
5. FIXED alkali precipitates a little of a white powder.
6. MINERAL alkali does the ſame.
7. A SOLUTION of mercury diſengages only ſome air bubbles.
8. A SOLUTION of ſilver turns it a little of a pale hue, and throws out a good many air bubbles.
9. IT does not diſſolve ſoap.
10. LIME-WATER occaſions a ſmall white precipitate.

THESE are the principal among all the different experiments I tried upon this water by reagents. I ſhall now proceed farther by evaporation, and compare both ways in order to diſcover the true nature of this very difficult water.

I FIRST evaporated three quarts, but finding hardly any *reſiduum* or pellicle, I added to it ten quarts, to evaporate, as before, in balneum mariæ. In the progreſs of evaporation ſome air bubbles came up ſticking to the veſſel. A piece of ſilver left in it a long time was not altered at all, which is a ſign that it contained very little or no ſulphur. The evaporation being reduced

to

to a quart, became clouded, and then a little of ſediment began to ſeparate, which being collected and examined, was found to be nothing but calcarious earth, which had been before diſſolved by aerial acid. There are hardly two grains of this earth to the quart, which is a proof of the ſmall quantity contained in it before the evaporation. On continuing the evaporation to dryneſs, and then diſſolving the reſiduum by different lotions in diſtilled water, and evaporating it again, I found a little of *marine calcarious ſalt*; hence it follows, that the warm ſpring water is one of the lighteſt known; it is almoſt as pure as diſtilled water mixed with ſome hepatic air. It contains to the quart:

| | |
|---|---|
| Of hepatic air - - - | |
| aerial acid - - - | |
| calcarious earth - - | 2 gr. |
| ſelenites - - - - | 1. |
| calcarious marine ſalt - | 1 $\frac{1}{2}$ |

THESE are all the contents which I obſerved, I could not determine the exact quantity of air, but leave this matter to the care of ſome future philoſopher, who will viſit the ſpring with a proper apparatus, to aſcertain this point, according to ſome new experiments lately made in Europe.

WHAT-

WHATEVER ſulphureous taſte this water may have, it is not poſſible to find any ſulphur in it: whether it is all diſſolved by hepatic air, or flies off; at leaſt it is certain that there is no ſediment of it, as is the caſe with reſpect to the water at *Aix-la-Chapelle*, where there is none to be found. When there is a ſediment of it, *Bergmann* found out the beſt proceſs to diſcover it; but this proceſs would not ſucceed upon the thermal hepatic water of this kind. The quantity of hepatic air, is in a ſmall proportion, and as it is very volatile, nothing can retain it to enable us to eſtimate the quantity of the ſulphur contained in it.

ALL theſe taken together, make it one of the lighteſt waters hitherto known. *Plombieres* water in Lorraine, in France, is very light, but it contains more ſelenites, &c. than our *thermal water*. On following the meadow, in the middle of it, there is another ſmall ſpring as warm as the other, which has not been opened: its water falls into the ſtream of the other ſpring. I believe this water is better for internal uſes than the great ſpring: it appears, that ſome iron, diſſolved by aerial acid, is contained in it. The hepatic air is not ſo ſtrong, and, in general, there are more contents in it.

ALL

ALL the right ſide of this hill contains warm waters, whilſt the left ſide contains none at all; the bottom of the run is covered by calcarious mephites, which is ſometimes cryſtallized, and ſometimes in rocks or maſſes. The great ſpring, as I have already ſaid, is ſituated upon a blue marble which decays ſlowly, and the water deſtroys the calcarious earth to ſuch a degree, that there is no ſolidity in the wall. I believe it would not be eaſy to make any ſolid building on the ſpring, on account of the great number of crevices formed by the water in the rock, as it is in all other ſprings.

ALL theſe vallies are compoſed of the ſame materials. The waters, in ſucceſſion of time, have left their ſediment under irregular forms, with intervals; new waters coming over, have either filled them, or waſhed ſome away, in ſuch a manner, as to make them fall, or have formed holes on dropping upon a ſoft ſediment. All theſe things are to be ſeen upon the place; hence that variety of caves, almoſt all formed in calcarious ſtone, and where there are, or have been, ſuch caves, the water has generated air; and aſſiſted by aerial acid, has diſſolved all the ſubſtance to carry it a little way off, and there left it, on account of different attractive bodies,

ſuch

ſuch as the atmoſphere, ſalts, &c. which it met on running down.

A GREAT peculiarity in theſe mountains, is this, that we find, between two ridges of *old freeſtone*, *cos antiquus*, materials of a more recent revolution, which has brought there calcarious blue earth, and it is upon this baſis that we diſcover all the mineral waters. Is this accumulation owing to a revolution, which took place before the other, or was it left there by the ſea?

ON going down about two miles, and following the ſtream, which cuts its way through the rock, we obſerve the blue ſtone covered by the ſediment of water. All this is formed by a ſelenites, and the calcarious mephites, or calcarious ſpar. Good, cool, freſh water is frequently to be found cloſe to the warm water; becauſe it comes from a higher place: the one iſſuing out of the the rock is cool, the other ſprings out of the bottom. It is poſſible, however, that they may have a communication in ſome place. The cold one takes hepatic air on falling upon the place of decompoſition, and impregnates itſelf; the remaining air comes up along with it, and appears under bubbles, becauſe the water can not diſſolve it all. This ſtrength of expanſion is greater on account of the heat and attraction

with

with the water and common air. In the ſweet ſprings putrid fermentation is the principal agent, as a good many experiments, which it would be tedious to relate here, will explain in time, the ſubject belonging to the natural hiſtory of mountains in general.

HAVING ſufficiently ſpoken of the warm ſpring, it now remains to give ſome information about its medical properties. *Hepatic air* is the moſt active of its products: that alone has a real effect upon the animal œconomy. The heat is another agent we muſt pay attention to, when patients wiſh to uſe the water of which I am ſpeaking. As for the ſalts and earth contained in it, I look upon them as being of very little effect. Their quantity being ſo ſmall is not ſufficient to prevent the relaxation which the bath often induces.

IT may be ordered by phyſicians as an aperitive in all kind of rheumatic pains, palſy, rigidity of the muſcular fibre, as well as in ſuppreſſed perſpiration, *catching of cold* upon the place, &c. This water may likewiſe be employed with advantage in particular caſes. The hepatic air in the warm bath will greatly aſſiſt the cure of cutaneous diſeaſes, as, itch, leproſy, elephantiaſis, all the ſcorbutic eruptions, old ulcers, ſwelled glands, irregular pains after old rheumatiſm, &c.

In theſe caſes it ought to be adviſed by all the learned phyſicians of this country.

I DO not ſpeak of this water as being able to operate complete and quick cures; but as a good preparative to be employed before uſing any of the others, which by their materials may better accompliſh a cure to the ſatisfaction of the patient. Any body who wiſhes to try of this water muſt uſe it with care, in order to avoid the relaxation which would keep him weak, and hinder the good effect of this, and of the others, to be taken for this purpoſe.

To drink this water it is better to put it in a bottle at the ſpring and cork it well; let it cool, then drink it, or elſe it is liable to relax the ſtomach. When this precaution is taken, it produces no ſuch effect, weak ſtomachs will digeſt it eaſy, eſpecially if it was poſſible to add ſome aerial acid; then it would be very eaſy to give it all the properties of other waters. Every thing in this renders it capable of receiving any new mixture: but it is not neceſſary to attempt it, the others being at hand for any purpoſe we may deſire.

CHAPTER

## CHAPTER V.

### *Of the Thermal water which is hotter than the preceding.*

ABOUT ſix miles from the preceding ſpring, on following the road between the two high ridges, we come to the end of a valley, where the water, or brook, has cut its way through the *petro-ſilex*, down to Jackſon's river. This bottom is covered by the various materials of the deſtroyed mountains on each ſide, and offers all kinds of ſtones, as, freeſtone of different colors, the red kind eſpecially, which is ſonorous. There is plenty of the blue marble croſſed by a white vein of *calcarious mephites:* all the ſurrounding ſubſtances are bottoms of old cavities filled up by fragments of all kind of materials. The uppermoſt of the mountain is cut in different cones all round, which are moſtly *ſterile*, or at leaſt vegetation is very poor all round about them, and in general there is little of water in proportion to the mountains.

THE ſprings are upon a *hillock*, and come out among mud and graſſes of different kinds; ſome holes have been cut in the calcarious ſediment upon the declivity, to make a kind of bath. The water ſprings through theſe ſediments, and is of

a middle temperature, between half boiling and warm water, ſo as to ſupport that heat very well on bathing in it. Whatever may be the heat of this water, it does not prove unfavorable to vegetation: there are plants growing in this water, and all the kinds of plants natural to ſprings in general live as well in this as in a cool water. This may be attributed to the aerial acid, which probably keeps them from being overheated, becauſe theſe waters contain more of this acid than they can retain in combination.

THERE are in the compoſition of the place adjacent to theſe waters all kinds of ſubſtances; but the chief of them is always of a calcarious nature, colored with iron, brought and accumulated there by the waters a long time ago. It ſeems that there is here a continual decompoſition and reaction of one ſubſtance upon another. It is highly probable that *pyrites* or *mundics*, contained under ground, are the cauſe (by their deflagration) of the heat and new compoſition of *aerated* water. Calcarious earth joining to the vitriolic acid of pyrites raiſe a heat, and then the aerial acid, diſengaged from its combination, breaks up in the water, carrying along with it ſome part of the iron left. This is the reaſon why the iron is to be obſerved at the ſpring, ſettling upon the ſtones, when a little of it remains yet in water.

THIS

THIS place (of all the different ſprings that I have ſeen in Europe and in America) affords one of the greateſt proofs of the opinion of philoſophers concerning the cauſe of heat in ſome ſprings; but not of every one, as I took notice of in this travel. Here, however, there is no better account to be given, and none more probable; becauſe there is plenty of pyrites: all the place is compoſed of a calcarious mephites, the water out of that place and cloſe to this ground is cool, and contains the other principles, except that it is not hot.

HENCE, and from a good many other experiments, I conclude that the *Hot ſprings* owe their *thermal* and *aerial* properties to a decompoſition of a pyrites, by the calcarious earth, and the vitriolic acid reacting upon each other; it thus produces aerial acid, which flying up, carries ſome iron along with it, and makes this water a *chalybeated* thermal water.

ALL the ſpongy ſediments around the ſpring, about half a mile, on following the ſtream, are of the ſame nature. The water detains its heat as long as there is any ſubſtance of the ſame compoſition, till it is mixed with other waters. Theſe ſediments are ſo much penetrated by the waters, that on walking upon them, there is a *crepitus*

or

or noiſe, under the feet, and on breaking ground we ſee water underneath. Any *vegetable* ſubſtance falling in, is ſoon covered by a light incruſtation, and retains its ſhape very accurately, and this incruſtation is effected in a ſhort time.

THE reader who is well acquainted with the theory of the different kinds of air, will eaſily perceive that there is a combination to form a new water. Theſe ſprings coming out of the calcarious ſediment, diſſolve and ſettle what they took before upon the place, and there is only loſt the fluid, which eſcaping, is regenerated in proportion. This is the nature of *thermal aer'd* water, which is very different from the preceding in its degree of heat, in the *aerial acid* which it contains, and in there being no *hepatic air*, &c.

HENCE, their medical properties are very different, the one being a palliatif and the other a curatif if it is properly uſed. This I ſhall prove farther by analyſis, and thus enable phyſicians to take this difference into conſideration.

## EXPERIMENTS BY RE-AGENTS.

THE water has no particular taſte, neither *acid*, *hepatic* or *aſtringent*. It is very clear, a great

great quantity of air bubbles comes through it to the ſurface, which being gathered, proves to be a *ſuperfluous aerial acid.*

1. GALL-TINCTURE poured in the water alters it but very little, but leaves an *iris pellicle* at the top: this is a proof of a very ſmall quantity of iron, the greateſt part ſettling in the ſpring as ſoon as there is a communication with the atmoſphere.
2. A BLUE-TINCTURE was not altered at all; this proves that the water has no ſuperfluous *aerial acid*, as would have been thought by the taſte of it.
3. FIXED alkali produces a white ſediment of a calcarious nature.
4. A SOLUTION of mercury forms a yellow precipitate, which was much more evident when I poured it in the ſpring itſelf; all the water was then turned yellow.
5. A SOLUTION of ſilver turned the water white.
6. IT does not diſſolve ſoap.
7. LIME-WATER is precipitated by it.

ALL the different ſmall ſprings upon the ſpot give the ſame products: it is not therefore neceſſary to believe that they are different, except in the ſenſation of the heat, according to the difference of the conſtitution, and irritability of the ſkin.

THE

THE more central the ſprings are, the greater is the heat, which is moſt owing to their being nearer the focus of the accumulated bed of reaction; however, this heat is always ſupportable, and never cauſes any irritation of the ſkin, and it may be ſupported by any patients without the inconvenience of a ſteam, as in the *warm bath* and *hepatic cool bath*.

THE only thing neceſſary here, are good accommodations, both for the patients a-part, and for ſuch people who go there only for amuſement and for company in ſummer. This ſpring might be improved a great deal, and with advantage to the owner; becauſe it is a fine place, and it is but a ſmall journey from it to the *Spaw-ſprings*.

ALL the experiments related above, would be ſufficient enough to prove the principles of this water, and to convince us of its properties; but there remain ſome others to be diſcovered yet, upon which it depends as much, ſuch as ſalts which muſt be contained in it; and to determine of what kind they are I ſhall proceed, before, by evaporation.

I EVAPORATED ten quarts of this water. A good deal of aerial acid came up ſwimming at the

the ſurface; then followed a white pellicle covering the whole, which ſoon falls to the bottom, till there is no more diſſolved by the *aerial acid*. Being evaporated to dryneſs, the *reſiduum* was impregnated with a pretty ſtrong ſulphurous ſmell, which, I believe is owing to that reaction upon pyrites. This ſmell is very often perceived in places where iron is moiſtened, or in ſtagnating waters, and is attended with an iris pellicle, improperly called *oily*.

THIS water ſeems to contain about eight grains of an earthy ſubſtance to the quart, and about five grains of different ſalts, which is a very proper quantity to make a good mineral water for drinking cold. Hence it is not ſurpriſing that it operates ſo well, in different diſorders, uſed as a bath. In both caſes it is able to give great relief to patients. From all the experiments it was found to contain as follows, viz.

| | |
|---|---|
| Of aerial acid - - | |
| lime aerated - - | 8 gr. |
| vitriol of magneſia - . | 2 |
| ſelenites - - | 1 |
| calcarious marine ſalt | 2 |
| iron - - - | $\frac{1}{4}$ and leſs. |

THESE are the true proportions I found by repeated trials, whatever may be their variation from accidental cauſes; but their virtues not being thereby affected, they may be very properly applied to in different diſeaſes, according to the advice of phyſicians.

HEAT and aerial acid are the principal agents in this water for external application: for internal uſes the other contents are ſufficient to have a very great effect, even in a ſhort time, as diluents, and aperitives; and being kept well corked to cool, it operates as a tonic. However, diſcordant it may ſeem to be, we ſhall find the oppoſite properties when the water is cooled.

HENCE it may be good in all pains of the rheumatic kind, in palſy, atony of any part whatever, &c. I obſerved a very great glandular ſwelling cured in a ſhort time, by bathing in, and drinking of it. The bath is very good to bring out again any humors which have been cured by repellents, as in diſorders of the ſkin, in which it is very beneficial. All kinds of *tophus*, or *hardneſs*, may be cured by bathing a long time, alſo expanſion of the milk cauſing all kind of *tumors*, whether running or not, will certainly be healed, if the patients be well governed.

verned. A great many other accidents of the lymphatic ſyſtem may be cured in the ſame way.

DISEASES which are occaſioned by *local plethora*, may be removed by bathing, and laſtly venereal pains, frequently called rheumatiſm, ſtiffneſs in joints, &c. will be a great deal alleviated, and the whole cure could be effected, on joining other remedies ſuitable to the caſe.

THESE few remarks are ſufficient to give a general idea of the ſeveral properties of theſe waters, to any phyſician, a little acquainted with his buſineſs, and any reader may very eaſily underſtand the explanation I have given. As for regimen, and diet, they muſt be directed according to the caſe and circumſtances, and they can not be determined but on ſeeing the patient upon the ſpot: I therefore thought it uſeleſs to give any table of them, and what I began on the ſubject, is not yet complete enough to appear in public: this requires ſome more obſervations and inquiries, reſpecting each diſorder in particular, and the application of the different ſprings, which I intend to treat of for the good of mankind, if I find ſufficient encouragement for it from the public.

## CONCLUSION.

FROM all the experiments and reſearches related in this treatiſe on the *mineral waters* of Virginia, I am led to conclude, that theſe are endowed with more powerful properties than any that I have analyſed formerly when I travelled and lived in Europe.

THE mineral waters, ſuch as, *Spaw*, *Seltzer*, *Pyrmont*, in *Germany*; *Plombieres*, *Bourbonne*, *Bagnieres*, *Bareges*, in *France*; the firſt of which are acidulous, the ſecond hepatics or ſulphurous, have ſome properties common to ours, but not to the ſame degree and certainty. A good many of them have not yet had their properties aſcertained; their analyſis being not correct, and there not being experiments ſufficient to enable phyſicians to adviſe one water in preference to another.

AND even in Paris, phyſicians of *high* reputation are rather governed by public opinion, from the patients deſire, than by the certainty of analyſis, and by experiments made after a ſolid method equally good for ſociety.

BEING perfectly acquainted with all this inſufficiency, I have attempted in this treatiſe to lay the

the whole of my inquiries upon a ſolid baſis, that of *obſervation* and *experiments*.

IN writing this treatiſe I have endeavoured to expreſs myſelf in a plain ſtyle, that I might be underſtood by every body, whether learned or not. Thus opinions, not having a ſufficient foundation, it is to be hoped, will exiſt no longer, and truth, reſulting from all theſe inquiries, be eſtabliſhed in their place.

GENERAL directions for uſing waters, being not ſufficient for every body, I thought that particular explanations or deſcriptions and compariſons would be much more eaſy to be underſtood by any perſon wanting to uſe theſe waters, eſpecially for thoſe, who are not acquainted with phyſicians, or who live far from them.

I THEREFORE collected all the properties of the *different waters* exiſting upon the ſpot in the ſame valley, and upon the ſame bottom, under the name of *acidulous*, that nobody might think that one or another was endowed with a different virtue than the *principal ſpring*; the difference which might be between them, reſiding only in the quantity of *inflammable* and *aerial acid*. This I obſerved in making experiments upon *butter-milk ſpring*, and ſome others all round theſe

places,

places. It is of no conſequence to patients which of theſe waters they uſe: they will anſwer the ſame purpoſe in the different caſes in which they may be applied.

WHAT I have ſaid in this treatiſe, I have proved to be true by the natural hiſtory of the place, and accordingly it was impoſſible to be otherwiſe; hence I found out that there was only a difference between the *acidulous* and *ſpaw*; this laſt having all round it acidulous water, as good as that of the other place, and this having no *ſpaw*, makes a great difference upon the whole, the greateſt part of patients wanting more to uſe *ſpaw*, either alone or mixed, &c.

I CAME, next, to an examination of the *ſulphureous*, or *cold hepatic* waters, it being proper to uſe them after the preceding ones, in a good many caſes, already explained.

FROM their principles I concluded, that they ought to follow according to the great cool temperature they have in ſummer, which, aſſiſted by their other contents, renders them very great tonics, in a great many diſorders, giving at once to the whole vaſcular ſyſtem an oſcillation neceſſary to a good circulation of the fluids.

EX-

EXPERIMENTS had confirmed my obſervation, before I had finiſhed *my analyſis*. I found that a preliminary uſe of the *acidulous* or *ſpaw* water was neceſſary, in order to prepare the body to receive the benefit of the others, or elſe it would fail in many caſes, as I had opportunity of obſerving it there, in different caſes, where atony was a principal cauſe of the complaint; then a ſudden impreſſion and action of cold and hepatic air, help the cure much quicker than it would have been operated before. I thought it better to ſpeak after of *thermals*; which are the ſecond claſs of waters. There is a great difference between them, in the degree of heat, and in the variety of their principles; one being hepatic, affords very few contents, and is one of the *lighteſt* waters in the world. The other, which is much more efficacious, contains aerial acid; this makes a great difference in their compoſition and virtues. The properties of the hepatic thermal, are ſuch, as to be an excellent preparative in any kind of cures, where relaxation is neceſſary. I explained the reaſon of it in its place, and this obſervation is very neceſſary, becauſe thoſe already in that habit of body muſt avoid their uſe, for fear of a greater relaxation and vice verſa: then there will be more ſatisfaction for the patient, &c.

BUT thoſe of a full complexion of body having other kinds of diſeaſes, may uſe them without being much afraid of this, at leaſt for a week.

THESE few remarks ſufficiently ſhow, how any one may come to a reſtoration of health by uſing theſe waters, eſpecially when there is no error committed in diet, &c. neceſſary conditions, when we are deſirous of our own conſervation, or to keep ourſelves in health, which is ſo precious to our exiſtence.

THE great number of experiments which I made, and the obſervations of ſeveral kinds neceſſary upon theſe matters, engaged me to publiſh this treatiſe, for the welfare of ſociety. There is nothing in it without having experiments and obſervations for its baſis; the errors I may have committed were not in my power to avoid: I attempted to be uſeful to my fellow-citizens, and to mankind in general.

*FINIS.*