An essay on the contents and virtues of Dunse-Spaw. In a letter to my Lord ------- / [Francis Home].

Contributors

Home, Francis, 1719-1813.

Publication/Creation

Edinburgh : Printed by R. Fleming for A. Kincaid and A. Donaldson, 1751.

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AN ESSAY ON THE CONTENTS AND VIRTUES OF DUNSE-SPAW.

In a LETTER to my Lord ------

----------*Nunc ego mitibus*
Mutare quæro triſtia ; ----------

HORAT. Lib. 1. Ode 16.

By FRANCIS HOME, M. D.

EDINBURGH:

Printed by R. FLEMING,
For A. KINCAID and A. DONALDSON.

M. DCC. LI.

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PART I.

SECTION I.

MY LORD,

ACCORDING to your command, I ſend you the following papers. Your lordſhip may remember, that the diſcourſe happened, one night, to turn upon *Dunſe*-ſpaw. You made, then, a very juſt obſervation: That, if it had no medicinal virtues, it did not deſerve to be in vogue: and, if it had any, 'twas pity, that, what was, in itſelf, good, ſhould have no better ſupport, than the tottering foundation of fancy and mode. Your lordſhip, then, asked me, to give you ſome account of that water. I promiſed, ſo far as I was able, to do it.

I COULD,

I COULD, no doubt, have formed, at that time, a pretty combination of ſteel, ſulphur, and ſalt; and have made the hypotheſis account for all the effects of the water. I ſhould, at laſt, perhaps, have given credit to it likewiſe, and fallen down before my own idol-notion. But had I endeavoured to make your lordſhip do the ſame, you would not, I know, have been ſo haſty in the worſhip. You would have expected proof. You would have asked to ſee the experiments, on which the plan had been formed. You would have, naturally, found out the laws of ſound inquiry. You would have ſhown us, that good ſenſe and philoſophy are very nearly allied.

FOR this, my lord, is the road, that philoſophy points out to its pupils. She allows but of one way to come at truth. She orders us, from known effects, to inveſtigate unknown cauſes; and, from particular cauſes, to proceed to more general ones, till we arrive at the moſt general. Thus, from repeated

peated trials and obſervations, certain concluſions are drawn; and the eternal and unchangeable properties of bodies evinced. This is called the *analytic* method of proceeding. And ſo true it is, that this is the only road for beings of our abilities to proceed in, that we neither do, nor can determine of any one effect in nature, unleſs from what we have ſeen before, in the like caſe. What our great moral poet, ſo juſtly, obſerves of God and man, may, with equal juſtice, be extended to the whole of creation:

* *Say firſt of God above, or man below,*
What can we reaſon, but from what we know?

WHEN the ſummit is once gained, we have liberty to return. Having found out the cauſe, it is then allowed us, to explain, from it, all the effects and phœnomena that appeared in all its different circumſtances. This affords the imagination enough of play. So

* Pope's 1. ethic epiſt. line 17.

So far is fancy from being damped by philoſophy, that it ſeems to ariſe, with double force, from the *ſynthetic* method: for ſo the latter is called. But we muſt take care that it is the latter, elſe, how ſhall we know, that the whole is not a plan of airy thought, which may be afterwards overturned by experiment!

IT is the neglect of this rule that has done ſo much harm to philoſophy, and made it ſo variable, ſince the beginning of the world. Self-conceit prompted men to give the world complete ſyſtems. The method of experiment was too tedious for that purpoſe. They applied to their own fancies; and there formed, and combined thoſe principles and laws, that were to anſwer every effect. Nature was immediately concluded to be the ſame with the workings of their brain. They impoſed on themſelves; they impoſed on the world: but not long. Another ſcheme, that happened to ſuit the age better, appeared, and the

the former was laid aſide. Thus, philoſophy, or rather opinion, for it deſerved no other name, behoved to be continually on the change.

OUR ſenſes, my lord, are deſigned for the uſes of common life. They are formed to obſerve the out-lines only of nature's works, but not her fineſt ſtrokes. It is not neceſſary for our happineſs that they ſhould: nay, it is neceſſary that they ſhould not. Experiments then, which are the objects of our ſenſes, and managed by them, can carry us no great length in knowledge, if not aſſiſted, and extended by the force of reaſon. 'Tis thus, that we are allowed to carry our thoughts beyond experiments; and by the light which theſe trials throw over the varied works of nature, form ſome judgment of their undiſcovered parts,

* *Ita res accendent lumina rebus.*

otherwiſe we ſhould make but very ſlow ad-

* Lucret. lib. 1.

vances in natural philoſophy; and be always, as a late author juſtly ſays, laying foundations, without attempting to build on them. By theſe analogical reaſonings, others are led to inquiry, and may be ſo happy, as to diſcover experiments to illuſtrate them; or, in their ſearch, find other truths more uſeful.

BUT here great caution is neceſſary. We ought never to truſt to reaſon alone, where experiment can have place: and tho' the latter cannot immediately be of uſe, yet we ought never to have it out of our view. When it refuſes to be of the party, 'tis better to act the ſceptic, than deceive ourſelves and others; and be at laſt, perhaps, confuted.

MINERAL waters, as parts of nature, are fit objects of natural philoſophy; and all inquiries into them ought to be guided by the ſame laws. Our buſineſs is to trace their principles from their effects. When

theſe

theſe are once aſcertained, we may ſafely, then, account for all the reſt of their effects and operations on the human body.

IT is but of late, that a regular ſcheme of inquiry has been projected. In the beginning of this century, *Hoffman* publiſhed thoſe admirable treatiſes on the *German* mineral waters. There is the ſame objection againſt the writers † before him, that *Horace* had againſt bad poets,

* *Infelix*

† DU CLOS is, ſtill, reckoned the beſt writer on the mineral waters of France. His experiments are too few, and too general to give riſe to any certain concluſions. Beſides they were made at Paris, and not at the different fountains, which is a conſiderable objection to them. He falls likewiſe into ſome errors of chymiſtry. His work, however, is a good general collection, and wrote diſtinctly. The experiments deſerve our credit the more, as they were performed before the royal academy of ſciences.

BLONDEL, on Aix waters, gives good rules with regard to drinking and bathing; but his examination is lame, and ſhews him to have been no chymiſt.

BRESMALL, in his Hydro-analyſis of Aix waters, diſcovers neither the phyſician nor chymiſt.

CHROUET,

* *Infelix operis ſumma, quia ponere totum neſcit.*

THAT *totum*, that whole, without which no work can be complete, is wanting in their performances. To remedy this, that great phyſician and chymiſt has laid down the † general

CHROUET, in his *Connoiſſance des eaux minerales d'Aix et de Spa*, tho' he follows no plan, yet is very ingenious; and has given us ſome curious and accurate experiments. His reaſoning ſeems juſt. He appears to be the beſt writer on the Spaw-waters.

LISTER has but very few experiments: even thoſe are in no order, and found to be moſtly falſe by future examination. His reaſoning is not much better, and generally ſo obſcure, that it cannot be underſtood.

GUIDOT, in his treatiſe on Bath waters, follows no plan; has few experiments of any conſequence; and ſeems not acquainted with the chymical properties of bodies. He is ſo far to be commended, as he relates ſome hiſtories of cures.

BOYLE, in his ſhort memoirs of the natural experimental hiſtory of mineral waters, affords many good hints, eſpecially as to their medicinal properties. Yet ſeveral of the heads of inquiry he propoſes can never be reduced to practice.

* Horat. de art. poet. lin. 54. † Opuſcula varia, de aqu. miner. earumque ſalutari virtute. Examen aqu. mineralium, obſerv. chymic. lib. 2. obſerv. 32.

general method of proceeding; and illuſtrated his ſcheme, by an accurate examination of the moſt celebrated waters in *Germany*.

BUT ſtill the out-lines only were drawn. The finiſhing was reſerved for a * late author. He has gone thro' the different ſteps of inquiry; and ſhown, how accurate they are, in his analyſis of Scarborough-water. Had we been favoured, with as juſt an account of its effects, on healthful and morbid bodies, and of all its medicinal circumſtances, as he ſeems to have once intended, the hiſtory of that water would have been complete.

A THOROUGH knowledge of the contents of mineral waters, gained from an accurate inquiry, is of great advantage to medicine. The phyſician is led, by it, to preſcribe, with a greater degree of certainty. He ſees where, in certain circumſtances, ſome of their principles may do harm; and obviates that,

* Dr. SHAW's inquiry into Scarborough Spaw-waters.

that, by diſpelling, or correcting them. He ſees by what principles the cure is to be effected, and may often increaſe thoſe according to pleaſure. His practice is built on the ſureſt foundations, thoſe of reaſon and experiment.

BUT medicine does not receive all the advantage. Natural philoſophy has, likewiſe, its ſhare. We learn, from the ingredients, what foſſils lye in the neighbouring parts; and, from the examination of the contents of mineral waters, may be led to many uſeful diſcoveries. Some particular * ſubſtances are waſhed from the interior parts of the earth; theſe, we never, perhaps, had ſeen produced, in a natural way; and, therefore, thought they were not the product of nature. We find, in the hot waters, a ſpecies of heat, very † different from that produced by

* ALKALINE ſalts, ſuch as are found in moſt of the mineral waters of Germany. Neutral purgative ſalts.

† THE thermæ affect the ſenſation of touch, leſs than common water heated to the ſame degree, by the thermometer. Their

by every kind of fire, which we have ſeen above ground. By means of theſe waters, we hold a correſpondence with the more central parts.

THE ſubject that we are going to enter on, is none of the moſt entertaining. Your patience, my lord, will be fully tried, before you get to the end; if ever you arrive that length. Yet the power of truth is, ſometimes, very ſtrong. Your lordſhip has heard of men, who have preferred a dry propoſition of *Euclid* to the humours of Sir *John*, or the ſquire; and of a great philoſopher, who had no pleaſure in the Eneid, but from the truth of its geography.

SECT.

Their action, in hardening or ſoftening vegetables, put into them, is, ſometimes, oppoſite to that of common water. They continue longer hot than common water; for the Bath-water is ſaid to retain its heat ſixteen hours, in froſty weather. They take as long time, as cold water, before they can be brought to boil over a fire.

SECT. II.

EVERY mineral water muſt flow thro' the neighbouring parts: it may be tinctured by them. We know that the mineral beds, which alter the water, are, often, found not far from * the place where it breaks out. If the ſame bodies, that the water contains, are diſcovered near the well, it is probable, that they have a ſhare in the formation of the mineral-ſpring. A previous examination, therefore, of the ſituation and ſoil, is abſolutely neceſſary.

THE well is ſituated in a valley, which lyes a ſhort mile on the ſouth-ſide of *Dunſe*. This bottom is waſhed by a brook, that runs from weſt to eaſt. On the ſouth-ſide of it there is a bank, that has the ſame direction. The brook, making a circular turn to the north, leaves a piece of ground betwixt

* ROCAS, a man of character, relates, that, following a hot ſpring under ground, he diſcovered, in a few days, the mineral bed, where the water turned warm; and beyond that found it cold.

twixt the bank and itſelf. In this ſpot the well lyes, juſt at the bottom of the bank, and about thirty paces from the brook. The pipes, out of which the water iſſues, are about three foot higher, than the ſurface of the brook, in the ſummer time; ſo that none of its water, probably, ever gets into the well.

THE old well, that was firſt diſcovered, in the 1747, by ſome people ſtraying that way, is cloſe by the ſide of the brook. It was ſubject, ſometimes, to be overflowed; and, therefore, it was thought proper, laſt year, to alter its ſituation. As it was probable that the mineral-ſtreams came from the bank, a ditch was dug along the bottom of it, to catch them: but on carrying it further weſt, than the well is ſituated, at preſent, none could be found. There are ſeveral reaſons, however, that lead me to think, that thoſe ſtreams, which ſupply the well, come from this bank, but lying deep, the ditch could not reach them. On digging

northwards, from the bank to the rivulet, the ſtreams were found in great plenty oozing out from a ſandy bottom. Theſe being collected into one reſervoir, whoſe ſides are ſecured with clay, and its bottom with ſtones, conſtitute the well. The ſtreams, that ſupplied the old well, have been caught, becauſe it ſeparates but little water now. The water of the new well is ſtronger than that of the old.

THE bank is about twelve foot high. The firſt *ſtratum* is of earth, and is ſix foot thick. Next comes a foot and a half of clay marl. The reſt is a ſandy ſoft ſtone, that effervesces a little with vinegar. On calcining * this ſtone, ſome particles were attracted by the magnet, and diſcovered themſelves to be iron. The marl deſerves our conſideration: but it will come better in † under the article of earth.

THE

* Keeping it in a ſtrong fire for ſome time. † Vid. Part 2. Sect. 5.

THE ſun can have no effect on the water, as the well is covered with gravel. No winds can eaſily reach it, but the north weſt and eaſt, which blow along the channel of the rivulet. It is neceſſary to mention its ſituation in reſpect of the winds; for theſe have been obſerved to affect, greatly, all waters. *Hippocrates* † has long ago made this obſervation. It is very remarkable in the ſpaw-waters: inſomuch, that the *Ligeois*, whoſe daily bread depends on the bottling of it, ſuſpend their labour, when certain winds blow. Thoſe waters, that are, thus, affected by the winds, muſt run, I imagine, near the ſurface, for a little way, before they appear; and, according as the ground is more, or leſs, opened, the volatile parts of the water are more, or leſs, diſſipated. This is the only account, my lord, I can give you of a phœnomenon, neglected by all the writers, yet known to every water-carrier about the Spaw. Laſt ſummer ſome imagined they perceived *Dunſe*-water ſtronger in the weſterly,

† Hippocrates de aere, aquis et locis.

ly, than the eaſterly winds. But with the former there was a long tract of dry weather; and, with the latter, rain came. As the water is, evidently, affected by dry and rainy weather, the change was, more probably, owing to this, than to the alteration of winds. Length of time, alone, can determine the truth of ſuch obſervations. The eaſterly winds blow juſt againſt the pipes, and may, perhaps, penetrate and affect the water. If this is obſerved to be the caſe, it may be, eaſily, remedied.

THE north pipe pours out forty two pounds of water in a minute, and the ſouth thirty ſix, in the ſame time. This makes in the whole ſeventy eight; ſo that, in twenty four hours, it ſeparates 112,320 pounds.

THERE is a bluiſh ſcum, or pellicle, appears, in great quantity, on the ſurface of the old well. The ſame is ſeen, where the water of the new well ſtagnates, or when allowed to ſtand at reſt in any veſſel. There are no fumes,

fumes, or volatile parts, to be diſcovered, any where on the ſtones, that ly over the old well. There is an okery red matter depoſited all over the bottom. So that the ſtones, on which the water falls from the pipe, are tinged with a red colour. The glaſſes, that are in uſe at the well, ſoon, gain a dusky yellowiſh colour, from the ſubtiler parts penetrating, and remaining there. The corks of bottles, that contain the water, are, commonly, turned black.

THE water, when taken up in a glaſs, ſparkles a little, and emits a few air bubbles. Some of them riſe two inches above the water. Air, then, is, already, diſcovered to be one of its principles.

ITS colour is like fine rock-water. The ſmell and taſte ſeems, to ſome, entirely ferruginous, and to come from the mineral; to others, a little on the gun-powder; to moſt, very pleaſant.

IT has been an uncontroverted opinion, ſince the days of *Hippocrates*, that the heavieſt

vieſt water is the worſt, and the lighteſt the beſt. This is a good general rule as to common water; tho' even, there, it meets with ſome exceptions. Snow water is the lighteſt of all, and, perhaps, the moſt unwholeſome. Its unhealthful effects appear too plainly on the inhabitants of the *Alps*. But this rule is ſtill liable to more objections in mineral waters. Many of them, we find, are heavier than common water. Moſt of them would, perhaps, be ſo, if it were not for the great quantity of air they contain. Nor is it at all ſurpriſing, that the weight of water ſhould be augmented, by minerals, and foſſils, that ſurpaſs it, ſo much, in their ſpecific gravity. A great part, nay the whole of their medicinal virtues, may depend on theſe weighty particles. It will, afterwards, appear, that the weight of *Dunſe*-water is owing to ſome fixt ſteely and terreſtrial particles; for, on their ſeparation and falling to the bottom, the elemental water ſhews itſelf to be very light.

* *Hoffman*,

* *Hoffman*, obſerving that the mineral waters of *Germany* were lighter when juſt taken up, than after they had been kept ſome time, imagined that all experiments, to diſcover their weight, were fallacious. The hydroſtatical cylinder he uſed, that has a neck marked with different degrees, is, indeed, not the moſt accurate inſtrument. He imagined its deſcent was hindred by an expanſive aëreo-ethereal principle in theſe waters, that, by endeavouring to take up a greater ſpace, gave them a falſe lightneſs. I confeſs, my lord, this reaſoning does not appear to me ſo concluſive; for, I imagine, this expanſive principle, acting in oppoſition to gravity, muſt, ſoon, have its action, upwards, deſtroy'd; and, conſequently, a balance and equilibrium of the whole maſs will, immediately, follow. The real air-bubbles, that mount up, ſtriking, with a force, the bottom of the hydroſtatical glaſs, immerſed in the water,

* De principiis et virtutibus præcipuorum medicatorum Germaniæ fontium, parag. 33. And, de fontis Spadani, et Swalbacenſis convenientia, parag. 14.

water, muſt hinder it, in ſome meaſure, from ſinking. This ought, indeed, to be conſidered: nor ſhould the gravity of any water be meaſured till theſe have expended themſelves. After this, it will admit as much certainty, as any other fluid. The ſpherical glaſs with ſcales is, certainly, the beſt inſtrument.

It is, likewiſe, neceſſary to examine the degree of heat in all mineral wells; for, from this, alone, we diſtinguiſh them into Thermæ and Acidulæ, or, in other words, hot and cold waters. The other diſtinctions, that are given, by authors, from different ſalts, metals, or ſulphur, are very unaccurate; becauſe all the three may, and do, ſometimes, exiſt in the ſame water. On the 16th of *June*, about half an hour after three in the afternoon, when the atmoſphere was heated to the 68th degree of *Farenheit*'s thermometer, the mercury, on putting it in the well water, fell to the 59th degree. A ſpring, at a little diſtance, on the

the other ſide of the brook, that was expoſed to the ſun, reduced the mercury to 54 degrees: on the 3d of *July*, which was a cloudy day, the ſame experiment was tried over again. In the atmoſphere, the mercury ſtood at 72 degrees; in the mineral well at 59; and in the ſpring at 54. Thus, by both theſe trials, *Dunſe*-water appears 5 degrees hotter than a ſpring expoſed to the ſouth: nor had the alteration of the atmoſphere any effect on either of them, About the end of *October*, after it had froze ſome days, and the ſtanding pools were covered with ice half an inch thick, the mercury, in the thermometer, immerſed in *Dunſe*-water, ſtood at 48 degrees. This ſpring appears, therefore, to have a certain degree of natural heat, independent of the atmoſphere; and deſerves to be claſſed betwixt hot and cold *Spaws*.

THE queſtion, how the Thermæ receive their heat, ſeems ſcarcely yet well reſolved by naturaliſts. It has been attributed to hot

vapours, mixing with theſe waters; to a violent motion in the water below ground; to its meeting with a calcarious earth; to putrefactions; to fermentation of oppoſite ſalts: but all theſe accounts are without any ſhew of reaſon. Some have made actual fire the cauſe of it, from obſerving volcano's in different parts of the earth; in *Iceland*, as well as *Italy*. Thoſe, near the volcano's, may, perhaps, be of this kind; as that in the *Campo Volcani* betwixt *Puteoli* and *Naples*. But, we know, this cannot be the caſe with the more diſtant ones: for actual fire never can ſubſiſt without a communication with the external air. Others, with more reaſon, attribute the heat to the accidental meeting of ſulphur, ſteel and water; for, theſe ingredients, mixed in a certain proportion, produce ſuch a degree of heat, as often ends in a flame. This may be allowed to be the caſe in ſulphureous waters, but can never be admitted in thoſe that have no ſulphur. Some hot waters there are of this kind. *Borcet*, which is the hotteſt

at

at *Aix*, and takes, if I remember right, nine minutes to boil an egg hard, contains, as we are told by writers, no ſulphur. Beſides; as vitriol of iron is always got, from the materials, when joined by art, we ought to expect it, likewiſe, from thoſe mixed, in the earth, by nature. But none has, ever, been procured from theſe ſulphureous *thermæ*.

THE moſt rational account of this affair ſeems to be, the natural heat of the more central parts of the earth, communicated to theſe waters, that riſe, directly, from the deeper parts. That the earth has a natural heat of its own, diſtinct from the external heat of the ſun, is very certain; for we find, in the bottom of mines, a much greater degree of heat, than there is at the ſurface when the weather is cold: the deeper we go, the heat increaſes the more. Whether this is owing to any attrition about the central parts; or to ſome other cauſe, I ſhall not pretend to determine. But it ſeems, evidently, to be a

heat

heat without a flame, and of the nature of that, which is formed by the attrition of hard bodies.

THE ſmall degree of heat, in *Dunſe*-water, may be accounted for from another cauſe. When ſteel is corroded by the acid of vitriol, we obſerve a conſiderable heat ariſe. Other bodies, that diſſolve ſteel, may have the ſame effect.

WE ſhall have occaſion, afterwards, to ſhow, that ſteel is diſſolved by water. To diſcover whether any heat was produced by the meeting of theſe two bodies, I put, on the 19th of *December*, two ounces of common water, and an ounce and an half of the pure filings of iron into one vial, and two ounces of water into another that was of the ſame ſize. Theſe two vials were corked, and ſet together, in the cooleſt part of the room. Next morning, a thermometer being immerſed in the vial, in which the iron and wa-

ter

ter were contained, the mercury ſtood at the 52 degree; when put into the vial where the water was, the mercury fell to the 51 degree. In the evening the mercury ſtood at the 54 degree in the former, and at 53 in the latter. Next morning the contents of both vials were of an equal heat. The water, in which the ſteel was infuſed, was now of a pale red. This laſt water I poured out, and put in as much freſh. In the evening the infuſion of ſteel was a degree hotter than the water alone. I, then, added to the former another half ounce of the filings of iron, and to each vial two ounces more of water. Next morning the infuſion of ſteel was an half degree hotter than the water in the other glaſs. The day after the mercury ſtood at the 48 degree in the water, but aroſe to the 50 degree, when immerſed in the infuſion. Theſe ſeveral trials incline me to believe, that a ſmall degree of heat, ſuch as that in *Dunſe*-Spaw, may ariſe from the ſolution of ſteel by water.

THIS

THIS water is obſerved to alter, greatly, for the worſe, in rainy weather; owing, no doubt, to the rain, that falls about the well, mixing with the mineral ſtreams, and ſo diluting them. This inconvenience might be obviated, by making the ſurface of the ground, in which the well is ſituated, ſlop to the brook; or carrying the rain off, as it falls, by hidden drains.

SECT. III.

THERE is a method, my lord, that chymiſts follow, to come at the knowledge of the principles of mineral waters, while they are, yet, mixt together. They apply to them different bodies, both ſimple and compound; and, from the different effects of that application, form a judgment of the contents. We ſhall call this method, as it has not, yet, got a name, the proof by *Commixtion*.

THE

THE examination of the effects, that bodies have on one another, is the examination of the univerſe: for the whole ſyſtem of material nature is carried on by the mutual operation of bodies. Its regularity is maintained by the conſtancy of theſe effects; which regularity muſt always ſubſiſt, while bodies are, what they are, at preſent. We are apt to neglect, or overlook thoſe changes, that, every moment, preſent themſelves to our eyes. It is, only, the uncommon, tho' not the leſs natural, that force our attention, and ſurprize us.

THERE is not, indeed, a more agreeable ſcene, in all natural philoſophy, than the ſtrange effects that are produced from the mixture of certain bodies. Some that are naturally cold turn * hot, upon their mixture, and burſt into a flame, while others produce

* Sulphur, mixed with filings of iron, and baked into a paſte with water, will, if covered with earth, take fire. Spirit of nitre, poured on any diſtilled vegetable oil, raiſes, inſtantaneouſly, a flame. The regulus of antimony, mixed with ſublimed mercury, will, often, take fire.

produce the intenſeſt degree of * cold that we know, tho' ſeparately they contain no great degree of it. Between ſome there is a ſtrong attraction; while others † repel, with ſuch force, as to endanger the lives of theſe preſent. Some have effects in a ‡ *vacuum*, that they have not in the air.

THERE can be no objection to this method of proceeding, by experiments of commixtion, as it depends on the unchangeable conſtitution of bodies; if the effects, reſulting from it, are, juſtly, and accurately, aſcertained. 'Tis true, ſome particular ſubſtances may be there, tho' the experiments of commixtion

* AMMONIAC ſalt, managed in a certain way, produces an intenſe degree of cold. Spirit of nitre, poured on ice, makes it much colder.

† IF braſs in fuſion is thrown into water, or a drop of water allowed to fall on it, the whole is ſcattered about, with great force, and horrid noiſe. The effects of this experiment ſeem greater than the exploſion of gun-powder. But, happily, it can never be made uſe of to the deſtruction of mankind.

‡ SPIRIT of nitre and filings of iron fulminate in vacuum.

mixtion do not diſcover them. They may exiſt in ſo ſmall a quantity, and ſo diluted with water, as not to have the degree of proximity requiſite to produce their uſual effects. But this, only, leads us to be cautious, how we deny their reality when they do not appear. It does not make the determination leſs certain, when they do. If we are at pains to fix the conſtant effects of theſe bodies, our judgment muſt be as certain and unchangeable, as the laws of nature.

How much the effects of theſe very common experiments ſtand in need of being fixt, every one, that has looked into the authors on mineral waters, muſt have obſerved. There is ſuch a confuſion on this ſubject, that, from the ſame experiments, very * different conſequences are drawn. To be aſ-

 ſured

* I ſhall only mention one inſtance of this among many. From a lacteſcency, or ſediment, on mixing oil of tartar p. d. with a mineral water, ſome have concluded, that it contained nitre; others ſea ſalt; others ſulphur; others calcarious earth.

ſured of a juſt concluſion, we muſt be aſſured of a juſt experiment on bodies ſeparately. It is neceſſary, therefore, my lord, to inform you of my intention in each experiment; deſcribe what would happen, if certain bodies had been, there, in ſufficient quantity; and explain, ſo far as I am able, the reaſon of theſe effects in compound bodies: for, in the ſimple, we can go no further than this; that ſuch is the will of the Author of nature.

* *Hanc rerum ſeriem ligat,*
Terras ac pelagus regens,
Et cælo imperitans Amor.

As the contents of mineral waters are either different ſalts, minerals, ſulphur, or earths; ſo theſe ought to ſerve as guides in our trials: and we ſhall accordingly examine them in that order. The experiments, that do not come under theſe heads, ſhall be conſidered by themſelves.

I. SEA

* BOETIUS de conſolat. philoſophiæ, lib. 2. metrum 8.

I. SEA ſalt is, almoſt, the only one, that ſhows itſelf in the proof by commixtion. Nitre may be diſcovered by making fleſh red, and when brown paper, dipt in the water and dried, becomes a match. But, to produce theſe effects, it muſt be in conſiderable quantity. Beſides; it is doubted, by many, whether it can ever be found in mineral waters, as it is the product of art and not of nature. To this ſentiment, however, I cannot agree. For the experiments on the mineral waters of *France*, performed before the academy of ſciences, diſcover that ſalt; and, as there is nothing improbable, in ſuppoſing it to be waſhed from the ſurface of the earth, where we know it is formed, and, by that means tincturing a ſtream, I ſee no reaſon why we ſhould reject it.

1. A SOLUTION of quick-ſilver in ſpirit of nitre formed, when mixed with *Dunſe*-water, a white cloud, which, after ſome minutes, fell to the bottom in form of a white ſubſtance.

ſtance. The ſame happened with common well water. But no change was made on diſtilled water.

2. A SOLUTION of ſilver in ſpirit of nitre produced a milkineſs or lacteſcency. The ſame happened with common well water. It produced no alteration on diſtilled water.

THESE two experiments give us, already, a great probability, that there is a mixture of ſea ſalt in *Dunſe*-Spaw; tho' not more, nor even ſo much, as in well water. The ſame experiment ſhould, always, be repeated on common and diſtilled waters, that we may ſee, whether the change ariſes from the water itſelf, or its foreign contents. It is the nature of ſea ſalt to precipitate ſilver, or quick-ſilver, When diſſolved in ſpirit of nitre, by turning the ſolution into an *aqua regia*, which we know rejects theſe bodies, and diſſolves gold alone. Whether this change happens, from a ſtronger attraction betwixt the ſpirit of nitre and ſea ſalt, than betwixt that

ſpirit

ſpirit and the metals that it has, already, diſſolved, or by ſome other power, is not yet determined.

IN making experiments with theſe and corroſive ſpirits, care muſt, always, be taken that the phials, which contain them, be ſtopt with glaſs ſtoppers; for theſe ſpirits corrode cork, and ſo produce an oily-like ſubſtance, that ſwims on the top, and, being mixed with waters, gives a falſe milkineſs to them. I was deceived myſelf, at firſt, in this way.

II. OF the mineral kingdom, copper and ſteel, alone, are allowed to tincture waters, becauſe theſe metals, alone, are found, in the bowels of the earth, corroded by an acid. But I ſee no reaſon, according to this very plan, why lead ſhould be excluded from that number, ſince it is ſo, eaſily, diſſolved by all acids. It will appear, afterwards, that all the other metals may impart their ſubtile particles to water. Quick-ſilver may with juſtice put in its claim; for we find it communi-

cates

cates ſomething to water, when ſhaked with it, that has, as a medicine, conſiderable virtues. But theſe queſtions we leave to be determined by future ages, which will have more facts to build on.

3. COPPER, when diſſolved by an acid, is diſcovered on putting a piece of iron into the ſolution. The particles of copper are not ſo ſtrongly attracted by the acid, as thoſe of iron; they are therefore let fall, and, by degrees, covering the plate of iron, give it a copper-colour. Several ſprings in * *Hungary* diſcover a copper by this method. This experiment was tried with *Dunſe*-water, but no change of colour happened to the iron. *Moffat* contains copper, in no inconſiderable quantity, but does not ſhow any on this trial. It is, therefore, probably, not diſſolved, there, by an acid; but exiſts in its natural form.

STEEL was the next object of my ſearch.

4. THE

* Vide Hoffman. de elementis aquarum mineralium recte dijudicandis et examinandis, parag. 44.

4. THE powder of Ballauſtine flowers gave *Dunſe*-water a purple colour. That of Sumach a browniſh red. That of Pomegranate the ſame. That of Oak-bark a deeper. Green tea turned it purple. * A tincture of Galls ſtruck the deepeſt purple. I found a certain quantity of the tincture was required to give it its deepeſt colour, and, when more than that was added, the colour turned lighter. Four drops of the tincture was the proper quantity to four ounces of the water; when forty was put in the ſame quantity, it was of a *Burgundy* colour.

IT is neceſſary, in order to compare the colours of different waters, that we ſhould have ſome method of fixing the colour. No words can, ever, convey the idea of theſe changeable ſhades. Nothing, but an exhibition of the ſame colour to the eye, can ſerve the purpoſe. This may be done with the ſalt

* The tincture, I made uſe of, was an ounce of boiling water poured on a drachm of galls, and allowed to ſtand an hour, then ſtrained thro' brown paper.

ſalt of ſteel. One grain of this was diſſolved in ſixty drops of common water. Six drops of this ſolution, added to four ounces of common water, in which was put, before, its proportion of the tincture of galls, ſtruck, preciſely, the colour of the mineral water. As the ſalt of ſteel, when rightly prepared, is always the ſame, a perſon in *China* may know the colour, in this way, as exactly as one at the well, and ſo compare it with the mineral waters there.

WHEN any water turns purple with theſe aſtringents, it is looked on as an undoubted mark of its containing ſteel. Nor, indeed, does there appear an objection of any force againſt this concluſion, ſeeing it is the only body known, on which theſe aſtringents have this effect. A late * author has given us a very ingenious theory to account for this phœnomenon. He imagines, that theſe aſtringents have an abſorbent power, by which they attract the acid that has diſſolved the iron,

* Dr. SHAW.

ron, and ſo leave the ſteely particles to float, by themſelves, in the liquid: theſe being black muſt, neceſſarily, give their colour to the fluid. The ſame thing happens in making ink with galls, water, and coperas, which is ſteel diſſolved by an acid. The galls attract or abſorb the acid, leave the irony particles at liberty to exert their natural colour, and ſo produce ink. This reaſoning he confirms by obſerving, that if oil of vitriol be added to any of theſe mixtures, made black with galls, they turn pellucid; becauſe there is, now, more acid than the galls can abſorb, and the remainder joins itſelf, again, to the ſteel.

WHAT the poet ſaid, my lord, of human life, may be as juſtly applied to theories:

* *Nihil eſt ab omni*
Parte beatum.

THERE is, generally, ſome little flaw, that renders the jewel of leſs value. I have never

* HORAT. lib. 2. od. 16.

been able to diſcover any attraction, or abſorption betwixt galls and acids. The experiment was made with both mineral and vegetable acids, but I never obſerved any attraction betwixt them, or that the acidity was, in the ſmalleſt degree, blunted by the galls. If it be ſaid, that the acid may be attracted, without being blunted, then mineral waters, and ink ſhould diſcover an acidity, after the galls have attracted the acid from the iron. But what ſeems, yet, a ſtronger argument againſt this theory, and ſhows, to the eye, that the acid is not concerned, is this: rub the filings of iron, galls, and diſtilled water, together, in a mortar, a black liquor, in half a minute, is produced. The reaſon then of this phœnomenon in ſteel waters, I chuſe, rather, to attribute to ſome change, wrought on either the ſteel, or galls, (for 'tis uncertain which) by the other, ſo that it is able to reflect the black or purple rays of light. What the change is, that makes them capable of reflecting theſe colours, ſeems a ſpeculation

culation too minute, for us, ever, to arrive at any degree of certainty with regard to it. We muſt, therefore, leave theſe theoretical points, for the more certain road of experiment.

Dunſe-water turned ſome kind of brandy black, whi~~ch~~, with another kind, it made no alteration. To alter the colour, I was told, was a proof that the brandy was good. On inquiry I was informed, that brandy was, often, brought home in oaken casks. The ſpirit, in that caſe, had drawn a tincture from the oak, and diſcovered it by its turning black with the mineral water. The longer time the ſpirit has been kept in the oaken cask, the deeper muſt the tincture be.

III. THE next experiments were made in purſuit of ſulphur. This is, often, difficult to be diſcovered; tho', in the opinion of a great * Chymiſt, oftner ſuſpected, than really exiſting

* HOFFMAN. de elementis aquar. miner. parag. 53. Pauciſſimæ enim calidarum ſoſpitalium aquarum ſunt, quæ ſulphur vehunt,

exiſting in theſe waters. It may be, there, in different ſhapes: in its native form; or diſſolved by an alkaline ſalt; as a volatile body; or as a fixt. The trials, to find out the fixt ſulphur, come in, more properly, in another place.

6. IF there was any volatile native, or diſſolved ſulphur, it would be found, ſublimed, on

vehunt; et ſi Aquiſgranenſes, et paucas forſan alias, excepe-ris, vix umbram ejus deprehendes. Sunt quidem plurimi, qui Carolinis, Wisbadenſibus et Emſenſibus, ſulphur affin-gunt, lepidam ſomnii a colore croceo, quo induſia alba in balneo inficiuntur, rationem cogentes, ſed longe alia eſt hu-jus tincturæ ratio, et mihi tam felici eſſe non contigit, ut ex his plurimiſque aliis ſulphur eruere et denudare potuiſſem, li-cet ſummo ſtudio et quæſitiſſimis artificiis examen inſtituerim. Eſt quoque fons fœtens et inurbani admodum, ovorum putri-dorum inſtar, odoris, in confiniis Frankofurti ad Mœnum, et qui ab ipſo perfluere putatur, in ipſa urbe, vernaculo vocant *den Faul-bran*. Hic egregia laxante virtute pollet, et in fe-bribus ad ſitim ſedandam avide ab ægrotantibus hauritur: ſed adornato curioſe ejus examine, pariter nihil plane ſulphu-ris in eo reperiri licuit. Notæ autem et characteres qui for-malis ſulphuris præſentiam produnt et arguunt, ſunt: ſi a-quæ argentum fuſco vel nigro inficiant colore, et poſt omni-modam liquoris exhalationem, concrementum relinquunt in-flammabile, quod cum ſale Tartari in hepar ſulphuris tran-ſit.----Such is the opinión of as great a chymiſt as ever has been.

on the ſtones, above the old well: but no ſuch thing can be obſerved. Sulphur is collected, in this manner, at *Aix*, in conſiderable quantity.

7. A PIECE of ſilver was kept a month in the water, but there was no change of colour, when taken out. The *Aix*-waters, in a few hours, turn ſilver firſt brown, then black.

THIS change of colour in ſilver is the moſt certain criterion of a ſulphur-water; and, where it does not happen, in a ſufficient time, the exiſtence of ſulphur is to be much ſuſpected. I was convinced of the truth of this by ſeveral experiments. Three grains of ſulphur, diſſolved by an alkaline ſalt, was mixed with five *Engliſh* pints of water. This ſolution was pellucid, and was ſo weak, that it had no ſulphureous ſmell: yet, in two hours, it tinged ſilver brown. The ſame quantity of ſulphur, in ſeven pints of water, made no change on the ſilver. Thus,

we ſee an inconſiderable quantity, even after it has loſt its ſulphureous ſmell, will diſcover itſelf by this experiment. A ſmaller portion than this ſcarce deſerves our notice. What ſhall we, then, think of waters, that ſeem to have a ſulphureous ſmell, and yet do not alter the colour of ſilver? This leads us to think, it is owing to ſome other cauſe.

NOTHING, that we know, can make ſulphur diſſolvable in water, but alkaline ſubſtances. It has been doubted, from this, by many chymiſts, whether ſulphur could ever be found, in mineral waters, without an alkaline ſalt. And, indeed, not without reaſon; for the two famous ſulphur-wells, *Aix* and *Geronſter*, have both an alkaline ſalt. To diſcover whether this was the caſe with *Dunſe*-ſpaw,

8. SPIRIT of nitre was mixed with it; but no change happened.

WHEN ſulphur is joined with an alkaline ſalt, and plentifully diſſolved in water, the mineral

mineral acids turn the ſolution milky. The reaſon given for this change is, That the alkaline ſalt is, more powerfully, attracted by the acid, than by the ſulphur, to which it before adhered, and ſo quits it: the ſulphur, left to itſelf, gives the liquid a milky colour, and falls, at laſt, to the bottom. But I muſt, freely, own, that on trying this experiment on ſuch a ſtrong ſolution of ſulphur, firſt opened by an alkaline ſalt, that the mixture tinged ſilver in ten minutes, and turned a ſolution of ſilver, in ſpirit of nitre, brown; this ſtrong ſolution of ſulphur, I ſay, was not in the leaſt altered by a mixture of the ſpirit of nitre. Thus far our endeavours to diſcover a ſulphur have been unſucceſsful.

IV. MY next experiments were made to diſcover an earth.

9. A ſolution of ſugar of lead in water was allowed to ſtand ſome weeks. A reddiſh tincture was, by this means, drawn from it,

it, which is much better than the ſimple ſolution; for that, being white, will give a falſe milkineſs to every liquor. This was mixed with *Dunſe*-water, and gave to it a reddiſh colour. In a few minutes a red ſediment was precipitated.

FROM this experiment I conclude, that there is an earthy principle in this water. That this concluſion is juſt, appears from the following trials. The ſame ſolution, mixed with rain water, made no precipitation. In rain water I diſſolved ſome common earth, and, after it had ſettled, poured the water off. Into this water the ſolution of ſugar of lead was dropt: in a few minutes a red ſediment was formed. The ſame experiment was repeated with the different kinds of marl, and it always ſucceeded in the ſame way: only there was a little difference in the colour of the different ſediments.

THE theory of theſe experiments ſeems to land in this; That there is a greater attraction

traction betwixt the abſorbent earth, of which there is a good quantity in all common earth, and the acid, than betwixt this laſt and the lead; for the ſugar of lead is a compoſition formed by an acid, corroding lead. That I might diſcover if this ſolution was affected by ſea ſalt, ſome of that ſalt was diſſolved in rain-water, and the ſolution poured on it. A milkineſs and precipitation followed. According, therefore, to the different effects of this experiment, different concluſions are to be drawn.

10. OIL of tartar *p. d.* being mixed with *Dunſe*-water, no lacteſcency happened, but a little whitiſh ſediment was ſeparated.

THIS ſhows, likewiſe, a terreſtrial principle in the water. The following experiment is a proof of it. Some earth, diſſolved in rain-water, was allowed to ſtand till it it ſettled. The clear water was poured into a glaſs. This, on ſtanding for ſome time, did not let fall a ſediment: but when I dropt

into it ſome oil of tartar *p. d.* a precipitation was made in two minutes. This experiment is, often, brought as a proof of ſea ſalt; it, therefore, needs to be ſet in a clear light. When a conſiderable quantity of ſea ſalt is diſſolved in water, if oil of tartar *p. d.* is poured on the mixture, it, immediately, turns milky, and is, ſoon, divided into white clouds, which all mount to the ſurface like an oil: this, at laſt, falls down, and forms a white cloudy ſediment. But ſea ſalt muſt be in conſiderable quantity to have this effect. Thus, the ſucceſs of experiments, to diſcover ſea ſalt, or earth, ſeems very different. Oil of tartar *p. d.* makes no change on nitre diſſolved in water, and therefore, it is ſurpriſing that it ſhould, ever, have been brought as a proof of nitre. Nor does it affect a ſolution of ſulphur, firſt opened by an alkaline ſalt.

V. 11. My next deſign was to diſcover, if there was any acid, or alkaline principle, in this water. On mixing oil of tartar *p. d.* with

with it, there was no inteſtine motion: therefore it contains no acid. Altho' all cold mineral wells are called *Acidulæ*, yet there has never any acid principles been diſcovered in them. *Hoffman* firſt ſet the world free from this miſtake. The ſubtile ſpirit of the *German*-waters, that affects the palate with a kind of ſharpneſs, led mankind firſt into that miſtake. This muſt, generally, be the caſe, when the proof depends on the ſenſes alone.

12. To diſcover if any of the principles were of an alkaline nature, diſtilled vinegar was mixed with it: no efferveſcence happened; only a few air-bubbles aroſe. Aqua fortis poured into it raiſed no inteſtine motion, but produced more air-bubbles. The ſame happened with ſpirit of vitriol. With oil of vitriol it efferveſced a little; but nothing can be drawn from this experiment, as the ſame happened, on trial, with common water. Altho' there does not appear any inteſtine motion in theſe experiments, yet the ſeparation of air-bubbles is a proof of ſomething gently alkaline.

alkaline. This is confirmed by the following experiment.

13. Syrup of violets was mixed with the mineral and common water. The ſyrup mixed with the firſt was greener than with the laſt: for, it muſt be remarked, that this ſyrup, when diluted with water, always, takes a greeniſh colour.

VI. SOME general experiments follow.

14. To diſcover whether the water was of a ſoft or hard nature; I tried it with ſoap, and found, that ſoap was, eaſily, diſſolved in it, when cold. I was told that this mineral water, after it had paſſed thro' the human body, and had been kept ſome time, waſhed like ſoap. The water, itſelf, turns linen yellow; an effect common to all ſteel waters.

15. To try if there was any thing in it hurtful to amphibious animals, a worm was put

put in the mineral water; it died in two hours. Another put into common water, for the ſame time, was not, in the leaſt, affected.

16. Six minnows were put into a glaſs of *Dunſe*-water: they ſeemed very uneaſy, breathed hard; came to the ſurface; and, often, leaped over the glaſs. Two died in an hour and a half; other two in three hours; the reſt ſeemed, at that time, very ſick. When the water had loſt its ſpirit, I obſerved that they recovered, and turned ſick, again, on the addition of freſh water. This effect is common, ſo far as I know, to all ſteel ſprings.

MY next trials were in the apothecary-way.

17. Two equal quantities of rhubarb were put into two ſeparate phials. *Dunſe*-water was poured into one, and common water into the other. After ſtanding twenty four hours,

hours, the mineral water drew the deepeſt tincture. The ſame experiment was made with *Dunſe*-water, after it had loſt its ſpirit, but this tincture was no deeper than that with common water.

18. THE ſame trial was made with ſenna, and the ſame thing happened.

19. BUT with ſaſſafras, the taſte, colour, and ſmell, were the ſame in both.

THESE experiments are, commonly, brought as proofs of an alkaline ſalt; for that, powerfully, diſſolves the reſine in theſe bodies. But, here, the diverſity of colour can be attributed to no ſuch cauſe. A volatile ſpirit ſeems, by the firſt experiment, to have the chief hand in it.

ITS effects on animal ſubſtances were next tried.

20. Upon equal quantities of fleſh, equal quantities of mineral and common water were

were poured. It was hot weather, ſo that both, in two days, ſmelt ſtrong. The fleſh, in both, ſeemed of the ſame colour.

21. THE ſame experiment was tried with urine. The mineral, four days after, was a degree lower in the ſtraw colour, but had a ſtronger ſmell.

22. WHEN the ſame trial was made on blood, the mineral drew a deeper tincture from it. After they had both ſtood ſix days, the mineral was ſtill reddiſh towards the top, but the common water, altho' it contained more ſea ſalt, was quite black. The firſt ſmelt but little; the other ſtunk abominably. *Dunſe*-Spaw would ſeem, by this laſt, to be an enemy to putrefaction.

23. UPON milk warmed, it made no alteration. This is a very material experiment in all waters, as to their uſe. The curdling of milk ſeems, in mineral ſprings, to depend on their neutral ſalt. This is evident from the

the *Scarborough*-Spaw. And now, my lord, enough, I think, is done in the way of commixtion: more would, perhaps, be tedious.

SECT. IV.

WE ought not to reſt contented with a view of mineral waters, when juſt taken from the well, and in their beſt condition. We ſhould obſerve what changes they undergo by time; what parts fly off; what remain; and what happens to theſe, both before and after putrefaction. This is a kind of natural analyſis, that theſe waters undergo, by which we diſcover parts, that, otherwiſe, we could never have ſeen. It teaches us ſeveral truths very uſeful to medicine and philoſophy. It has, hitherto, been too little regarded.

1. *Dunſe*-water, expoſed to the air, gathers a ſcum in a little time. Great plenty of this is found on the old well, and where the water of the new ſtagnates. I could never obſerve

obſerve any on the water, when put in bottles well corked and waxed over. This might, perhaps, be owing to the carriage.

2. A RED ſediment is ſeparated, in great plenty, from the water, wherever it runs, ſo as to tinge all the ſtones red. The ſame happens when the water is bottled for ſome time.

3. AFTER the water has been kept twenty four hours, it loſes its white colour, and turns, remarkably, bluiſh. The ferruginous taſte is, then, gone; and the mineral water appears, to the palate, in no way different from common water.

4. IF the water is expoſed to the open air, for twenty minutes, it takes but a very light colour with galls. When it had ſtood two hours and an half, no alteration was made on it by the tincture. The heat of the atmoſphere was, then, at the 68th degree of *Farenheit*'s thermometer.

5. SOME of it was kept, for half an hour, in a heat, equal to that of the human body. It took, then, no tincture from galls. Twenty minutes in boiling water, or, perhaps, much leſs time, deſtroys the tincturing quality likewiſe.

6. SOME bottles of *Dunſe*-water, well corked and waxed over, were carried five miles from the ſpring. When opened the water took no tincture. I found, however, afterwards, that ſome of this tincturing principle could be retained, if the bottles, even unwaxed, were carried with their necks downwards.

THESE experiments ſhew us, that the ſteely principle, very quickly, diſappears. Whether it flies off, or is changed, will be the ſubject of a future inquiry. This water ſeems to loſe it ſooner than any yet deſcribed. Authors, indeed, have been a little inaccurate in this point; our ſurprize muſt be

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the greater, ſince, from this ſteely ſpirit, they deduce moſt of the medicinal virtues, that theſe waters have. * *Hoffman* ſays, "That "the *Pyrmont* water loſes, in twenty four "hours, its power of ſtriking a tincture with "galls, when expoſed to the open air." Yet we know, that this ſpirit can be detained, for years, in bottles well corked. † *Liſter*, ſpeaking of the *Bath*-waters, ſays, "That in "frofty weather, they preſerve, for a long "time, their tincturing quality, but loſe it, "ſoon, in thaw: yet, when well bottled and "corked, they preſerve it for many days." ‡ Dr. *Shaw* tells us, "That *Scarborough*-"water, expoſed, loſes its power of receiving "a tincture from galls: yet it carries in bot-"tles." But the time he has not mentioned. In another place, "nor does the mineral ſpi-"rit, or light irony principle of the *Scarbo-*"*rough*-ſpaw water appear to be, extremely, "light and volatile." There is a ſpring in *Miſnia*, deſcribed by *Hoffman*, that ſeems to have

* De principiis et virtutibus præcipuorum medicatorum Germaniæ fontium. † P. 233. ‡ P. 91. and 145.

have a ſpirit of equal ſubtilty with *Dunſe-ſpaw*. We ſhall have an occaſion, * afterwards, to deſcribe this laſt mentioned mineral water.

AFTER the ſteely principle has diſappeared, the water ſeems, on trial, to be the ſame as to its other effects. It appeared to differ only in its ſpecifick gravity. The ſame inſtrument, that I uſed before, weighed ſix grains more, after the oker was depoſited, than in water where the principles were yet intire. Thus it becomes the ſeven hundred and fifty fifth part lighter than when firſt drawn from the ſpring; and the one thouſand one hundred and thirty third part lighter than the brook-water.

THE *ſcum*, or *pellicle* gathered on the ſurface of the water, by a natural ſeparation, deſerves our conſideration. Altho' it is a part, that muſt, immediately, ſtrike the eye: altho' it is a part much uſed, in different diſeaſes, by

* Vid. part 2. ſect. 7.

by thoſe that frequent mineral waters; yet, it has been, intirely, neglected by all authors. Whether they judged it too ſubtile, or too trifling a part, I know not. It is not, perhaps, ſo ſubtile, as to elude our experiments: and ſure, that ought never to be accounted a trifle, which is ſo beneficial to mankind.

7. THE *ſcum*, when yet on the ſurface of the water, has a bluiſh purple colour; but, when taken off with a ſpoon, it turns, in that very inſtant, red. After it was carried ſome miles, the mixture appeared turbid and red. Being ſet down to ſettle, inſtead of appearing, again, on the ſurface, as was expected, it fell to the bottom in form of reddiſh pellicles floating up and down. After it had ſettled, the clear water was poured off. The red ſubſtance, that remained, was tried with a mixture of galls, but no change of colour happened.

8. THE remaining water that adhered was evaporated. The powder was of a light red colour,

colour, felt fat and a little gritty in the mouth, and ſeemed to have a ferruginous taſte.

9. MIXED with galls and water, and allowed to ſtand twenty four hours, a red tincture was formed.

10. SOME of it was calcined in a crucible, for two hours; the loadſtone, attracted the whole, after it came from the fire, and ſhewed it to be iron.

THUS its nature ſeems very ſimple, and eaſily diſcovered. A ſcum, like this, is obſerved in all ſolutions of iron, whether by mineral or vegetable acids, and in the tinctures of iron made with * water. It is formed by the ſubtiler particles of ſteel, carried up to the ſurface by the continual ſeparation of air-bubbles. How minute they are, their application to the eye, without pain, plainly diſcovers. Their external effects on the human body ſhow, evidently, that they muſt enter the

* Vide ſect. 6. part 2.

the pores, and, conſequently, that they are much attenuated.

THE remaining part, that is, naturally, ſeparated from the water, on ſtanding; and is to be obſerved in bottles, after the water has been there ſome days, is called, by writers, *Oker*, *Rubrick*, or *mater ferri*. As the quantity, that I had occaſion for, in the following experiments, could not be collected from bottles; it was gathered from the ſurface of the pebbles, on which the ſtream, from the pipes, falls.

11. THE oker, being dried and reduced to powder, was rubbed with water in a mortar, but the mixture would take no tincture with galls.

12. WHEN dried it appeared like brick duſt, and taſted like fat clay. It melted in the mouth without being in the leaſt grittiſh. Some ſmall ſhining particles appeared in it. When viewed with a microſcope, it appeared

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an opaque body, without any diſtinction of parts.

13. IT did not effervesce, nor diſſolve in diſtilled vinegar, or ſpirit of vitriol. Some writers alledge, that the oker of all ſteel waters effervesces with the laſt. This is found to be the caſe with the *German* waters: therefore, they conclude it is ſo with all others. The oker, that is ſeparated from them, contains a portion of alkaline ſalt; and it is this part that raiſes a conflict with acids.

14. WHEN mixed with ſyrup of violets, it gave the mixture its own reddiſh colour.

15. BEING put on a red hot iron it ſparkled, but did not burn blue, nor emit any ſulphureous flames. In ſulphureous water the oker is found to contain ſulphur.

16. I MIXED ſome oker and ammoniack ſalt together, and ſublimed them. The ſublimed flowers were ſomewhat yellow and a little

little aſtringent. I, therefore, imagined that the ſteel was ſublimed; for it mounts, when treated in this way, with the ſalt. But no martial tincture could be drawn from it with ſpirit of wine. The tincture was evaporated, but no iron was diſcovered by the magnet. As the end of this experiment ſeems to contradict the beginning, no concluſion can be drawn from it.

17. SOME oker calcined in a coal fire, for an hour, was much redder, and attracted by the loadſtone: this was not the caſe before ignition. It was afterwards put in the ſtrongeſt heat of a ſmith's forge for an hour. When it was taken out, there were a few dark-blue gritty particles looſe, but the greateſt part was fixt, like a metallic matter, to the bottom of the crucible, and appeared like melted iron: theſe were, forcibly, attracted by the magnet. Thus, the oker ſeems to melt into iron, with a degree of heat, that is not very intenſe.

18. THE calcined oker, mixed with galls and water, and allowed to ſtand twenty four hours, produced no purple tincture. The difference, betwixt this experiment, and that with the ſcum, is worth remarking; and may depend, perhaps, on the minuteneſs of the ſteely particles, in the former.

THE oker has, generally, been looked on as the ruſt of the iron; but its viſcous taſte confutes this opinion: nor does it appear, that the ſteel ever had an acid joined to it. There is ſuch a reſemblance both of figure and compoſition, betwixt it and the ſcum, that I am led to think them the ſame. The moſt plauſible theory, with regard to it, is this. The particles of ſteel, that form the ſcum, are carried up to the ſurface of the water by the air-bubbles that are continually riſing. They remain on this ſurface by a repulſive force, that is to be obſerved betwixt ſteel and water. By the continual addition of more particles the ſpecific gravity of the ſcum is, at laſt, able to overcome the force of

repul-

repulſion: then the ſcum falls to the bottom and becomes the oker. This happened to the ſcum, as I obſerved, when mixed with water. I have ſeen theſe red pellicles hanging down, in the water, from the ſcum, and juſt ready to leave it. Theſe in their deſcent, thro' the water, carry along part of the ſalts, earths, and what other bodies there is in it. By this means, they muſt * differ in different waters;

* MONS. CHROUET is the only perſon, ſo far as I know, that has ever made any experiments on the oker of mineral waters. He has given us the compoſition of that found in the different ſprings of the Spaw.

THE oker of the Tonnilet is very red and taſtes like ſugar. It ſeems to contain ſome allum. When put on a red hot iron it burns like ſulphur, and detonates with nitre. With galls it gives no tincture, nor is attracted by the loadſtone till fuſed. No alkali is found in it when calcined.

THAT of the Geronſter is yellow and taſtes ſaltiſh. In five ounces of it he found two ſcruples of a bitter ſalt, neither acid nor alkaline, but eaſily, with a ſmall heat, going into the latter claſs. When calcined it turned red, and was attracted by the loadſtone. With galls it turned black. Some of it was boiled in water and oil of tartar, p. d. was put in; this turned it quite red. On adding warm water to this tincture, there was a precipitation of a white matter, that appeared

waters; be more impure than the ſcum; contain a leſs proportion of ſteel; and have a greater attraction and union betwixt their particles. They muſt, likewiſe, in ſome meaſure, diſcover the other contents of mineral waters.

SECT. V.

THERE is no change, my lord, ſo common in nature, as that of bodies from an intire ſtate to a corrupted one. All vegetables, whether *aceſcent*, *alkaleſcent*, *auſtere*, *aromatic*, *inſipid*, *cold*, or *hot*, are liable to putrefaction; and, generally, end in it. Animal bodies are in a continual tendency to it;

peared to be ſulphur by its acid fumes and detonating with nitre.

THAT of the Pohon is yellow and ſharp on the tongue. Put on a red hot iron it has a ferruginous ſmell, and, after, made a tincture with galls. But it was not attracted by the magnet.

THAT of the Sauveniere has the ſame colour, but is ſweet. It contains about the fourth part ſulphur. When calcined it is attracted by the magnet. From five ounces a drachm of ſalt, like Tonnilet, is got.

it; and, in this way, their vegetable aliments are turned into their nature. When the addition of freſh juices, the motion of the fluids, and the expulſion of the corrupted is, once, put a ſtop to by death, this change, then, goes ſpeedily on.

AN end ſo very general, and ſo deſtructive in appearance, may lead a careleſs obſerver to think, that nature is plotting, by it, her own ruin.

* *Sic omnia fatis*
In pejus ruere, ac retro relapſa referri.

THIS may, perhaps, be the firſt reflection. But a further view will, ſoon, force us to alter our ſentiments. Corruption is obſerved to be the parent of vegetation. By the influence of the air, the putrified body is recalled from that ſtate; and conſtitutes, again, the bland juices of vegetables. This, then, is the circle, that nature has choſen to move in. To keep it complete, it is, wiſely,

* Virgil Georg. 1. line 200.

ly, ordained, that all vegetable and animal bodies ſhould, at laſt, end in this ſtate; and their very diſſolution be attended with benefit to mankind.

† *Quæcunque videntur*
Aliud ex alio reficit natura.

THIS natural proceſs is not attended, with ſuch a variety of circumſtances in animal bodies, as in vegetable. Animals are, already, on the confines of putrefaction. But vegetables have a ſurpriſing change to undergo: and, therefore, the variety, attending it, ſtrikes us the more. Your lordſhip has, no doubt, often, obſerved theſe changes, where a quantity of vegetables have been laid together to rot, or when a rick of hay has been ſtacked too green. I ſhall, therefore, only recall, to your mind, the principal circumſtances attending it, and the alteration that is made by it. Theſe are neceſſary to be known, in order

† Lucretius lib. 1.

order to underſtand the change in the mineral-water.

IF the ſoft recent parts of vegetables are, in the ſummer-time, heaped together, and the free circulation of air is obſtructed, a ſharp ſmell, ſtill, however, their own, is firſt felt: they begin to be hot towards the middle: this increaſes, every day, more and more, in proportion to the preſſure, moiſture, and want of air. As the heat advances, they loſe their peculiar ſmell; and gain a fetid one, with a horrid cadaverous taſte. If the heap and preſſure be great, and the moiſture not over prevalent, the heat, often, burſts into a flame. When that does not happen, putrefaction runs its courſe, till the whole maſs is changed into a ſubſtance, very diſagreeable both in ſmell and taſte. This is always the ſame, however different the vegetable matter be; and reſembles corrupted animal ſubſtances.

If this putrified maſs is examined by chymiſtry, it affords the ſame principles, that animal ſubſtances do, a fetid water, volatile alkaline ſalt, a thick ſtinking oil, and a pure earthy *reſiduum*; principles! very oppoſite indeed, to thoſe it contained, in a ſound ſtate. There ſeems no difference betwixt putrified vegetables and animal matter. The effect, then, of this natural proceſs is, to render the ſalts and oils alkaline, volatile, and fetid; and to reduce all ſubſtances, whether animal, or vegetable, to the very ſelf-ſame principles.

To account for all theſe changes, theory ſeems yet deficient. The common opinion is, that they are owing to the air, incloſed in theſe bodies, raiſing, by the ſtruggles it makes to get free, an inteſtine motion: and, by this, the ſalts and oils are attenuated and rendered volatile. But this is only putting the difficulty a ſtep further off. The next queſtion muſt be, What makes the air ſo fond of getting away? It is, generally, thought, that

that the action of the external air is neceſſary to this change. This appears to me not well founded. For, I find that water putrifies, when kept, from all contact with the external air, by good corks ſealed over. The air-pump has led people into this notion. No putrefaction is obſerved, there, when the air has been exhauſted. From this a general concluſion is drawn. But it is unwarrantable, as differing, in circumſtances, from the common proceſs. For, not only the external air is drawn off, but, with it, the internal likewiſe. Liquids loſe it as the action of the air-pump goes on: and, if ſolids do not quit with it, directly; yet it will, immediately, eſcape, when unfettered, before it has wrought any change on the maſs. There is ſomething, in this affair, not well underſtood yet, nor, perhaps, ever will.

* *Multa petentibus*
Multa deſunt,

* Horat. lib. 3. ode 16.

is a maxim, my lord, as true in purſuit of knowledge, as in purſuit of riches.

WATERS, when ſtagnating and expoſed to heat, undergo this change. Thoſe, from rivers, or wells, ſoon change their colour, taſte, and ſmell, and turn ſo fetid, that the ſeamen cannot drink them. The more impure they are, the ſooner they putrify. *Thames*-water ſpoils in a few days; but, when it comes into the hot countries, it, again, purifies itſelf. Marſhy waters, that contain the greateſt quantity of oily particles, by ſtanding on a fat earth, ſpoil ſooneſt. This change in waters is owing to the different ſubſtances, that they have collected, from earth, air, vegetables, or animals, and from the inviſible creatures that inhabit them. Theſe undergo the general proceſs, and impart to the water their ſmell and taſte. But, being rendered volatile by it, they fly off; the earthy parts ſink to the bottom; and the water is left as pure, nay more ſo, than it was at firſt. It

does

does not appear, that the elemental particles of water are ever altered: therefore, the ſmaller quantity of foreign ſubſtances it contains, the leſs liable is it to putrify. The time that different waters take, before they ſubmit to this change, gives a conſiderable inſight into their nature. Mineral waters have never, yet, been conſidered in this point of light. Experiment, always, rewards its pupils.

1. ON the 10th of *June*, a bottle of *Dunſe*-water was ſet in a ſouth window, expoſed to the ſun and weather: but was ſcarcely altered on the fifth of *July*. The ſame water, well corked and ſealed over, and placed in the room, was not altered in that time: but, after this laſt had been kept for ſix weeks, it had a nauſeous ſmell and taſte. That which was expoſed, without the window, in bottles not corked, was no more altered than before; for the putrid particles flew off as they were formed.

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2. THE ſpecific gravity of the corrupted mineral-water was the ſame with the vapid.

3. WITH the tincture of galls a deep *Burgundy* colour was formed. What was expoſed, without a cork, ſuffered no alteration with the galls. This phœnomenon ſurpriſed me not a little, when it was firſt diſcovered. That it ſhould regain its ſteely ſpirit, after it was loſt, would have met, unleſs ſeen, with little faith. I cannot, poſitively, ſay the preciſe time, that that ſpirit diſcovers itſelf; but it appears to be, with the beginning change to putrefaction.

THE reaſon of it, on the principles laid down, ſeems to be this. The inteſtine motion of the water, acts, powerfully, on its contents; renders them ſmaller; makes them volatile, and fit to mount into the air. The fixt iron, which we will afterwards diſcover in the water, is attenuated by this action; reduced into very minute particles; and ſo brought

brought to a ſtate of volatility. To confirm this reaſoning, we obſerved that its ſmell, taſte, and tincturing quality, went off in a very little time. Beſides, on calcining the *reſiduum*, the magnet did not diſcover any iron particles. This is a ſufficient proof of their being volatilized.

4. ON dropping ſpirit of nitre into it, no change happened.

5. No milkineſs was obſerved with a ſolution of ſilver in ſpirit of nitre.

6. A SOLUTION of quickſilver produced a yellow cloud; a yellow ſediment was ſoon precipitated.

7. SYRUP of violets was turned a little green.

8. THE bottles, when the water is poured out, have a gunpowder ſmell. A black powder is found ſticking to the bottom. No

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oker, or red pellicles are to be ſeen. The black ſubſtance is, probably, ſome part of the iron that cannot be rendered volatile.

9. To diſcover if there was any ſulphur in the putrified water, as the ſmell ſeemed to indicate, a piece of ſilver was put in it for four days. It appeared, when taken out, to be a little dusky. From this, it ſeems, now, to contain a very ſmall proportion of ſulphur. Shall we conclude, then, becauſe it is found in the putrified water, therefore it muſt exiſt in the water before corruption? The concluſion, my lord, would be too far ſtrained: eſpecially as this ſmall quantity may ariſe from another ſource.

IRON, evidently, contains an inflammable principle. It is thus diſcovered. Iron, when ignited, or its powder dropt in the flame of a candle, ſparkles: when corroded with the acid of vitriol, a ſulphureous ſteam ariſes from it;

it; and, if this ſteam be confined, by ſtopping the mouth of the bottle, till it is gathered in ſome quantity, and then, ſuddenly, unſtopped at the flame of a candle, it will take fire, and make a noiſe, like the exploſion of gun-powder. Whatever diſſolves the iron, lets the inflammable principle eſcape. Putrefaction has this effect. There is, then, no cauſe of wonder, that the putrified water is found to alter the colour of ſilver a little; for the tinging of ſilver ſeems to be owing to the inflammable part of the ſulphur. Charcoal and an alkaline ſalt, fuſed together over the fire, form a ſulphureous ſubſtance that tinges ſilver black. This experiment ſhews, that the alteration of colour is made by the inflammable principle of the ſulphur, and not by its acid. We are led, by this, to obſerve, what a ſmall quantity of ſulphur, will diſcover itſelf, by its effects, on ſilver: for there was no more, in a bottle of water, than what could eſcape from a half grain of fixt ſteel.

* Dr. *Shaw* juſt hints, "That he diſcovered "a ſulphur, in the putrified *Scarborough* wa- "ter; but does not allow it to be a principle; "and ſuppoſes it generated, as wine is, by "fermentation."

10. THREE *Engliſh* pints of this water was evaporated, and gave three grains and a half of remainder. This, put on a red hot iron, did not emit any ſulphureous ſmell. It contains, therefore, no fixt ſulphur.

11. SOME of this *reſiduum* was calcined in the fire, but none of its particles were attracted by the magnet. Thus, we ſee, that the fixt ſteel is rendered ſo volatile, as to leave the water altogether.

PART

* P. 136. he gives a promiſe, in this place, of ſome experiments on the putrified Scarborough water; but, to our misfortune, never has done it.

PART II.

SECTION I.

IT may, perhaps, be doubted, my lord, whether chymiſtry has been of great advantage to the practice of medicine. This diſadvantage has, certainly, attended it, that, for its preparations, ſimple medicines have been neglected; in which claſs moſt of our ſpecifics have been found, and in which we are to hope for more. But its uſe, in the theory of phyſic, and in natural philoſophy, can never be doubted. In the firſt it is very extenſive. Many natural operations of the body are explained by it; the tranſmutation of victuals into our ſubſtance; the formation of chyle; of bile; of the ſalts; of the oils; of urine; and almoſt all the changes that happen in the human compoſition. It opens, likewiſe, to our view, the unnatural operations in our bodies, if I may call thoſe of

diſeaſes by that name. The noxious effects of putrid effluvia; the conſequences of ſtagnation in our fluids; the progreſs of fevers; and many other diſeaſes are ſet, by it, in a clear light.

To natural philoſophy it has been of very great advantage. The varied actions of bodies are now deduced from their conſtituent principles. Chymiſtry, properly managed, is the only ſcience, that I know, capable of diſcovering theſe. There is no other, that can teach us to diſunite bodies; mix them; and obſerve the different effects that happen. There is no other that can transform *cold* bodies into *fire*; *fixt* into *volatile*; *fluid* into *ſolid*, and *ſolid* into *fluid*; *mild* into *corroſive*, and *corroſive*, again, into *mild*. By theſe we underſtand the operations of nature. The metallurgic, the dying, and ſeveral other arts have reaped great advantage from it. How far farming and cookery might be reduced within its rules, and improved by it, would be

be worth the conſideration of ſome ingenious perſon. So far from being arrived at full perfection, chymiſtry ſeems, yet, ſcarcely, out of its cradle. The experiments, already made, bear no proportion to the various trials and various mixtures that might be made.

THE opinion of the firſt chymiſts, who imagined that ſalt, ſulphur, and mercury, were the only conſtituent principles of all bodies, has been exploded, for near a century. The firſt * chymiſts knew nothing of natural philoſophy, or its laws; and, what is worſe, were, I doubt, ſcarce honeſt men. They endeavoured to impoſe on the world, and have been found guilty of falſehood. In their wild ſearch, however, after the ſovereign Elixir, that was to make man as eternal as his Maker; and the philoſopher's ſtone, that, by changing every thing into gold, was to render him, almoſt, as powerful, many uſeful diſcoveries were made. The wild enthuſiaſm of the firſt cultivators of this ſcience was, perhaps,

* Baſilius Valentinus, Paracelſus, Helmont.

perhaps, of more advantage to it, than the ſlow advances of more regular enquirers would have been. At laſt *Boyle* appeared, and placed chymiſtry on a rational footing.

THERE is a great objection againſt admitting the parts, that are ſeparated, by the extreme heat of fire, as natural conſtituent parts of bodies: becauſe they may, by its action, be generated, or produced from other principles. Nor do our modern chymiſts aſſert them to be natural. Theſe are not, abſolutely, however, to be rejected: for nature, we find, produces principles like thoſe which ariſe from fire. Alkaline ſalts are diſcovered in the *German* waters. Their title to be eſteemed natural, is as good as that of the mineral acids; ſince the firſt is found unmixed, the laſt always attached to bodies. But there lyes no objection againſt admitting theſe parts, as conſtituent principles, which are ſeparated by a heat no greater than that of a ſummer ſun. There is no neceſſity of ever

uſing

uſing a greater degree in the analyſis of mineral waters.

THE firſt part of this letter, my lord, was taken up in examining *Dunſe*-water by additions of different materials. But this proof is not ſo certain, nor convincing, as the expoſing of thoſe very principles to the eye. This is the buſineſs of *Analyſis*. By the former ſet of experiments, we had a great probability, that this Spaw is a compound of air, water, ſalt, earth, and a chalybeat principle: if we can ſeparate theſe parts, ſo as to expoſe them to the eye and examination, we ſhall have a complete evidence of their reality.

1. ONE pound *Engliſh* weight, which is thirteen ounces and a half apothecary, was, at the well, put into a retort, and ſet in a gentle ſand heat, with a receiver luted to it. The water was ſcarcely hot, when ſomething came thro' the luting, and expanded it ſo, that it obliged me to make it faſt with brown paper. What was in the retort, ſoon, turned

ed of a light reddiſh colour; and a red ſilmy ſubſtance like a ſpider's web rolled together, fell to the bottom. After all had come over into the receiver, that would, with this gentle heat, I found, in it, thirteen ounces and two drachms of water; and, in the retort, one grain and a half of *reſiduum*. Thus almoſt two drachms had eſcaped.

2. To find out what it was that went off ſo ſoon, the beginning of the ſame proceſs was, again, repeated. After this ſubtile matter had paſſed thro' the luting, and a very ſmall quantity of water had come over into the receiver, I ſeparated the glaſſes, and tried the water in the retort and receiver with the tincture of galls, but no change of colour happened. So that this ſubtile matter appears to have been the chalybeat ſpirit, with ſome air and water.

3. Two pound *Engliſh*, or twenty ſeven ounces apothecary, was evaporated, in a ſand heat, not exceeding the warmth of the ſun.

It

It turned, in a little time, of a ſtraw colour, and depoſited reddiſh floating pellicles, that touched the bottom, but did not ly on it. After all the water was evaporated, the *reſiduum* weighed two grains and three fourths of a grain.

5. THE colour of the *reſiduum* is like high-coloured ſnuff. It feels gritty betwixt the teeth. A very nice taſte can diſcover ſomething ſaltiſh in it. It appears, in the microſcope to be an opaque body, intermixed with diaphanous particles; theſe, probably, were ſalt.

5. THE *reſiduum* I put into the glaſs again, and ſet it in a pretty ſtrong ſand heat. It, ſoon, ſeparated into two different ſubſtances; and theſe took two different poſts. A grey earthy part lay at the bottom. About two inches up the ſides of the glaſs and round it, there was a whitiſh circle, that ſtuck faſt. It taſted ſaline and like ſea ſalt. The powder on the bottom ſeemed earth.

6. THIS

6. THIS ſaline circle was diſſolved in diſtilled water. Being evaporated, I found, at the bottom of the cup, one grain of a ſubſtance that looked like fine earth, yet taſted ſomewhat ſaltiſh, and above it a circle of reddiſh ſalt, that weighed about half a grain, and was the ſixth part of the whole.

7. To diſcover if there was any fixt ſteel in the *reſiduum*, I ſublimed it with Ammoniac ſalt. The flowers after ſublimation appeared of various colours, but moſtly blackiſh, as the martial flowers do; and had a very ſtiptic taſte. Spirit of wine, in three days, drew no martial tincture from them. Galls had no effect on this tincture: nor the loadſtone on its *reſiduum*. No concluſion can be drawn from this experiment.

8. SOME of the *reſiduum* was calcined in a ſtrong fire. It had, after calcination, an iron colour; and, by the magnet, ſhewed great plenty of iron particles, which it did not before ignition.

9. To

9. To diſcover the proportion of fixt ſteel in the calcined *reſiduum*, I diſſolved three grains of it in water, and poured it off, when the firſt and heavieſt parts had juſt fallen to the bottom, but before the light earthy could arrive there. This was repeated till the water came off clear. The remainder was attracted, wholly, by the loadſtone; and weighed one grain and three fourths. Theſe three grains were ſeven before calcination. Thus, about the fourth part of the *reſiduum* appears to be fixt ſteel. As ſome of the earth might have been attracted along with the ſteel, the following experiment was tried to make the affair more certain.

10. Fifty five grains of calcined *reſiduum*, that made, before calcination, two drachms and twenty four grains, was put into a reverberatory furnace, with an equal quantity of common flux and charcoal powder. After it had ſuſtained the ſtrongeſt fire for half an hour the crucible was taken out; but no iron was found fuſed at the bottom of the cru-

cible, nor did the magnet attract any particles from it. In this experiment the iron ſeems either to have paſſed thro' the pores of the crucible, by the extreme heat of the fire, or to have been perhaps deſtroyed by too great a quantity of the common flux.

THAT we might diſcover, whether there was any * fixt ſulphur,

11. THE *reſiduum* was rubbed, for ſome time, on ſilver, but no blackneſs was produced.

12. SOME

* MONSIEUR CHROUET diſcovered a ſulphur in the reſiduum of the Spaw-waters. From 100 pound of the Geronſter, he got a half ounce of glutinous earth, that was fat on the fingers, detonated with ſaltpetre, and emitted a ſuffocating vapour like ſulphur.

THE reſiduum of 100 pound of the Pohon gave an ounce of ſulphureous matter.

FROM the reſiduum of 100 pound of Tonnilet he got two drachms and a half of red ſalt, that would not dry for being unctuous: it detonated with ſaltpetre like common ſulphur.

FROM the reſiduum of a like quantity of the Sauveniere, no mention is made by him of any ſulphureous body.

12. SOME of it was put on a red hot iron: It ſparkled, like ſnuff thrown in the fire, but did not emit blue, or ſulphureous flames.

13. A DRACHM of oil of tartar *p. d.* was mixed with ſixteen grains of it, and put over the fire. This was infuſed, afterwards, in ſpirit of wine, for four days. The tincture never turned red; nor did any milkineſs or precipitation happen, on a mixture of ſpirit of nitre.

THUS, we have been in ſearch of a volatile and fixt ſulphur, by all the experiments that are ſaid to diſcover it: but in vain. Shall I therefore deny that there is a ſulphur in it? no, my lord: the concluſion would be too ſtrong. I can ſay no more, than that theſe experiments have not been able to diſcover any. I ſhould look, however, on any perſon, aſſerting its exiſtence, without a proof by experiment, as very oppoſite to the character of a candid enquirer into truth.

As to the ſmell and taſte of ſulphur, which ſome find in this water, I muſt obſerve, that theſe ſenſes are very deceitful. The *German*-waters taſting acid and ſharp, when they are juſt the oppoſite, is a ſignal proof that inferences, drawn from the ſenſes, are fallacious, when truſted to alone. Many bodies, we know, that contain no ſulphur, have this ſmell. Sea-water, when putrid, ſmells like rotten eggs. And how do we know but ſteel, or any other matter may be ſo modeled, as to produce the ſame effect on the ſenſes?

SULPHUR has two very different and oppoſite ſmells. When burnt, it ſends out a ſuffocating vapour, that is very uneaſy to reſpiration: this proceeds from its acid; and is not what we have to do with at preſent. The other is, when it is joined and opened by an alkaline ſalt; then it has a peculiar ſmell, ſomething like rotten eggs. This is owing to its oily part, after the acid has been attracted

tracted by the alkaline ſalt: hence ariſes the ſmell of gunpowder when burnt, the alkaline ſalt in the nitre operating, in this manner, on the acid of the ſulphur. It is this fœtor that is ſuppoſed to be in *Dunſe*-ſpaw. But as no alkaline ſalt is diſcovered in it, this ſmell, if any ſuch it has, ariſes from the inflammable part of the iron itſelf. How little will do this, the ſubtile effluvia of bodies, that, for years, ſend their odorous particles a great way round, without any loſs of ſubſtance worth mentioning, evidently demonſtrate. But this little, that eſcapes, perhaps, from the ſubtilized iron, can, in no ſhape, merit the title of a principal, or conſtituent part.

WHETHER there is any other ſubtile matter of an ethereal kind, or unknown ſteams raiſed by central fire, joined to this water, may admit of a queſtion; but it is not ſo eaſy to come to a concluſion with regard to it. What eſcapes experiment, has not eſcaped theory. But, as we are ſure of nothing without

out the firſt, we ſhall never admit any thing on the credit of the laſt alone. The analyſis, that we have purſued in this ſection, has diſcovered, to the eye, air, water, ſalt, earth, and ſteel to be the principles that go to the compoſition of this mineral ſpring. Each of theſe deſerves our conſideration in particular.

SECT. II.

THE different methods, that diſcover air in mineral waters, and which I purſued in the examination of this, are theſe:

1. WHEN water is taken, from the well, in a glaſs, we are to obſerve whether any air-bubbles mount from the bottom to the ſurface, and ſo eſcape. A few of theſe are to be ſeen in *Dunſe*-water. In the *German*-waters, eſpecially thoſe of the higher *Germany*, theſe air-bubbles are in great quantity. A glaſs of *Selſer*-water, freſh from the well, ſeemed as brisk and ſparkling, as a glaſs of *Champaign*;

Champaign; and appeared, to the taſte, ſo like it, that, had I not ſeen it taken from the fountain, I ſhould have deemed it rather wine than water. This great quantity of air is, probably, the cauſe of that delicious cut-throat taſte, as *Champaign* drinkers expreſs it, in theſe waters. All fermented liquors, that have ſtood any time in bottles, contain much of this aereal principle, and produce the ſame ſenſation. Or, perhaps, what raiſes and begets the air, may cauſe the taſte.

2. IF mineral-water, juſt taken from the well, is obſerved to be much lighter than the common ſort, then it is, generally, thought to contain more air. *Dunſe*-water is heavier. But this proof, for ſeveral reaſons, is not to be depended on.

3. WHEN a quantity of the mineral water is put in a bottle with a long neck, if the water, after it has been kept for ſome time, is obſerved to ſubſide, this is a ſign, that a quantity

quantity of air was lodged between the aqueous particles, and kept them ſeparate; but, after it has made its eſcape, they approach nearer, and the ſurface ſinks. In this way *Dunſe*-water diſcovers no air.

4. FREQUENT eructation, after drinking any fluid, diſcovers the aereal principle; for common water has no ſuch effect on us. Nothing of this kind is felt on drinking *Dunſe*-water.

5. LET a bottle be almoſt filled with mineral-water; ſhake it for ſome time; keeping the mouth of the bottle well ſtopt. If there is much air in the water, it will ruſh out with a noiſe on unſtopping the bottle. *Dunſe*-water diſcovers very little air in this way.

6. LIQUIDS, that contain much air, often burſt the bottles. But this water never does. The *German*-waters are allowed to ſtand,

ſtand, for ſome time, uncorked, that the air may eſcape.

7. WHEN water, containing much air, is put over a fire, there is a great agitation and expanſion from the rarefaction of the aereal particles. Thus, water that contains moſt air heats ſooneſt. *Dunſe*-water, put over a gentle fire, did not ſimmer.

8. THERE is not a better way to diſcover the quantity of air, than by the air-pump. When, by it, the preſſure of the atmoſphere is taken off, and the water eaſed of an incumbent load, the particles of incloſed air join, recover their properties, and eſcape in form of air-bubbles. In this way moſt of the fixt air is extracted, and becomes viſible to the eye. *Dunſe*-water diſcovers, by this experiment, more air, than common water does.

ON mixing *Rheniſh* wine and ſugar with the *German*-waters, an ebullition, immediately,

ately, ariſes, and a great quantity of air flies off. Thus air is, indeed, produced, but, it ſeems, rather from the alkaline ſalts and acid of the *Rheniſh*, than from the water itſelf. This experiment is, therefore, deluſive.

ALL theſe experiments allow the air to eſcape; and, therefore, afford no juſt meaſure of its quantity. To attain this, we muſt catch the air, and exhibit it to the eye. An ingenious * gentleman, to whom the world is indebted for a train of experiments, has taught us a way to meaſure the quantity of air in all fluids. Following his method,

9. I PLACED an inverted bottle, full of this water, in a glaſs ciſtern, containing the ſame

* Dr. STEPHEN HALES. By this method he got from 54 cubic inches of well water, one cubic inch of air. From Briſtol and Holt water the ſame. From Pyrmont twice as much. A good quantity from Spaw and Tunbridge. A great deal from bottled beer. From Ebſham and Acton little more than from common water. From Bath very little. Had he informed us of the preciſe heat and time, that theſe quantities were ſeparated, we could have compared Dunſe-water with them.

ſame water. The ciſtern was ſet in a kettle of water, heated to the degree of the human body. In half an hour, about the eighth of a cubical inch of air was generated and collected in the upper part of the bottle.

10. DR. *Shaw* gives us a method of catching the air, better fitted for our purpoſe, as we can handle and examine it in what ſhape we pleaſe. A bladder, well oiled on the outſide, is to be tied very cloſe to the neck of a bottle filled with the mineral water; care muſt be taken to admit no external air, and the ſides of the bladder ſqueezed cloſe together. As the air ſeparates, the bladder is blown up. This experiment being made on a bottle of *Dunſe*-water, expoſed to a gentle heat, equal to that of the human, for an hour, the bladder contained about the eighth of a cubical inch. The ſame bottle was expoſed to the atmoſphere for nine days, and produced two cubical inches.

AIR,

AIR, collected from the water in this way, appears to be elaſtic, and capable of rarefaction and preſſure, ſo far as I obſerved. It overcomes the whole force of the atmoſphere by diſtending the bladder, and muſt be in equilibrium with it. It ſeemed to be of the ſame nature with our atmoſpherical air.

THE manner of its formation appears to be this. Steel contains a great quantity of this fluid in a fixt ſtate, which makes its appearance on any diſſolution, or ſeparation of its parts. When it is diſſolved by the mineral acids, a great quantity of air-bubbles, continually, eſcape. The ſame happens, tho' in a ſmaller degree, when the particles of ſteel are * ſeparated by water. In this laſt way, a ſmall portion of air, more than that of common water, is generated. I rather chuſe to deduce its exiſtence from fixt air, than from particles of iron, thrown off, and ſo becoming repellent air, tho' it is the opinion of ſome † great men. Air ſeems to be ſo general

* Vid. part 2. ſect. 6. † Sir Iſaac Newton, Hales.

neral an element, ſo uſeful, with qualities ſo uniform and certain, that 'tis probable it was created, in the beginning, a body diſtinct from all others; tho' capable of change, yet always ready to return to its old form.

* *Nihil antiqua lege ſolutum*
Linquit propriæ ſtationis opus.

GREAT feats, I obſerve, are expected from the oſcillatory motion of this air, ſo plentifully contained in ſome waters, after it has entered the veſſels. The effects of this are deduced from the effects of common air. † Authors ſay, that it enters the fine veſſels, opens obſtructions, and cleanſes all the canals of the body. I ſhould, hardly, my lord, differ from them, or doubt of theſe effects, were I not backed by all the writers on natural philoſophy. From them we learn, that air, fixt in bodies, loſes its elaſticity, and is no more

* Boethius, lib. 1. metr. 5. † Hoffman, when he aſſigns effects to the aerial ethereal principle, ſeems, evidently, indeed, to mean the ſpirit. De element. aq. miner. examinandis, parag. 14.

more a real active element. Such is the ſituation of that in our fluids; which, not being elaſtic, can have no oſcillatory motion, or expanſive force. If it had, the effects would be terrible. For the expanſion of air, from the freezing point, only, to the heat of ſummer, is in the proportion of ſix to ſeven. As our bodies contain more air than an equal quantity of the atmoſphere, and the winter cold is often far beyond the freezing point, we would be torn to pieces, if the air, mixed with our fluids, ſtill enjoyed the power of expanſion. Beſides, we find, that air, injected into the veſſels, proves certain death.

11. To put this queſtion beyond all doubt by experiment, I catched ſome blood in the ſmall gut of a fowl, as it flowed from a vein, taking care to admit no external air. The gut being cloſely tied, was put in a glaſs, from which the air was, immediately, extracted. But the gut, full of blood, did not ſwell after the preſſure of the external air was taken off.

off. This ſhews, that the air contained in the blood was not rareſiable or elaſtic.

IT appears, that air never acts as air in the human veſſels; and, therefore, as to theſe effects, it matters not, whether mineral waters contain much, or little of it. Shall I, then, deny the fixt air any power over our frame? no, my lord: but till that is once aſcertained, 'tis impoſſible to ſay, whether a greater quantity of it, than uſual, in the blood, will do good, or harm. It may, perhaps, aſſiſt the animalization, or tendency of our fluids to putrefaction: but as this is uncertain, and the common quantity of air ſerves very well the common purpoſes of life, I muſt doubt of any advantage a greater ſhare of it would be to the human frame.

BUT the effects of too much air, in the firſt paſſages, is but too plain. There it produces eructations, pains, ſwellings, ſpaſms, convulſions, as the hiſtory of thoſe mineral waters, that contain much of it, ſhow. To prevent

prevent theſe effects, hot carminative medicines are taken along with them. Is this then a principle to be wiſhed for in great abundance? by no means. As this ingredient can be of no ſervice in the habit of the body, and can do much harm in the ſtomach and inteſtines, *Dunſe*-water is, certainly, ſo much the better, the leſs it contains of it. As a proof of this, I know no ſuch effects happen on drinking it, tho' no preventives are uſed, as, frequently, do in a courſe of the *German* waters.

SECT. III.

THIS fair and varying ſcene of nature is upheld by change; and change is effected by motion. Were all bodies fixt, it would require great force to make their component parts alter their ſituation; and they would retain, for ever, the ſame unvaried force, unleſs expoſed to the violence of attrition. A fluid body, therefore, that moved with eaſe itſelf, and would be the cauſe of motion in others,

others, was abſolutely neceſſary, in the ſtructure of this globe; for it was deſigned to be comely and uſeful to its inhabitants. Water anſwers this purpoſe. It divides, imbibes, tranſports the ſolid parts; and, by applying them elſewhere, is the cauſe of increaſe and vegetation. It is no leſs neceſſary to putrefaction, the other great change in nature; which, without this element, can never go on. The life of animals and circulation of their juices depend on it. The greateſt part, both of vegetable and animal ſubſtances, is found to conſiſt of pure water. The mineral kingdom owes, perhaps, in ſome meaſure, its ſtability to the want of this principle. So general and uſeful a part of the works of nature demands our conſideration.

WHAT was ſeparated by diſtillation from the *Dunſe*-water ſeemed to be pure elemental water. A ſolution of ſilver in ſpirit of nitre made no alteration in it. Nor did galls. The colour of ſilver was not altered by lying ma-

ny days in it. Nothing impure or * heterogeneous appeared, on trial, mixed with it.

ONE of our greateſt modern † phyſicians aſſerts, That the good effects of mineral waters depend, not on their ingredients, but on the elemental water. As a proof of this, he informs us that ſeveral wells in *Germany*, of very great fame, contain no mineral particles, but draw their virtues from a pure light water alone. Of this kind are the *Toplicenſes*, *Schlanginbadenſes* of *Heſſe*, *Friginwalgenſes*, and others. Theſe can boaſt of nothing chalybeat, earthy, or ſaline, and yet have great virtues, uſed internally, or externally. They are lighter than rain water, and leave no ſediment on evaporation. Altho' this concluſion is puſhed rather too far, yet it cannot be denied that much depends on the purity

* MINERAL waters diſtilled have diſcovered their qualities. Monſ. Chrouet ſays, That what was diſtilled from the Geronſter a ſecond time was bitter, and had a ſulphureous ſmell; what came from the Pohon was ſharp, and had no ſmell of ſulphur.

† HOFFMAN de therm. et acidul. uſu et abuſu, parag. 6.

purity of the watry principle, and that it is of ſervice, not only as a vehicle to the others, but as an active part.

WATER is allowed, by all the writers of natural philoſophy, to be a very ſubtile body: even more ſo than air. It has penetrated the *pores of gold. It is probable, then, that there is no vaſcular part of the human body, how minute ſoever, which this conſtituent part cannot with eaſe paſs through. We can with no juſtice refuſe it a circulation through the nerves, if they are pervious, as they ſeem to be. It muſt be the moſt general circulating principle of our fluids, and ſerve as a vehicle to the reſt. As its uſe is great, ſo its deficiency muſt be as greatly felt. When this happens in a particular place, then an obſtruction is formed: but if the caſe be general

* To diſcover whether water could be compreſſed into narrower bounds, the Florentine ſociety made a hollow globe of gold, filled it with water, and ſqueezed the ſides together with the utmoſt force of machines. The water was not compreſſed, but forced thro' the pores of the gold, and appeared like dew on the ſurface.

neral with the whole fluids, as ſometimes happens in inflammatory fevers, when their oilineſs rejects the water, moſt horrid ſymptoms ariſe, and death treads faſt at their heels.

OBSTRUCTIONS, under which name moſt diſeaſes rank themſelves, ariſe from the cloſe attraction of the more ſolid parts, while the fluid are preſſed out. Water ſeems well fitted to remove them. Its ſubtility carries it every where; its diſſolving power opens; its fluidity waſhes away; its blandneſs ſheaths; while its continual ſecretion carries off all unnatural concretions. If obſtructions can be opened by art, this ſeems to bid the faireſt chance for being the inſtrument. All theſe good effects we are to expect from this principle of *Dunſe*-water, which is very ſoft, and, after the precipitation of the mineral parts, light as the pureſt rain water. I imagined that its paſſage thro' the marly bed might give it that ſoftneſs, and found, by experiments, that water, hardned by a ſolution of

ſea

ſea ſalt, was made more ſoft and leſs ſalt by a mixture of marly earth.

As the neighbouring fountain always ſupplies your lordſhip's own cup, it will not be diſagreeable, I ſuppoſe, to be informed, what are the criterions of good water; what the properties of its different kinds; and in what manner they may be beſt mended when bad: a ſpeculation very uſeful to mankind, but more particularly to one of your lordſhip's temperance. *Hippocrates* thought this ſubject not unworthy his conſideration, and has left us a few good obſervations on the effects of different waters. * Some of great character among the moderns have attempted this ſubject.

GOOD water is known by the following properties:

IT has neither colour, taſte, nor ſmell; for theſe diſcover a mixture of other bodies.

IT

* Boerhaave, Hoffman.

IT is light. This appears by its quick heating and cooling: but more certainly by the hydroſtatical balance. The hydrometer, with a long neck, divided into different degrees, to mark its different depths, anſwers very well the purpoſes of common life. The lightneſs and gravity of common water, I find, depends not on the quantity of air contained in them, but on a mixture of earth and ſea ſalt, which are found more or leſs in almoſt all. On mixing both theſe materials with water, I found it ſpecifically heavier.

IT muſt be light on the ſtomach by a quick and eaſy paſſage out of it. This levity is very different from the former; for water heavy in the balance may be very light in the ſtomach. This ſeems to depend on great purity, or, perhaps, a ſpirituous principle. The ſenſation is our only teſt of this quality.

THE longer water remains in an uncorrupted ſtate, the better it muſt be. The progreſs of putrefaction is in proportion to its vege-

vegetable, or animal contents. Hence rivers, that waſh great cities, and ſtanding waters, are, of all others, the moſt liable to corruption.

To be ſoft is one of the chief properties in the offices of common life. The hardneſs of water, I find, depends moſtly, if not entirely, on ſea ſalt: for water, that eaſily diſſolves ſoap, is hindered from doing it by a mixture of ſea ſalt; even after ſoap is diſſolved, the equal ſolution is curdled by an addition of that ſalt. As the ſame effect happens betwixt ſalt of tartar and ſea ſalt, the curdling of ſoap muſt, ſtill, be owing to the action of theſe two. From this we can eaſily account why hard water ſhould be ſuch a friend to the ſcurvy. The criterions of ſoft water are, that it brews well; boils peaſe without making them hard; diſſolves ſoap equally; and waſhes dirt entirely out of linnen. We muſt take care, however, not to miſtake a degree of putrefaction for ſoftneſs, for we find water ſoftens in its tendency to corruption.

tion. Hard water may agree beſt with ſome conſtitutions.

IT ſhould not turn turbid with a ſolution of ſilver in ſpirit of nitre; nor milky with oil of tartar *p. d.* or cloudy with a ſolution of ſugar of lead in water. Theſe changes diſcover a mixture of ſaline and terreſtrial particles.

AGAIN. The ſmaller proportion of terreſtrial particles it contains, ſo much the better. Water can never be got entirely free from them: not even rain water. Yet, there, they make but an inconſiderable part. Several ſprings approach near it. This purity is known from its leaving no † incruſtations on the ſides and bottoms of kettles that have been in long uſe. But the moſt certain method, to diſcover the proportion of pure element to the ſolid part, is evaporation:

† HALES tell us that there is a ſpring in the palace-yard of Hampton-court, that left no ſtrong concretions on a kettle, in which it had been boiled, without cleaning for fourteen years.

on: by that the whole is made viſible and capable of weight. The nearer it approaches to rain water, ſo much the better.

THESE, my lord, are the ſigns of good water; and, thus, every one, who is as much concerned as your lordſhip, can, with eaſe, diſcover, whether that, which he uſes, is ſo, or not. I have given no rules but what may be eaſily underſtood, and as eaſily applied. It is to be regretted, that we have not a natural hiſtory, on this ſcheme, of all the waters, whether well, fountain, or river, in every county: their defects might, in ſome meaſure, be corrected, and the inhabitants reap the benefit.

WATER in general is divided into theſe claſſes; rain, fountain, well, river and lake. The character and properties of each is worth the inquiring into.

THE air contains every thing that can be made volatile by the ſun, fire, ſubterraneous

heat, putrefaction, fermentation, attrition, or efferveſcence. And, therefore, different ſalts, oils, ſpirits, earths and metals, too, are, continually, floating in the atmoſphere. Rain, that aſcended in form of vapour, floated in it, and again deſcends, muſt contain all theſe different bodies. As theſe effluvia alter, ſo muſt rain. It is very different, therefore, in different ſeaſons; very different in drought from what it is in moiſt weather; very different after thunder from that which falls at any other time. This water at beſt is found impure; contains often the ſeeds of many plants; † when kept, changes into a thick mucilaginous body; and putrifies ſoon. It is, however, in general, better than moſt fountain water. It is very light, heats and cools ſoon, diſſolves ſoap eaſily, and has ſcarcely any ſediment, when it is gathered at a diſtance from any city; for the ſmoke of towns defiles it much. It is thought to be beſt in the eaſt and ſouth winds, and in the month

† BOERHAAVE found in it the ſeeds of the Alga fluviatilis, and the Fungi.

month of *May*, being then replete with the fineſt effluvia of the earth.

RAIN, having fallen on the earth, ſinks a few feet, glides along the ſandy ſtratum, towards the more depending places, till it finds an exit, and then appears, again, in ſprings. Hence they are moſt common in thoſe vallies that are ſurrounded by hills. *Switzerland*, the higheſt country in *Europe*, gives riſe to the greateſt rivers in *France*, *Germany*, and *Italy*. Rain ſtrained, thus, thro' ſand, which is nothing elſe but a quantity of irregular flints, fitted to intercept all heterogeneous particles, muſt appear more pure, if it met with nothing diſſolvable in the way. But it can ſcarcely miſs of this: and therefore comes out more impure; ſometimes medicated; nay even poiſonous. It is, in general, heavier than rain water; contains ſea-ſalt; and depoſites *fæces*; eſpecially, when boiled. Springs that come from calcareous ground, or rocks, are obſerved to be hard and bad: as are likewiſe thoſe in the neighbourhood of

hot

hot wells. What paſſes thro' ſand and gravel is the beſt, for from theſe it can take no tartarine qualities.

PIT well-water differs very little from fountain in origin, being ſtrained thro' the ſame ſandy ſtratum, which is commonly found ten or twelve feet below the ſurface. But as it does not run like ſprings, 'tis more impure. Reſt gives it a degree of corruption, that fountains are ſtrangers to. Well-water is always harder when low, than when full, from a greater quantity of ſea-ſalt: and all-wiſe the regulation is! for, then, the water tends faſter to corruption from the ſcanty ſupply.

RIVERS owe their origin moſtly to ſprings; and muſt have their qualities. But as they are inhabited by fiſh; as they ſweep the plains; as they receive the filth of great cities; as they are expoſed to all animals; and as their ſubtiler parts are exhaled, they muſt be, conſiderably, more impure than the former. They differ, according to their circumſtances,

cumſtances, from one another; nay, often, from themſelves. Such an odds there is in their ſpecific gravity alone, that a bark, which can keep above water in the *Mayne*, will ſink in the *Rhine*. So nothing can be ſaid about them in general. They are commonly more impure; ſofter; lighter; and more inclinable to putrefaction, than fountain-water.

THE water of lakes, moraſſes, ſtagnating canals, ditches and bogs is ſupplied by ſprings and rain. Theſe are replete with the impure ſlimy ſubſtances from the earth; the ſalts and oils of the acrid plants * that grow in them; whatever air can give, and winds can bring; or whatever fiſhes, or other animals leave behind. Thus, it is the moſt impure of all; and always prone to putrefaction, when favoured by the heat. Inſtead of containing inſipid bland juices, it muſt

* THE plants, that grow in ſtagnating waters, are, generally, of a ſharp nature, and ſome of them even cauſtic. As the Acorus, Arum, Aconitum, Cicuta aquatica, Naſturtium aquaticum, Perſicaria acris.

muſt be full of acrid and volatile. Hence the country around is always unhealthful, from theſe volatile parts flying off; and is viſited, in great heats, with epidemic and peſtilential diſeaſes. Theſe are the unfitteſt of all for uſe. They are the moſt acrid, moſt impure, and moſt ponderous of all waters.

As in many places, eſpecially the low and flat counties, no good water can be found, it may be of benefit to their inhabitants to learn the art of rendering them pleaſant and healthful. The chymical methods of diſtillation and precipitation can never be brought into common life. I ſhall only mention what is in every one's power, and may be followed at almoſt no expence.

FROM theſe obſervations it appears, that the impurity of water ariſes, either from a degree of putrefaction, or too great a proportion of ſaline and terreſtrial particles. The firſt is the caſe of all ſtagnating pools, or wa-

ter

ter kept too long; the laſt, of rivers and ſprings. When corruption once begins, which is known from its bad ſmell and taſte, the water muſt be freed from theſe volatile acrid particles, e'er it can be uſed. If neceſſity requires an immediate remedy, they muſt be diſpelled by boiling. The heat and agitation of the water ſends off theſe noxious parts; and the terreſtrial, being freed from the volatile, that ſuſpended them, ſink to the bottom, after the boiling is over. Where no volatile ſalts, or oils are to be diſpelled, the action of the fire rather hurts water, by robbing it of the moſt active particles.

NATURE, when the progreſs of corruption is not ſtopped, frees herſelf from theſe noxious parts, by rendering them ſo volatile, that, without any aſſiſtance, they fly off. By imitating her, we ſhall arrive at the ſame end. Let, therefore, the putrefaction be encouraged by cloſeneſs, heat, and great veſſels. In time it becomes fit for uſe; and is, then, thought to be as pure as diſtilled water. This

practice

practice is ſaid to be common in *Rome* with the *Tyber*-water. This always happens in long voyages: and this is the only way to procure good diſtilled water from the ſea.

WHEN the ſaline, or terreſtrial parts prevail too much, ſo as to render it hard and heavy, they muſt be ſeparated. *Tranſcolation* is the ſureſt way to obtain this end. The *Sicilians* purify their water by paſſing it thro' a ſtone called a filtre. Sand is the fitteſt body for this purpoſe. It communicates nothing; and ſo effectually ſtops every heterogeneous body, that ſea ſalt, and all earthy particles, are detained by it. A well dug in the ſhore often affords freſh water. The *Auſtrian* army, when encamped in *Hungary*, find no good water, unleſs when on the banks of ſome great river. When they are obliged to uſe lake-water, they purify it in this manner. A long ſmall boat is divided into ſeveral different apartments by croſs partitions. They fill them all, except the laſt, with ſand. The boat is put in the lake. A hole

hole level with the ſurface of the water is made in the end of the boat, which lets the water into the firſt diviſion. From this it gets into the ſecond by a hole made in the bottom of the firſt partition. From the ſecond it runs into the third thro' a hole in the top of the ſecond partition; and ſo, alternately, above and below, that it may be obliged to paſs thro' all the ſand. At the top of the laſt diviſion there is a pipe, thro' which the water comes, at pleaſure, as pure as from a fine ſpring. Thus all bad effects are prevented.

WHERE the water is bad, I would propoſe ſome ſuch ſcheme to be followed in every houſe. Some casks, divided in the middle, and filled with ſand, would ſerve the purpoſe very well. Into the firſt of theſe diviſions the water might be thrown as into a ciſtern. The casks behoved to be joined by pipes. By making it circulate thus thro' eight or ten diviſions, filled with ſand to the

top, a pure ſpring may be had any where; and a marſhy flat country vye, in good water, with the inhabitants of the vallies.

SECT. IV.

LEST the general tendency of bodies to putrefaction ſhould go on too faſt, and nature herſelf, at laſt, diſſolve in corruption, it was neceſſary there ſhould be ſome bar to its progreſs. Sea ſalt was, therefore, mixed with almoſt all matter. Its quantity is diſcovered to be in proportion * to the force of its antagoniſt. All waters, whether ſpring, well, or river, have a ſhare of it, and ſhow how univerſal this principle is over all the earth.

WE have, already, diſcovered a ſalt in the *reſiduum* of the *Dunſe*-water, and found it to be about the ſixth part of the whole. The follow-

* TOWARDS the north, and eſpecially in the Baltick, a pound of ſea water contains but two drachms of ſalt. In our ſeas the ſame quantity has twice as much; and about the Spaniſh coaſt it affords an ounce. This muſt ariſe from more ſalt-pits in the ſouthern, than northern latitudes.

following experiments were tried to aſcertain its nature.

1. THIRTY two pound of water was evaporated, and the *reſiduum* diſſolved in rain water filtrated, and ſet on a gentle fire. When there was about ſix ounces, it had a ſaltiſh taſte like a ſolution of ſea ſalt. When it was near evaporated, I ſet it to cryſtalize; and got two grains of cryſtals. The remaining liquor was ſalt and bitter, and would not cryſtalize. On evaporation twelve grains of a ſaltiſh powder was got, for the fineſt of the earth had paſſed, with the ſalt, thro' the brown paper. With a little heat the ſalt ſeparated itſelf from the earthy part, in the form of a circle, an inch from the bottom. It weighed ſix grains.

2. THE cryſtals taſted juſt like ſea ſalt, and were of a cubical figure.

3. THEY decrepitated and crackled when put on a red hot iron.

4. THE

4. THE ſalt got by evaporation, when diſſolved in water, made no change on ſyrup of violets. Nor was altered with diſtilled vinegar. Raiſed a little motion with ſpirit of vitriol; which might be owing to ſome of the earth ſtill adhering to it. Appeared milky with a ſolution of ſilver.

5. WHEN oil of vitriol was poured on it, the ſame white vapour and pungent ſmell aroſe, as from an equal quantity of ſea ſalt, mixed with the ſame acid.

THESE characteriſtical properties appertain only to ſea ſalt, and ſhewed it evidently to belong to that claſs. Nor was there any occaſion to ſearch in it, for the other effects of that ſalt; ſuch as diſſolving in ſix times its weight of water; proving a menſtruum for gold: aſſiſting in the formation of ſteel: affording the ſpirit of ſea ſalt: melting with difficulty over the fire, and paſſing, at length, thro' the crucible. Its ſmall degree of volatility is ſeldom mentioned among theſe properties,

perties, tho' I find it riſes an inch or two along the ſides of the glaſs.

IT is obſerved by chymiſts, that there is a certain portion of this ſalt, which will not cryſtalize, and remains behind a bitter ſalt liquor. This part is called the Bittern; and appears to be very diſtinct from the former. It conſiſts of the acid of vitriol, and an alkaline earth: for the former is, eaſily, attracted from the latter by an addition of a fixt alkaline ſalt. Moſt of the ſalt in *Dunſe*-water ſeems to be of this ſort.

As the proportion of it is leſs here, than in common water, it ſcarcely merited our attention as a principle, if not to fix its ſpecies, and ſhun all imputation of inaccuracy. The quantity is but ſmall, in proportion to what we, daily, take with our victuals. Its univerſal uſe demands a ſcrutiny into its nature and effects.

IT is got from pits, fountains, or the ſea. All theſe ſeem to be the ſame at bottom; and differ only as they are differently mixed with ſulphureous, oily, earthy, or calcareous particles. What is moſt depurate is the beſt. Rock ſalt appears to grow in the pits. It ſeems to be formed by a conjunction of an acid and mineral alkali; the laſt is, probably, of the ſame nature with that found in the *German* mineral waters.

ITS effects on the human body are more the ſubject of obſervation, and admit of greater certainty. The grateful taſte it gives to things, otherwiſe inſipid, is the cauſe of its univerſal uſe, and the method nature takes to force it on us. It cleans the palate; gently ſtimulates the nerves; and renders them of delicate ſenſation to other things; while itſelf is moſt grateful to the taſte. By gently vellicating the coats of the ſtomach, its motion is quickened, and the ſecretion of its fluids is augmented: hence digeſtion is promoted. It has been alledged, that people will not

not fatten without it. The inhabitants of *Greenland*, *Lapland* and *Nova Zembla*, where ſalt, on account of ſcarcity, is not uſed, are obſerved to be of low ſtature, weak, and unfit for fatigue: whereas thoſe of *Finland*, where ſalt is in plenty, are robuſt, laborious, and warlike.

AFTER it has got into the habit, it aſſiſts, by its ſtimulating power, all the natural ſecretions of the body; and, ſo, helps to carry off thoſe particles, that are unfit to circulate. Thoſe that work in the pits are healthful. It has been obſerved that people, who uſe little ſalt, are oftner troubled with diſeaſes, than they who take it moderately.

BUT its chief uſe in life is owing to the power it has of reſiſting putrefaction. The benefit that ariſes from this property is great. The human body is continually tending to corruption; and would, perhaps, go on too faſt, eſpecially in the young, the active, and inflammatory, were it not retarded by a mixture

ture of this with our victuals. Our bodies are, thus, kept continually ſalted. What was to withſtand corruption muſt needs be incorruptible itſelf. There are few ſubſtances equal to it in this reſpect. Diſſolve it in fluids, it is ſtill recovered again intire. It eſcapes, unaltered, from the human body. The proceſs of putrefaction, that changes other ſalts, has no effect on this. Nothing in ſhort but the extreme violence of the fire can make an impreſſion on it. If this body grows, while it is ſcarce capable of change, the ſum total muſt be in continual increaſe. Hence the ſea muſt advance in ſaltneſs, from the addition of freſh particles brought to it by the rivers, while none can get out.

SECT. V.

TO give this globe a firmneſs and ſtability, an earthy ſubſtance was neceſſary. Fire, water, air, ſalts, and oils, were either liquid, or eaſily diſſolvable in liquids; and ſo unfit to bear the weight of animals. A terreſtrial principle, then, was made the baſis of the

the whole, with different degrees of coheſion, and ſcarce diſſolvable in water.

* *Sic igitur terræ concreto corpore pondus*
Conſtitit.

THIS is the principle that gives ſolidity to the vegetable, the animal, and, perhaps, to the mineral kingdom. It is, always, diſcovered in the two firſt; and, often, in the laſt. Salts † and oils ‡ ſeem to become volatile when freed from it. Yet how ſmall a quantity ſerves theſe purpoſes! for the proportion of earth in bodies is but very inconſiderable.

WHETHER all earths be, ultimately, the ſame, and the difference only depending on

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* LUCRETIUS, lib. 5.

† PUTREFACTION ſeems to render the ſalts and oils volatile, by ſeparating them from the earthy part; for every thing flies off except that.

‡ THE oftner oils are diſtilled, the purer and more volatile they become; for they leave much earth behind them every time. When ſalts are impure from a mixture of oil, chymiſts mix earth with them. By this means the oils are fixt, and the ſalts aſcend more pure.

the different arrangement of ſimilar component particles, and the various mixture of other elements, would, perhaps, be too ſubtile a ſcrutiny. There is great reaſon to think ſo: for the virgin earth, extracted, by chymiſts, from vegetable and animal ſubſtances, is the ſame. Yet, in a general way of ſpeaking, the word varies much, and different profeſſions attach different ideas to it. The farmer has quite a different notion of earth from the chymiſt, and the chymiſt from the examiner of mineral waters.

BY the laſt, every thing that remains indiſſolvable, after the ſalts have been extracted from the *reſiduum*, is called Earth. But as this name is too general, and takes in, not only earthy ſubſtances, but mineral and ſulphureous likewiſe, they have confined it to certain kinds, that have been obſerved in mineral waters.

OKERY earth, according to them, has a yellow, or red colour: a rough aſtringent taſte: and yields iron on fuſion.

CALCA-

CALCAREOUS earth diſſolves eaſily in the mouth: efferveſces with acids: turns corroſive, like lime, by fire. Theſe qualities quadrate exactly with one ſort of marl; and, therefore, this earth is not accurately defined.

STONY earths are known by falling immediately to the ground like ſand. By turning into glaſs with a fixt alkali.

THE marly earth is another mentioned by writers; but in ſuch general terms, and ſo inaccurately, that its properties are not to be learned from them. 'Tis impoſſible, as there are different kinds of marl, to give a deſcription that will ſuit every ſort. Therefore, as it is much uſed; as its properties are unknown; nay the very names of its different kinds unheard, where it is not found; and as the ſubject, ſo far as I know, lyes yet untouched: an attempt to diſcover its qualities and compoſition cannot be diſagreeable to one, who is ſo great an improver as your lordſhip. We are, naturally, led to it by our

ſubject,

ſubject, as the earthy part of *Dunſe*-water is of the marly kind, and the bank near the well is full of it.

IF marl diſſolves eaſily in water, and diſcovers little, or no ſand, betwixt the teeth, or fingers, it is, then, thought good. Theſe are the only ways it is tried before it is made uſe of: but they are too inacurate to fix a certain judgment of its goodneſs. This muſt ariſe from the ſtrength of its properties, diſcovered by the following experiments:

THERE are three different kinds, *clay*, *ſlate* and *ſhell Marl*. The clay marl, when hard, crumbles down eaſily betwixt the fingers; and diſſolves in the mouth. It has, commonly, ſome ſhining particles in it. There are various colours of it.

SLATE marl ſeparates into *laminæ* like ſlate; diſſolves eaſily in the mouth; and has a fattiſh taſte like chocolate. When good,

it

it has not the leaſt grittineſs. That uſed in theſe experiments was extremely good, but very hard.

THE ſhell marl is commonly found in boggy ground, about a foot below the ſurface. It has an odorous ſmell, and diſſolves in the mouth with a little grittineſs. There are a vaſt number of ſmall white ſhells, ſome entire, ſome broken, to be ſeen in it, with ſtraws and other dirt. By the microſcope it appears an open, cotton-like body, full of white ſhells. This kind has the leaſt coheſion and ſpecific gravity.

1. To diſcover the time and force of ſolution in water, three ounces of this was added to nine drachms of each kind. In a few minutes the clay marl cracked, and fell down in pieces: the ſlate marl burſted, and ſeparated itſelf into *laminæ*: but the ſhell ſtill kept its form, tho', now, become very ſoft. With a tea-ſpoon I uſed a little force to break them down: the ſhell marl eaſily yielded to it;

it; the clay marl more difficultly; but the ſlate marl was too hard to be divided with this ſmall force. The ſhell marl was, now, ſwelled to a ſize, much greater than the others; and had ſucked up all the water; while theſe had imbibed but little. Thus, it ſeems to have the ſtrongeſt imbibing, diſſolving, and expanſive force, while the other two, compared to it, are but weak in theſe reſpects. The clay ſeems to diſſolve eaſier than the ſlate marl.

2. I TRIED them next with different acids, that of vinegar, ſpirit of vitriol, and ſpirit of nitre. With them all there was a ſtrong ebullition and effervescence. But the ſhell marl required ſix times more acid to ſaturate it, than the other kinds; and effervesced with a greater vehemence. A drachm of clay marl attracted forty gutts of ſpirit of nitre: as much ſlate marl took twenty eight: but the ſhell marl required two hundred and forty.

3. WHEN

3. WHEN the acid of vitriol was joined to the clay marl, I perceived a ſulphureous ſmell. This I thought proceeded from the iron it contained; but galls made no change.

4. To diſcover if they contained any ſalt, I diſſolved them in water, filtrated, and evaporated it. A very inconſiderable portion, of a browniſh ſubſtance, was got from ſhell marl, that had a bitteriſh and ſomewhat ſaltiſh taſte. Still a ſmaller quantity of this was got from the other two ſorts. They do not contain, then, any ſalt; at leaſt, of a perfect kind. That bitteriſh ſubſtance was poſſibly generated by the action of the air, as they had been kept for ſome time.

5. I ENDEAVOURED to ſeparate theſe marls into different parts, by diſtillation in cloſe veſſels.

FOURTEEN drachms of clay marl gave a drachm and a half of water, and twelve of *reſiduum*, ſo that half a drachm, perhaps, of water

water or air, had eſcaped thro' the luting. The diſtilled water had a marly taſte; was very ſoft; turned a little green with ſyrup of violets; but did not effervesce with ſpirit of vitriol.

SLATE marl, treated the ſame way, gave the ſame water, but in ſmaller proportion. Thus it contains no oil, tho' the taſte would incline me to think it did.

ON opening the glaſſes, in which the ſhell marl was diſtilled, a volatile pungent ſmell, like that of ſpirit of hartshorn, iſſued out. The neck of the retort was covered with a thick empyreumatic oil, too heavy to riſe further. In the receiver was a volatile alkaline ſpirit, with ſome thick fetid oil on the top. Shell marl, then, appears to be an animal ſubſtance; and, like it, contains earth, water, two oils, and a ſalt capable, by fire, of turning alkaline and volatile. It is, therefore, very different from the two former.

6. I TRI-

6. I TRIED next what alterations an open ſtrong fire would make in theſe bodies.

A DRACHM of clay marl calcined, for an hour, in the ſtrongeſt heat of a ſmith's forge, loſt ten grains, and was of a light ſnuff colour. It was no longer diſſolvable in the mouth, in water, or vinegar. The magnet diſcovered iron in it.

THE ſame quantity of ſlate marl, calcined the ſame time, loſt eighteen grains. It was of a dark red colour; nor would it diſſolve in water, or vinegar. The loadſtone diſcovered in it a great quantity of iron.

THE ſame quantity of ſhell marl loſt thirty two grains. Its colour was but little altered. It diſſolved in the mouth with a ſweetiſh taſte like lime; effervеſced with acids; attracted water, and gave it the ſame taſte, that lime does. No iron was diſcovered in it. Hence appears another great difference betwixt theſe marls.

A GREAT many more trials might be made, but I truſt theſe are ſufficient for aſcertaining their properties, nature and compoſition. Whether the difference, in theſe experiments, betwixt the clay and ſlate marl, ariſes from a difference of ſubſtance, or coheſion, matters not. It is enough that they are found different.

LET us now ſee to what ſpecies of theſe the earthy part of *Dunſe*-water belongs. It was of a light colour: effervеſced with acids, and deſtroyed their acidity: turned red on calcination, and was no longer diſſolvable in water. Thus, it appears to belong to the clay, or ſlate marl: more probably to the laſt.

THE effects of this earth, on the human body, muſt be to abſorb and deſtroy all acidity in the ſtomach and inteſtines, and to turn it into ſomething neutral and innocent. I ſcarcely believe its operation will go much further: tho' that, indeed, is no deſpicable effect, as gripes, cholic, purging, are often

en owing to the prevalence of acidity. It ſeems in no ſhape inferior to crabs-eyes, or any other ſweetner; for that is the name abſorbents generally get.

How theſe marls are uſed in agriculture, your lordſhip is better able to inſtruct me. Some looſe thoughts, on their manner of operation, and fertilizing ground, may not be diſagreeable. 'Tis a ſpeculation worthy of attention: and, once eſtabliſhed, may afford the improver ſeveral hints in the application of this excellent manure. It will ſerve as a ſpecimen of the junction, hinted above, betwixt chymiſtry and the farming art; and ſhow, that the plan is not quite ſo chimerical, as it appeared, perhaps, at firſt ſight.

THE operations of all bodies are to be drawn from their known qualities and properties, aſcertained by experiment. Reaſoning, on any other footing, is chimerical and deluſive. The moſt remarkable, then, if not the only, properties in marl are, its ſwelling

and

and burſting with water; and its power of attracting acids. On theſe two qualities we muſt proceed, if we have a mind to travel on ſure ground.

IF therefore the ſoil be too adheſive and ſtiff, as farmers call it, marl muſt ſwell, looſen, burſt, attenuate, and open the glebe, when once the moiſture has acted on it. The roots of plants will, then, puſh themſelves down eaſier and further, and ſo draw nouriſhment from a greater diſtance. This effect, as it is wrought in a mechanical way, I chuſe to call its *mechanical power*.

7. TO make it obvious to the naked ſenſe, equal quantities of the different kinds of marl were mixed with equal quantities of ſtiff clay; formed into ſeparate balls with water; and dry'd before the fire. A ball equal to the former was formed of pure clay. Theſe, when dried, were put into water that covered but one half of them. The two balls made of clay, and ſlate marl with clay, fell down

down in powder, by degrees, to the bottom. The ball made of ſhell marl and clay ſwelled, cracked, and attracted the water over the half that was above its ſurface. It turned ſoft, but did not fall down in powder. The ball of pure clay was not in the leaſt affected. This experiment brings home to the eye the mechanical effect of marl, and ſhews its ſtrong attenuating power, when mixed with a ſtiff clay. It has been uſed on ſuch ground with great ſucceſs. I am not ignorant, that it has a quite contrary effect on light ground; or is thought to have. It may well be ſo. As marl has a certain degree of coheſion, it will bring all ground, that has leſs than itſelf, to its own firmneſs, and render very light ground more ſtiff.

THE *Roman* poet and farmer, when ſpeaking of opening ground and fitting it for the roots of young trees, gives this advice;

* *Aut lapidem bibulum, aut ſqualentes infode conchas.*

THIS

* VIRGIL, Georg. II. l. 347.

THIS deſcription agrees ſo well with the different kinds of marl, and their effects, that I am almoſt led to think he ſpeaks of them. Whether this criticiſm be juſt or not, your lordſhip is the beſt judge, as he ſeems your favourite poet.

BUT the great effects, that marl diſcovers in aſſiſting vegetation, can never be owing, entirely, to this mechanical power. For how would it better ground, that is, already, of a due conſiſtence? It muſt have another power independent of this: and this we muſt ſeek for in the other quality, that of attracting acids. If we examine the different compoſts, made uſe of to enrich land, we ſhall ſoon diſcover them to be of an alkaline nature. All animal and vegetable ſubſtances putrified, dung, ſoot, are volatile alkalines. The aſhes of wood contain a fixt alkaline ſalt. Lime and chalk are of that nature. All theſe effervеſce with acids. In this alone they all agree; while in other circumſtances they differ widely. On this alone their vegetating

getating power muſt then depend. Here marl agrees with theſe; and, from hence, derives its *fructifying power*. For ſo I would call this laſt, to diſtinguiſh it from the mechanical.

MARL and theſe other manures operate, I imagine, in this manner. The atmoſphere moſt certainly contains an acid. Alkaline ſalts, expoſed for a time, turn neutral; which can only be effectuated by receiving an acid from the air. Their affording, under theſe circumſtances, an acid puts it beyond all doubt. The *caput mortuum* of vitriol or allum, generates new ſalts in the air. Lead in time turns to ceruſs. But the formation of nitre is the moſt convincing proof of this acid. Whether this be of one kind *, as the chymiſts ſeem to think, by naming it the Vague acid, or of different ſorts, I ſhall not pretend

* IT appears to be the vitriolic acid. This acid ſeems capable of being changed into the marine or nitrous acid, according to the matrix to which it is joined.

pretend to determine. 'Tis enough for me, that experiment diſcovers it.

IF marl, then, is expoſed to the atmoſphere, it muſt, it will attract the acid; and turn into ſome neutral body. The ſame muſt happen to the other alkaline manures. This is the unknown principle that the glebe receives from the influence of the air; for all ſoils contain a proportion of alkaline particles. The quantity imbibed muſt be according to the expoſition of freſh attractive matter. This obſervation every farmer has made, without knowing the cauſe. Experience teaches him, that the action of the plough makes his fields more fertile.

* *Illa ſeges demum votis reſpondit avari*
Agricolæ, bis quæ ſolem, bis frigora ſenſit:
Illius immenſæ ruperunt horrea meſſes.

WERE it not a dangerous way of reaſoning to argue from final cauſes, it might be eaſy to ſhow, that nothing could counteract the

* VIRGIL, Georg. I. l. 47.

the alkaline corrupted quality of putrefaction, and bring it to a wholeſome neutral ſtate, but the agency of an acid. But we need no uncertain proof, as experiment is our friend.

THE nature of that neutral ſubſtance, formed by marl, and the acid of the air, may be gueſſed at by the formation of nitre. This is manufactured in the *Indies*, by expoſing alkaline bodies to the air; and is, therefore, very analogous to our preſent purpoſe. Putrified ſubſtances, old lime, and a ſort of earth like our marl, are made uſe of to be changed, by the aerial acid, into a neutral ſalt, fit to become nitre, when treated in a certain way. Such, likewiſe, muſt be the product from marl and other compoſts. Could we diſcover ſuch a ſalt from a junction of marl and acids, this theory would be greatly confirmed.

8. I SATURATED the different kinds of marl with the acid of vinegar. When they had ſtood ſome days, and were dry again, I

found a ſaline ſubſtance, in great plenty, ſhooting up the ſides of the cups. This ſalt was white, and taſted rough in the mouth. The ſame experiment was tried with the ſpirit of vitriol: but, with it, little ſalt was procured. Whether this was owing to the peculiar nature of the acid, or to the ſhortneſs of time it was allowed to ſtand, I know not.

9. To ſaturate marl with the ſpirit of nitre, into which the acid ſpirit of the air is probably changed by the matrix, ſeemed to come nearer the point. To a drachm of ſhell marl, as much ſpirit of nitre was added, as it would abſorb. This was diluted with water; filtrated; and evaporated. From this I got forty five grains of a whitiſh ſalt, that had a bitter, pungent, nitrous taſte. It was ſwelled up to a great degree. It would not cryſtallize, but agreed with nitre in almoſt all its properties. Brown paper dipt in a ſolution of it, and dried, was turned into a ſparkling match, and burnt to the end. It preſerved fleſh, and turned it red. It deflagrated as

nitre

nitre does, with the coal of burnt wood. I tried to bring it to cryſtallize, by an addition of ſalt of tartar; but I could not accompliſh it. There ſeems to be a ſecret in the manufacture of nitre that we are not yet well acquainted with.

A SALT, that ſeemed of the ſame nature, was got, in this way, from clay and ſlate marl; but in much ſmaller quantity than from the former. Lime, ſaturated with the ſame acid, yielded it in great abundance. How far theſe experiments will be of uſe in other points; how far they determine the compoſition of ſalts; and diſcover the operations of nature; how far thoſe, from different acids differ; or if thoſe, from different manures and the ſame acid, agree; theſe queſtions, I ſay, merit conſideration. But this is not the place. Our only intention, here, is, to find out the nature of that neutral ſubſtance, formed by the marl and acid of the air. This appears, even to the ſenſes, to be a ſalt of the nitrous kind.

IF there is any acid in the ground that renders it unfruitful, as the vitriolic acid is thought to do, the marl will attract it, and convert it, from a noxious, into a neutral fruitful principle. The effects here muſt be the ſame as in the former caſe.

THIS theory, if juſt, ſhould account for the different operations of theſe different marls. The ſhell marl produces as good crops the firſt year, after it is laid on, as it does in any of the ſubſequent. The clay marl has not its ſtrongeſt effect generally till the third year. Slate marl is ſtill more ſlow in its operation: ſome out of the ſame pit, that I had mine, lay on the ground undiſſolved for four years, without enriching it in the leaſt. The formation of the nitrous ſalt, that ſeeming cauſe of vegetation, muſt depend on, and be in proportion to their power of attracting acids, and ſmall degree of coheſion, by which a greater number of particles are in action. The ſhell marl we found to be the moſt ſoluble in water, and to attract acids with the

greateſt

greateſt force; the clay marl came next; and laſt of all the ſlate. They muſt, then, form themſelves into that nitrous ſalt, and have their effects in the ſame courſe, as experience has obſerved. The ſame turn they keep in looſing their effects, for the ſooneſt converted into ſalt, muſt be the ſooneſt exhauſted. Thus the reaſoning anſwers exactly to obſervation: no ſmall confirmation of its truth.

ALL theories, my lord, are liable to objections; altho', in this, not one ſtep has been made without experiment. There is but one objection occurs to me at preſent: for I ſhall make no ſcruple to let you ſee the weak ſide of this theory, as well as its ſtrong. It is ſaid that marl laid on ground, a ſecond time, after the effect of the former has been gone, does not enrich it: why ſhould not this marl attract the acid, as well, as the former? We have had, my lord, ſuch ſhort experience, as yet, of this manure, that the fact, I doubt, is not well aſcertained. If future experience confirm it, may we not attribute the loſs of

fertility

fertility to ſomething, the firſt marl has left behind, that may prove an enemy to vegetation? Marl, by the trials I have made, does not ſeem all convertible into ſalt.

ITS manner of acting may, perhaps, afford your lordſhip ſome hints in the application and management of it. The obſervations made on the formation of nitre, in thoſe countries where it is manufactured, may be of uſe in this point. Great heat, great cold, or much rain hinder the production of it; for the heat dries too much, and the rain waſhes it away. The ſummer nights favour greatly its generation. The eaſt and north winds are obſerved to bring more of that acid with them, than the weſt, or ſouth. The heat, rain, and winds, tho' not under our command, yet have their times and ſeaſons. All manures are to be expoſed in thoſe that ſuit beſt in general.

THE management of marl, after it is laid on the ground, may differ according to the intention.

intention. If its mechanical power is, particularly, wanted, 'tis worth conſidering whether the plow ſhould not be uſed directly, that, being mixed with the glebe, it may attenuate the ſoil more forcibly. If its fructifying power is only expected, it appears probable, that its effects muſt be ſtronger, when much expoſed to the influence of the air, than if directly buried. Being a ſtranger to the practice of the farming art, I am not capable of diſcovering all the advantages, that may, perhaps, be drawn from theſe experiments. This task I leave to your lordſhip's judgment, that experience and reaſoning may go hand in hand.

SECT. VI.

MINERAL waters have a ſubtile ſpirit, which acts on the whole, as the animal ſoul does on body. A great part of their agency is owing to its activity. It cannot be ſhown to the ſenſes; tho', by its effects, the ſenſes, evidently, diſcover it. And,

when

when it flies off, the remaining water is little better than the common ſort.

WHOEVER has looked into thoſe authors, that have given us the marks of this ſpirit, muſt have obſerved, that moſt of them belong to the air. Air and ſpirit ſeem, indeed, intimately united in many waters; for the firſt carries off the laſt along with it; and appears to be its vehicle. Yet, as they are by nature different, they ought, if poſſible, to be ſeparated; and the criterions of both eſtabliſhed. Thoſe of air were aſcertained before: thoſe of ſpirit ſhall be mentioned now.

1. MINERAL water diſcovers a ſpirit, if its taſte and ſmell, at the fountain, ſeems ſpirituous; but flat and vapid, when expoſed to the air for ſome time. Something very ſubtile is, by this means, diſcovered to fly off.

2. IF it appears light on the ſtomach, when drunk at the well; and heavy, after it has been kept.

3. IF,

3. IF, in the air-pump, ſomething beſides the air flies off; and its ſmell and taſte differ, when examined after.

4. IF the water, drunk at the fountain, has an intoxicating quality. Some of the *German* waters have this to a great degree.

5. IF galls have no effect on the water, after it has ſtood a few hours. This ſhews the ſpirit to be of a ſteely nature. That of the *German* waters ſeems to be ſomething very different, and, according to a great chymiſt*, is, "Aether combined with the univer-" ſal ſulphureous ens of minerals, and per-" vading the earth." This account of the matter, tho' obſcure, ſhows, that he thinks their ſpirit different from any preparation of ſteel. *Dunſe*-water poſſeſſes all theſe properties of ſpirit: and as they decreaſe, in the ſame degree with the tincturing quality, it evidently appears to be a chalybeat ſpirit.

* Hoffman. de elementis aq. miner. &c. parag. 18.

IN what ſhape this chalybeat principle exiſts in mineral waters, is a queſtion that has much perplexed authors. The orthodox opinion is, that it lurks under the form of a ſalt, or vitriol of ſteel: the meaning of which is, that the iron has been corroded by an acid, and is ſtill joined to it, juſt like the ſalt, or vitriol of ſteel made by art. This opinion takes its riſe, from a reſemblance, that ſalt of ſteel, diſſolved in water, has to ſteel waters. This reſemblance conſiſts in the following circumſtances. Their taſte is ſomewhat like. Both turn purple with galls. Both recover their former pellucidity with an acid, and turn purple, again, with an alkali. Both depoſite an oker. From this reſemblance they concluded, that a vitriol muſt be contained in theſe waters. But is not the concluſion ſomewhat ſtrained? Muſt the reſemblance of mineral waters to this preparation exclude their reſemblance to others? or have theſe authors examined each ſhape that ſteel could be put in, ſo as to ſay, that this preparation alone

alone enjoyed theſe properties? if not; the conſequence will hardly be admitted.

IF common vitriol and that of mineral waters agree in theſe points; in others they diſagree as remarkably. Common vitriol is of a fixt nature; that of mineral waters of a volatile. The firſt can always be made appear; the laſt never *. Salt of ſteel, diſſolved in water, loſes its tincturing quality, if expoſed to the air, for ſome weeks. But this difference of time ſhows a great difference in their nature. There is an experiment that ſeems, at firſt ſight, to favour this ſide of the queſtion. Oil of tartar *p. d.* dropt into a ſolution of vitriol, turns it green, and thick. It is, probably, owing to the acid of the ſteel being attracted by the alkaline ſalt. No ſuch effect is obſerved in mineral waters. I, therefore, concluded, that no acid was joined to their ſteel. But, on a narrow examination, I, afterwards, found, that more vitriol was required

* HELMONT pretends to have extracted vitriol from the Spaw; but none gives credit to him now.

quired to produce this effect, than what could be ſuppoſed in mineral waters, and that this experiment could prove nothing.

SWAYED, however, by the other arguments, that great chymiſt *Hoffman* * denies the vitriol of mineral waters to be the ſame with the common; but ſtill inſiſts, from the former reſemblance, that it muſt be a vitriol, tho' of a particular kind.

† *Hac urget lupus, hac canis.*

Chrouet is the only author, I have met with, who, not being able to extract vitriol, from theſe waters, doubts of its exiſtence. But he brings no argument to ſupport his opinion. Nay even relapſes ‡ into the common doctrine.

THIS

* DE thermarum et acidularum uſu et abuſu, parag. 3.

† HORAT. ſatyr. 2. lib. 2. l. 64.

‡ SPEAKING of the formation of mineral waters, he ſays, "Suppoſing a ſulphureous earth and an alkaline fixt ſalt met "together, the acid of the air, attracted by the alkaline "ſalt, muſt produce a fermentation and ſwelling; which "does,

THIS was my own caſe, after trying ſeveral experiments in vain; till I obſerved, that *Dunſe*-water, by keeping, recovered its ſteely ſpirit. This could happen, ſo far as appeared to me, by no other means, but by a ſolution of the remaining fixt ſteel. No acid could join it. A very ſimple experiment was made to determine this. Five grains of ſteel filings were infuſed, for two days, in an ounce of diſtilled water. This infuſion took a deep tincture with galls. Spirit of vitriol turned it pellucid again. Many air-bubbles were obſerved adhering to the filings of iron, during the time of infuſion, which aroſe on touching the glaſs. A reddiſh okery matter fell to the bottom, that increaſed every day. A ſcum, too, was obſerved. This ſolution, expoſed to the air, for ſome hours, loſt its tinging

" done, the mixture retires within itſelf and then becomes " the ore of iron. If running water paſs through it, while " yet in this ſoft ſtate, the imperfect ore, and air, ariſing " from the mixture, will be waſhed away. A little of the " aerial acid, being joined to the ſteel, whenever the water " comes to the open air, the acid flies off, and the ſteel " falls, like an excrement, to the bottom." This account of the affair is neither more, nor leſs, than a vitriol.

tinging quality. This experiment ſucceeded with different kinds of water. I found it neceſſary to cork the bottle well. As this ſolution has the effects of mineral waters, without being liable to the weighty objections of a ſuppoſed vitriol, why ſhould we not conclude, that the ſteel of mineral waters is like this; minutely divided, but in no wiſe altered? I can, for my ſhare, ſee no objection againſt the juſtneſs of this concluſion. Whether theſe arguments ſtrike equally, againſt all mineral waters, that contain ſteel, I leave others to judge.

THIS ſteely principle diſappears, at different times, in different waters. *Dunſe*-ſpaw loſes it ſooner, than any we find, yet, deſcribed. Loſe it, is a word I have, purpoſely, uſed thro' the whole work; becauſe it anſwers equally well, whether the chalybeat ſpirit flies off, or is changed into a fixt ſteel. To have called it volatile, would have been taking that for granted, which had not been proved; and fixing a prepoſſeſſion, a thing

every

every enquirer into truth ought to ſhun. This queſtion is of conſiderable importance; has not, yet, been determined, ſo far as I know; and its determination muſt greatly affect our reaſonings on the medicinal operations of theſe waters.

THE ſteely ſpirit appears to be volatile, and not metamorphoſed, from theſe circumſtances.

6. A CONSIDERABLE difference is obſerved in the water, and the chalybeat ſpirit much longer retained, when it is carried from the well with the necks of the bottles down. Were it changed, the poſition of the bottles would make no difference. But it muſt eſcape, eaſier, thro' the cork, than glaſs.

7. IT is gone, before any viſible alteration happens in the water; or precipitation is made.

8. A BOTTLE, half full of the water, was ſhaked, for a quarter of an hour. This had now loſt all its tincturing quality; while that, which ſtood in another bottle, equally full, for the ſame time, was not ſenſibly altered.

tered. This ſhaking ſhould rather have hindered the coalition of particles; ſtopt the formation of fixt ſteel; and ſo have proved an enemy to all change. But, on the ſyſtem of its being volatile, 'tis eaſily accounted for, why the expoſing it more to the atmoſphere, by toſſing, ſhould rob it, ſooner, of its volatile parts.

9. IT is no ſmall confirmation of this volatility, that the chalybeat ſpirit of the putrified water is, beyond all doubt, volatile: for no ſteel is found in the *reſiduum* of it. Nor is the fixt ſteel, diſcovered in freſh water, any objection againſt the volatility of its ſpirit: even this endeavours to get off, and riſes to the top in form of a ſcum; but theſe particles, not being ſubtile enough, cannot get away, and ſo become the fixt ſteel.

THESE, joined to an experiment which follows, that ſhows a diminution of its weight, while neither air, nor water could poſſibly eſcape, afford as great a degree of certainty, as

as the nature of the queſtion will admit, that the chalybeat ſpirit is volatile.

IF it could be caught, we might, then, fix its weight and properties more certainly. *Hoffman*, for this purpoſe, adviſes diſtillation in cloſe veſſels. But how unfit this operation is to lay hold of it, has, already, appeared. I endeavoured to catch it in bladders, well oiled, and ty'd round the mouths of bottles, that contained the water. The air, caught in this way, gave no demonſtration of containing a ſteely ſpirit: for water, impregnated, again, with it, did not alter with galls. Several other attempts were made: but all in vain. Its ſubtility ſeemed almoſt beyond that of matter.

A VERY * ingenious attempt has been made to determine the quantity of ſteel in mineral waters. But as it depends, entirely, on the ſteel exiſting, in theſe, under a vitriolic form, we cannot, having once deni-

* IN a paper by Mr. Monro, vid. med. eſſ. vol. III.

ed the vitriol, reaſon on it, or draw any concluſions from it. The experiment, however, is of ſingular uſe, as it determines, exactly, the colour different waters take with galls; and gives us a power of communicating that colour to another; an affair of no ſmall importance. On that very ingenious gentleman's ſcheme I have determined this point already.

IF the quantity of volatile ſpirit is conſiderable, there ſhould be a ſenſible decreaſe of weight. To aſcertain this point,

10. I PUT twelve ounces of *Dunſe*-water in a phial; corked it well; ſealed it over; and weighed it, in exact ſcales, with the greateſt nicety. It ſtood thus, for twelve hours, till I imagined the volatile ſpirit had eſcaped. It was, then, twelve grains lighter. Galls had no effect on it. The ſame experiment was tried a ſecond time, and I found a loſs of ſeven grains. This difference might have been owing to my holding the bottle for

a few

a few minutes uncorked. I ſhall not pretend to ſay, that this diminution of weight was owing, entirely, to the volatile chalybeat ſpirit. But it appeared neither owing to air, nor the vapour of water; for no loſs of weight was obſerved in common water treated the ſame way. The queſtion is difficult; the determination dangerous.

BY volatility naturaliſts mean no more, than ſuch an attenuation of particles, as makes them fit to mount in the air. How it ſhould do ſo, is thus explained by the learned Dr. *Friend* *. In dividing bodies the quantity of matter decreaſes faſter than the ſurface. All matter, therefore, may be reduced to ſuch minute parts, by carrying on the diviſion, that the contents will hold but a ſmall proportion to the ſurface. Lightneſs, then, or volatility, which is only a higher degree of it, is nothing elſe but a ſmall quantity of matter under a large ſurface. In this way all bodies may become volatile; and the heavieſt made lighter

* Prælectiones chemicæ, cap. de ſublimatione.

lighter than the lighteſt, if we had a full power to divide, as far as we pleaſed.

THAT particles rendered very minute become volatile, is very evident. The action of putrefaction rendering the ſalts volatile, and the action of fermentation forming a volatile ſpirit, by the attenuating power of theſe two proceſſes, are convincing proofs of it. But that this depends on the cauſe aſſigned by *Friend* ſeems very doubtful. The enlarging of the ſurface of a body may make it more eaſily carried up into the air by other bodies, ſuch as fire, air, *&c.* or it may be the leſs able to disjoin and ſeparate, by its ſpecific gravity, the particles of air through which it muſt paſs in deſcending; but I can never ſee how it can riſe of itſelf on theſe principles. There ſeems to be an attraction, or ſome other power in the air, that is the chief cauſe of volatility. The great *Boyle* has juſt given us a hint of it *.

"But

* VOL. III. of the mechanical origin and production of volatility.

" But the account, on which, by its bare " preſence, or peculiar operations, conduces " to the volatilization of ſome bodies, is a " thing very difficult to be determined, with- " out having recourſe to ſome notions about " gravity and levity, and of the conſtituti- " on of the corpuſcles, that compoſe the air; " which I take to be both very numerous, " and no leſs various. And, therefore, I muſt " not, in theſe occaſional notes, launch out " into ſuch a ſubject, though, for fear I " ſhould be blamed for too much ſlighting " my old acquaintance the air, I durſt not " quite omit the power it has to diſpoſe ſome " bodies to volatility."

As vaſt ſubtility begets volatility; ſo great volatility argues vaſt ſubtility and minuteneſs. There are not many things in nature that ſeem more ſo than this ſpirit. Glaſs, that can preſerve all odours, confine the effluvia of diſeaſes, and retain the moſt volatile chymical ſalts, allows this to eſcape through its pores in a few hours. Art can never arrive

at

at any ſuch manufacture. How powerfully muſt this ſpirit operate on the human body! As ſteel it will have all the effects of that mineral. But as ſteel, extremely ſubtilized, it muſt have them in a great degree.

THE properties of ſteel are, already, too well known to trouble your lordſhip with a detail of them. For its great ſervice, it merited the conſideration of phyſicians; and has had it. Its power of opening obſtructions; encreaſing heat; thinning viſcid blood; ſtrengthening the fibres, and acting by diureſis, has already been fully explained by others. No more commentaries are neceſſary on this head.

THE effects of this martial ſpirit appear from the following experiment:

II. SOME of the mineral-water was put in a bladder, whoſe neck, for two inches, was twiſted hard; firmly tied; and, then, ſealed over with wax. The bladder was put into

into water, heated to the degree of the human body. After it had remained there for half an hour, the bladder was opened, but the volatile ſpirit had eſcaped.

THIS experiment brings its action home to the very eye; and ſhews how ſoon it will penetrate through the coats of the ſtomach, and the whole body. If, in half an hour, it could paſs through the moſt membranous part of an ox, ſure the ſoft and tender coats of the ſtomach will not be able to contain it ſo long. Great part of its action muſt be exerciſed in the neighbouring parts. It muſt ſoon pervade the whole body.

SECT. VII.

WATER may be tinctured with minerals, either by their vapour, or ſubtile particles. We have a probability, that the firſt may, ſometimes, be the caſe; for the ſteam of iron, corroded by the ſpirit of vitriol, if confined, and directed towards pure wa-

ter,

ter, is found to give it a *Spaw* taſte. But this muſt ſeldom be the caſe; and but for a ſhort time. Fermentations, ebullitions, and corroſions in the bowels of the earth cannot laſt long. The other way where the mineral beds are waſhed by water, ſubtilized, and carried along, is, probably, the moſt general. *Dunſe*-ſpaw, I imagine, is of this kind. A mineral bed of iron, and a marly ſoil appear ſufficient to produce ſuch a ſpring. This account of its formation is plain and ſimple; and, therefore, more conſonant to the general proceeding of nature.

It will, perhaps, amuſe your lordſhip to run a compariſon betwixt this ſpaw and thoſe of other countries. If we can find any that contain the ſame principles, they will ſerve as a foundation for extending the ſalutary effects of this, which is but yet in its infancy. The analogical reaſoning may, then, be uſed with ſafety; and the uſe of the water preſcribed with greater certainty. The contents of theſe waters muſt be taken on truſt from the beſt

beſt authors. None is equal of himſelf to this task.

IN the * deſcriptions of the *French* mineral-waters, there is an account of one that appears ſimilar to ours. The water of *Provins* is ferruginous. On evaporation a ſubtile earth, like ruſt, fell to the bottom. A portion of this formed a circle round the glaſs, and taſted ſalt. This ſalt did not moiſten in the air, and appeared to be that portion of ſea ſalt, which does not cryſtallize. Its earth was whitiſh; diſſolved in vinegar; and, when ignited, took a red colour. By this deſcription its contents appear to be the ſame with thoſe of *Dunſe*-ſpaw. But, unluckily, its virtues are not related, nor have I been able, as yet, to come to the knowledge of them.

THE waters of *Aix* are hot; contain ſulphur in great quantity; an alkaline ſalt; ſome ſea ſalt; and earth that ſeems to be of the ſtony kind. A pound of water has twenty five grains of this ſalt, and five of earth.

* DU CLOS.

THE different ſprings of the *Spaw* * differ more in the quantity than quality of their ingredients. The *Pohon* conſiſts moſtly of a ſteel; yet has a little ſulphur, and lixivial ſalt. The *Geronſter* has little ſteel, but much ſulphur, and lixivial ſalt. The *Tonnilet* has a fatty unctuous ſalt that partakes of allum; ſulphur; and fixt iron. The *Sauveniere* contains lixivial ſalt; ſulphur; and iron.

Selter water affords nothing but a pure alkaline ſalt. It ſeemed to me, when taſted at the fountain, to be the moſt ſpirituous of all the *German*-waters, and to have moſt of the intoxicating quality.

Pyrmont water has much ſpirit; a great quantity of ſteel; ſome ſea ſalt; and an alkaline ſubſtance, whether earth or ſalt, is left uncertain: moſt probably the laſt.

THESE

* THE contents of the Spaw are rather taken from Chrouet than Hoffman, becauſe the laſt does not ſeem to have made his experiments on the ſpot, nor does he inform us from what fountain the water was taken: tho' it ſeems to be from the Pohon. He denies a ſulphur in that which he examined. The contents of the reſt are from him.

THESE differ very much from the contents of ours. There is one, however, that reſembles it, nearly, in its main contents. It gets its name from *Lauchſtadienſis*, a place in *Miſnia*, belonging to the elector of *Saxony*. The water is heavy at the fountain; but light if kept ſome hours. With oil of tartar *p. d.* a fine earth is precipitated. It turns purple with galls: depoſites an oker: and remains long uncorrupted. Its ſubtile chalybeat ſpirit leaves it ſoon, if expoſed to the air, or heat. *Hoffman*, contrary to his common doctrine, aſſerts, that the ſteel exiſts, here, in its pure native form †.

THE virtues of this water are delivered to us at full length. It gives a great appetite; quickens the pulſe; and raiſes a roſy colour in the cheek. 'Tis good for all weakneſs of the firſt paſſages; bad digeſtion; vomiting of viſcid mucus; habitual tendency to looſeneſs;

† IN hac autem, marti nativa adhuc conſtat integritas, neque quippiam alieni ſociatum, et hanc ob cauſam omni detrimentali et pernicioſo effectu deſtitutus eſt. De fonte martiato Lauchſtadienſi, parag. 11.

neſs; general laxity, and weakneſs of the body; obſtructions of the liver, ſpleen, or any other part; jaundice; chloroſis; ſtone; ſcurvy; gout; ſciatic; nervous ſpaſms; and hyſteric fits. When uſed as a bath, it cures weakneſs of the limbs; ſtiffneſs from the gout, or other cauſe; all tumours, and pains in old people from laxity; obſtructions of the glands; and defedations of the skin.

LET us now, my lord, come home to our own country, and examine the moſt famous mineral waters in it. The contents of our two hot ſprings, *Bath* and *Briſtol*, are not, yet, well aſcertained. Authors differ much about them, and have left a great deal for further enquiry.

Bath, by experiment, diſcovers a volatile ſteel; abſorbent earth; a neutral ſalt; a very little ſea ſalt; and * ſulphur.

THE

* SILVER is turned black by the Bath-waters. Sulphurous fumes are emitted on burning the reſiduum. See Guidot on Bath-waters.

THE contents of *Briſtol* are, yet, more dubious. Theſe, taken from the experiments, and not the concluſions of authors, ſeem to be a volatile ſpirit; ſea ſalt; a neutral ſalt; and a calcareous earth.

Scarborough has been happy in an enquirer. It contains a ſteely ſpirit; alkaline earth; a great portion of a purgative neutral ſalt; with a ſmall quantity of ſea ſalt.

Moffat * diſcovers a volatile ſulphur, or ſome conſtituent parts of ſulphur; copper; ſea ſalt; and abſorbent earth.

Cornhill water has had a reputation for many years; and, therefore, deſerves to be examined: more eſpecially as no account is, yet, given of its contents. This ſpring is exceeding cold, and demands carminatives, and other helps to obviate this quality. It has a blue colour, no ſmell, and a taſte reſembling a very weak ſolution of Glauber ſalt.

* SEE an accurate examination of this water by Dr. Plummer med. eſſays, vol. I.

ſalt. A ſcum and okery ſubſtance is ſeparated. It is very little heavier than the brook water that runs by.

NEITHER ſilver, nor iron were diſcoloured by it. Galls had no effect. Oil of tartar *p. d.* turned it milky. A ſolution of ſugar of lead formed yellow clouds, that depoſited a red powder. Quick-ſilver, diſſolved in ſpirit of nitre, turned it yellow. Spirit of nitre and oil of vitriol made no alteration. Neither did a ſolution of corroſive ſublimate; ſyrup of violets; or diſtilled vinegar. A ſolution of ſilver in ſpirit of nitre raiſed a milkineſs, which in a few minutes changed into a sky-blue colour above, and a red below: in a quarter of an hour the mixture was of a deep purple, with a conſiderable precipitation of a leaden-coloured powder. I am at a loſs, my lord, to determine, whether or not this laſt experiment argues a ſulphur. Chymiſts agree in calling thoſe waters ſulphureous, that turn a ſolution of ſilver black. But that was not the colour in this experiment. In

froſty

frosty weather this experiment does not succeed so well; for then, the matter precipitated is only altered in its colour. Worms were not affected by this water. Milk was curdled by it. Soap is not dissolved in it.

THE oker is of a brick colour; and has no taste; effervesces strongly with vinegar; gives no sulphureous smell when put on a red hot iron; nor detonates with nitre. After calcination none of the oker is attracted by the magnet, nor strikes a colour with galls and water. Thus, tho' the oker and scum of *Cornhill* water resembles those of *Dunse*, they appear very different by experiment. All okers have hitherto been imagined of the same irony nature.

WHEN kept a day it loses its peculiar taste. This discovers a spirit in it. Of what nature this spirit is, I cannot say. It is not a volatile sulphur, because the water, deprived of it, still alters a solution of silver in spirit of nitre.

Two

Two *Engliſh* pints evaporated gave twenty grains of *reſiduum*. The ſecond part of ſea ſalt made four grains of this. The other ſixteen were compoſed of a terreſtrial ſubſtance of a particular nature, nor reſembling any yet deſcribed. This began to be depoſited, before the water was half evaporated; and, therefore, ſhewed itſelf to belong to the claſs of earths. It is white; ſparkling; taſteleſs; ſcarce diſſolvable in the mouth or water; neither acid, nor alkaline; and, when viewed by a microſcope, appears to be a congeries of pellucid particles like ſalt. When the water is evaporated over a ſtrong fire, it covers the bottom of the veſſel, like a ſtony concretion. But, if the heat is gentle, it ſhews itſelf in a looſe form, as ſo many white *ſpiculæ*. As it does not diſſolve, like ſalts, in water, I chuſe to claſs it with earthy ſubſtances; tho', in many reſpects, it appears like the ſaline. This earth is purgative.

PART

PART III.

SECTION I.

MINERAL waters, whoſe ſalutary effects are ſo evident to the vulgar, were eſteemed the favours of heaven, and put under the guardianſhip of the gods. Thus the *Calderinæ* were conſecrated to *Juno*; the *Cluſinæ* to *Æſculapius*; the *Albulæ* to *Hygeia*; and the *Bath* waters to *Minerva*. Great men often ſhared in the honour, as diſcoverers, or encouragers of theſe reſervoirs of health. *Aix* waters are called *Graniæ*, from *Granicus* a *Roman* general who firſt diſcovered them, and built a caſtle for their protection. The *Carolinæ* had their name from the emperor *Charles*. Mankind are, generally, grateful for any ſervice done them; and tranſmit the names of their benefactors, with honour, to poſterity: this acknowledgment is the only one they are ca-

pable of; tho', indeed, a great one. And when I look forward into the annals of futurity, I cannot but imagine your lordſhip's name ſtands inrolled there. Nay, more; you deſerve it. To reward induſtry; promote manufacture; and encourage trade, are more uſeful qualities, than to extend our limits. The firſt tends to the happineſs of mankind; the latter to their miſery. One peoples, while the other diſpeoples the world. Thus much we owe you when alive: thus much poſterity will pay, when you are no more.

YOUR lordſhip, tired with the former ſcrutiny into the contents of this water, will naturally fall into the following train of reflection. "All this may be amuſing; but where "is the profit? what avails it, how numerous "are the contents, if not beneficial to man-"kind? Its effects on the human body are, "alone, to be the meaſure of its value. On "theſe, only, I muſt form my judgment: "on threſe, only, will the world paſs ſentence

"on

" on its reputation and merits. Let me hear, " then, of its medicinal benefits: give me " facts: produce your vouchers: and, withal, " teach me by what methods theſe ſalutary " ends are beſt attained." Enough, my lord. The value of mineral waters, as of every thing elſe in life, ought, certainly, to be meaſured by their ſervice to mankind. This is the only juſt criterion of our eſteem. And of this good ſenſe is always a ſufficient judge: nor ſtands it in need of any foreign help.

BEFORE I proceed to the effects of this water on unhealthful bodies, it ſeems but natural to take notice of its effects on healthful. There its operations muſt be more genuine and uniform. Diſeaſes may alter very much the ſolids, the fluids, and the different ſecretions. Whoever would argue that this water has a purgative quality, from obſerving ſuch an effect in ſome morbid caſes, or in cold weather, would find himſelf groſsly miſtaken. The conſidering its effects on healthful bodies ſeems to be the beſt me-

thod

thod to aſcertain its natural operations on the body. 'Tis, indeed, ſurpriſing that authors have neglected this point. Nor know I any, who has delivered obſervations, purpoſely made, on ſound bodies.

THE firſt day that this water is drunk, it, commonly, leaves a particular taſte on the tongue; and produces diſagreeable eructations, a nauſea, and ſickneſs. Theſe ſeldom appear after the firſt day; and are owing to the ſtomach not being rightly prepared for the water. Thoſe, who have previouſly taken a vomit, are ſeldom, or never, troubled with theſe complaints.

EVERY one obſerves that, during the time of drinking the water, their ſpirits are remarkably raiſed, and that its effects are in ſome meaſure analogous to thoſe of wine. It gives all the flow of ſpirits that the juice of the grape does, without the ſubſequent head-ach. I have ſeen it open the mouth of one who had been ſilent for months before.

In

In ſhort it is a moſt ſociable water. This operation is ſo quick, after drinking ſome glaſſes of water, that it can be imputed to nothing but its volatile ſpirit; and is a ſtrong proof of its ſpeedy agency and penetration through the ſmalleſt veſſels.

THE head is ſometimes affected by it, as by too much wine. Something like drunkenneſs is produced. Many have found it difficult to ſit on horſeback in this condition. But the giddineſs laſts not long; and ſeems to ariſe from the above-mentioned cauſe.

IT raiſes an appetite, and enables the ſtomach to digeſt a greater quantity of victuals. This, in ſome meaſure, is to be attributed to early riſing and exerciſe; but, ſtill, the mineral water muſt have its ſhare by waſhing away the old contents of the ſtomach, and ſtrengthening its fibres. For the ſenſation of hunger is ſuppoſed to ariſe from the friction of the bare nerves on the oppoſite ſides:

and

and a great part of digeſtion is performed by the force of the muſcular fibres.

DURING its uſe, the belly is, generally, ſomewhat bound. This is an effect of ſteel, whether prepared by art, or nature. It ſeems to be owing to the fibres of the inteſtines being more contracted, and ſo rendered ſtronger. By this means they force a greater quantity of the fluid parts of the nouriſhment into the veſſels, while the remainder, more hardened than uſual, paſſes ſlowly through the inteſtines. *Hales* has made the contracting power of ſteel-waters evident by * experiment.

IT makes the *fæces* black. This likewiſe proceeds from the ſteel. It is, perhaps, effected in ſome ſuch way, as by the mixture of galls: or by the fixt ſteel mixt with the fibrous part of our aliment.

IT acts as a diuretic, and ſeldom purges, unleſs where the *viſcera* are unſound, or the weather

*VID. Hæmaſtaticks, experim. 18.

weather cold. The time alters according to the conſtitution, and manner of drinking. A fluid ſcarce deſerves the name of diuretic, when no more is ſecreted, than what was taken by the mouth. Water cannot properly be called a diuretic medicine. But *Dunſe*-Spaw has a juſt title: for the quantity ſecreted is more, by ſome ounces, than what was taken in added to the uſual ſecretion. On this quality many of its good effects muſt depend.

IT, generally, makes the pulſe more frequent during the time of drinking. At half an hour paſt five in the morning, my pulſe beat an hundred and forty ſtrokes in two minutes. In two hours, having drunk two *Engliſh* pints and an half, it roſe to a hundred and fifty five. Thus the water quickened it about the eleventh part. This is eaſily accounted for from its contracting power. The blood muſt move through the contracted veſſels with a greater velocity than before:

as

as a ſtream, pent up betwixt rocks, is more rapid than when expanded over the plain.

I COULD perceive no change in the fulneſs or force of the pulſe. But we have not ſuch a juſt meaſure of theſe, as the watch is of its frequency.

THE queſtion was ſeveral times put to me, whether the water heated: for ſome ſuch ſenſation is raiſed by the drinking of it. The thermometer is the only juſt criterion of the preſence or abſence of heat. Our ſenſes are very deluſive in this point. I have ſeen frequent inſtances of this deception. A perſon, in a cold fit of an ague, is conſiderably hotter, than in good health. The thermometer is the only teſt, then, of real heat; and, to that, I applied for a determination. No increaſe of heat was obſerved on drinking two *Engliſh* pints and an half.

WHAT effect it has on perſpiration I was not able to diſcover, for want of a proper inſtrument

ſtrument to reduce that ſecretion to weight and meaſure. 'Tis probable, however, that it is conſiderably increaſed, from the greater vigour of the veſſels, frequency of the pulſe, and diminution of the inteſtinal diſcharge; for the increaſe of the reinal cannot make up for the decreaſe of the laſt. Beſides, if the inviſible perſpiratory matter was not in proportion to the quantity of aliment, the veſſels would very ſoon be too full.

IT is very common for thoſe in good health to have puſtular eruptions over the skin, on their firſt drinking the water. Mr. *Hood* was a remarkable inſtance of this among many. He went to the well to bear ſome friends company. After he had drunk the water ſix days, large boils appeared over his body, and increaſed to ſuch a degree, that he was confined to his bed. When they were retiring, he drank more water; but none, afterwards, appeared, the inflammatory matter being exhauſted. This cutaneous eruption ceaſing after a certain time ſhows,

that the water does not generate, but expel the noxious humours. Whether this is effected by the increaſed force of the veſſels, or in ſome other unknown way, I ſhall not pretend to determine. But ſure I am the effect muſt be ſalutary. How far, in theſe luxurious times, it may be proper for every one to purify, for ſome weeks each year, eſpecially for thoſe mewed up in large cities, I leave common ſenſe to determine for itſelf. If the wheels of a watch are cleaned at ſtated times, they will never ſtop, till wore out, naturally, by attrition, or damaged by ſome external accident. This is an effect, ſo far as I know, not yet related of any mineral water.

I SHALL not ſcruple to acquaint your lordſhip with its ill effects, as well as its good. If drunk, when any freſh cold is caught, it makes the perſon hot, feveriſh, and uneaſy: and no wonder, when its natural effect is to make the pulſe more frequent. This is not to be laid to the account of the water, but to that of its

its injudicious uſe, while the body is really in an unhealthful ſtate.

I HAVE known two inſtances of its producing twitchings and gentle ſpaſms in the ſtomach. Theſe ſeemed owing to the mucus that guards the nerves, being waſhed away, by which the ſubtile, active, and irregular particles of ſteel made too ſtrong impreſſions. What confirms this reaſoning is, that, after deſiſting for ſome days, till the mucus is formed, the water may be ſafely, again, uſed. Some perſons may have ſuch delicate and irritable nerves, as to be more liable to theſe pains than others.

SECT. II.

IT is much to be regreted, that public records have not been kept of all the effects, that appeared upon diſeaſes on the uſe of mineral waters. It would be of ſervice to mankind, if every remarkable caſe was diſtinctly wrote and hung up in the church.

Theſe

Theſe would be as ſo many phyſicians to give advice to thoſe who pleaſed to conſult them. This, my lord, is no ideal ſcheme. It has been done. The ancients, we know, when they eſcaped any great ſickneſs, or other danger, hung up accounts of the affair in their temples. Theſe, from the vow made during the danger, were called votive tables; and are ſaid to have ſupplied *Hippocrates* * with a number of his excellent hiſtories and prognoſtics. Shall we, then, of a purer religion, fail in our acknowledgments and gratitude? ſurely not: for doing good to man is the higheſt gratitude to the Supreme Being.

IT would have been more for our benefit, had the writers on mineral waters, inſtead of telling us that they cure ſuch diſeaſes, given us the plain naked hiſtory of theſe cures, and left every one to judge for himſelf. Theſe paintings repreſent the whole ſcene to the eyes; let the reader into ſeveral ſecrets, that the narrator is not aware of; anſwer a thouſand

* VID. Plin. nat. hiſt. lib. 29.

ſand queſtions; and act the whole over again. While the bare information of being good for this, or for that diſeaſe, touches only the ear, and gains but little credit.

THIS method I ſhall follow, as the juſteſt way of dealing with your lordſhip. The effects of *Dunſe*-Spaw ſhall be laid before you: I will only act the part of a narrator: your own judgment ſhall determine. To proceed in this way is to proceed impartially.

FACT is often in danger of loſing credit by bad reaſoning. That theſe hiſtories may not ſuffer, in this way, I ſhall deliver them, as they came from the perſons themſelves, and leave the theory to be managed as you pleaſe. What may pleaſe me, may not pleaſe your lordſhip. Beſides, the greateſt phyſicians are not agreed about the cauſes of diſeaſes; nor ever will. The ſpeculation is too abſtruſe to admit of any great certainty. If, then, we are ignorant of the cauſes of diſeaſes, our reaſoning on the action of mineral

waters,

waters, in removing theſe cauſes, muſt be very uncertain.

As this well is ſtill in an infant ſtate, no great number of theſe hiſtories can be expected. Nor have they all come to my knowledge. Even in thoſe that have, the curious cannot be ſatisfied in the minute circumſtances, as I had them by relation. Order requires that we begin with the diſeaſes of the firſt paſſages, where its greateſt power muſt be exerciſed, being more immediately applied there.

IT has been found ſerviceable in flatulencies of the ſtomach. A young lady, troubled with frequent eructations, ſwelling of the ſtomach, and an uneaſy choking ſenſation, was cured of theſe ſymptoms by this water.

GREAT benefit has been found, where the ſtomach was ſo weak, as not to be capable to digeſt, or even retain the aliments. Mrs. *Murdoch* of *Ayton* had been afflicted with

with a pain of her ſtomach for many years, and taken many medicines with little ſucceſs. In the ſpring 1749 ſhe drank *Dunſe*-water, and found herſelf better. But in the *September* following ſhe was worſe than ever; and her diſeaſe kept on the increaſe all the winter and ſpring following. She was now emaciated, weak, and ſcarce able to walk. Her ſtomach rejected all kind of food, even the lighteſt: for ſhe had abſtained from all kinds of fleſh for a long time. Her pain was ſo great after eating, that ſhe was generally obliged to force up her victuals before they had undergone any change. This diſagreeable task made her almoſt abſtain from victuals. She had no feveriſh, or nervous ſymptoms. In this condition ſhe went to *Dunſe*-well about the 5th of *April*. She drunk a bottle of water every morning, at firſt in bed. The pain of her ſtomach quickly abated; in a few days ſhe eat her victuals with an appetite; retained, and digeſted them. When ſhe was able ſhe went to the well; and,

and, in ſix weeks recovered her health and ſtrength.

Two young gentlemen, who had the ſame ſymptoms, tho' not of ſo long continuance, were relieved from them by the uſe of this water.

THE following is an inſtance of its not ſuiting every caſe. —— *Wight* of *Deadriggs*, a boy about fourteen years of age, had been troubled, for four years, with continual vomitings. He drunk of *Dunſe*-water for five weeks without any ſucceſs. When I ſaw him he was much emaciate, and without fever. Frequent giddineſs and pale urine ſhowed the diſeaſe to be nervous, and his vomiting ſymptomatic. And, accordingly, he was cured in a few weeks by nervous medicines.

WHEN it thus operates on the ſtomach, it cannot miſs to have analogous effects on weak inteſtines. This diſeaſe is known by great

great flatulency, liquid *fæces*, and tendency to a purging on the leaſt cold. A gentleman, in theſe circumſtances, found himſelf, after drinking this water, leſs liable to thoſe ſymptoms afterwards.

LET us follow the water into the habit of the body, and view its operations in opening obſtructions of the different viſcera. Steel waters have always been reckoned good for the ſpleen and liver. *John Millar* had been troubled, for many months, with a heavy pain in the place where the ſpleen is ſituated, which ſymptom was augmented by hard labour. Sometimes a ſwelling was perceived outwardly. On drinking this water the pain went off.

A GENTLEMAN, who had laboured under the ſame ſymptoms for four months, had been blooded frequently, and bliſtered on the part, without any conſiderable relief, was eaſed of all his complaints in nine days.

THE reverend Mr. *Home* miniſter of *Fogo* was ſeized in *February* 1742 with a great pain, and fulneſs in the region of the liver; frequent vomitings; bileous eructations; coſtiveneſs; and a degree of fever, with heat, thirſt, and reſtleſsneſs. He did not get ſo free from theſe ſymptoms, but that he was troubled with frequent returns of them for ſix years. About the middle of *July* 1748 he was ſeized in the old way with the additional ſymptoms of the jaundice. When all theſe, except the pain and yellow colour, were a little abated by proper evacuations, he began to drink the water. All the ſymptoms went off in three weeks. Nor has he ever felt, for theſe two years paſt, the leaſt degree of thoſe ſymptoms, that had ſtuck by him for ſix years before.

FOR the glandular obſtructions in the king's evil it has been found of ſervice. Two or three caſes might be produced in its favour. *David Wight* a boy about twelve years of age had laboured under this diſeaſe for ſix years.

years. There was a running and hardneſs from the maxillary glands in both ſides. He had tried *Moffat* and *Corſtorphin* waters with advantage; but as the ſwelling and hardneſs was never carried off, the running always returned. He came to *Dunſe* about the middle of *July*, and drank a bottle of water every morning. It acted as a diuretic. In a month the ſores were all dried up, and the part quite ſoft. He continued drinking the water for two months longer, and is at preſent free from his former diſeaſe. As *Moffat*-water has ſtood the teſt of many years, and wrought remarkable cures in this diſeaſe, we are in juſtice bound to give it ſtill the preference: at leaſt, until *Dunſe* can produce as many. The experience of many years muſt weigh down that of a few.

INSTANCES of its curing the ſcab have been numerous. In ſome of theſe it has been little leſs virulent than the leproſy, and had ſtood its ground againſt all medicines for many years. This water forces the eruption

out

out in greater quantity at firſt, and never ceaſes, till it has ejected the whole matter.

ITS effects in the ſcurvy are theſe. Mrs. *Smith* of *Dunſe* had a dry ſcorbutic ſcurf over her legs and arms, that could be ſcraped off with a knife. The parts below were fiery and itchy. After trying medicines with no ſucceſs, ſhe drank the water for ſix weeks. In the *January* following her diſeaſe went off, and her skin turned ſoft and ſmooth. I muſt inform your lordſhip that this diſeaſe often retires after the medicines, that wrought the cure, have been left off. Nature when ſtrengthened performs the reſt herſelf.

---------had been troubled with a ſwelling and cruſty ſcab over her face. Her gums were tumid; her teeth looſe; her joints and head pained. The corroſive matter ſeparated from her face attacked the ſeptum of her noſe and bred ulcers there. On drinking the water for two months, the ſwelling of her face fell; the ſcabs diſappeared, and the ulcers healed.

Eliſa-

Eliſabeth Anderſon of *Eymouth* was, in *January* laſt, covered over with moſt inveterate white ſcales from head to foot. She loſt her appetite; turned ſick; weak; unable to walk, or endure the leaſt motion. She ſent for the water, and drank it at the rate of four *Scots* pints in the day. In a little time ſhe was freed from all her complaints.

SEVERAL ſcorbutic ſpots of many years ſtanding have been carried off by this water. One particularly in the palm of the hand, that mattered, and gave great trouble to the gentleman that had it.

BUT the compleateſt and furtheſt advanced ſcurvy was that of ------. He had ulcers in his gums and tongue; livid ſpots in his legs; looſe teeth; ſleepineſs; and ſwelling of his legs: ſymptoms of this diſeaſe in its higheſt degree. But the uſe of this water in a few weeks carried them off.

ITS effects in nervous caſes are yet dubious. Some have been the better for its uſe; while others have not. Future experience muſt fix the limits. A gentlewoman in *Eymouth* had always a tendency to a nervous diſorder, which appeared more plainly in 1745, after ſhe had beheld the terrors of a ſtorm at ſea. The diſeaſe continued on the increaſe till *October* laſt. She had, then, frequent ſtartings and ſhakings over all her body, preceeded by an aking of the parts. A numbneſs and inſenſibility, often, ſeized her from her loins downwards; which was followed by a quick ſenſibility and tenderneſs of the parts. She complained of ſpaſms in her breaſts; loſs of appetite; clear urine; ſalt ſpittle; and a ſharp humour from her noſe. The muſcles of her forehead, eyes, and mouth were, frequently, convulſed; and diſtorted her face. Her jaw was often forced open to admit victuals; and, after all, ſhe could neither chew, nor ſwallow them. Painful and diſagreeable thoughts aroſe with the paroxiſm. In this ſtate ſhe came to *Dunſe*-well. After drinking

drinking the water three weeks, ſhe recovered her health, and has continued for ſix months quite well.

IT has been tried with advantage in freſh paralytic diſorders. Mr. -------, far advanced in years, was, laſt winter, attacked with a paralytic diſorder. His legs had almoſt loſt their feeling, ſtrength, and motion. His arms were little better. His tongue refuſed to do its office. His internal faculties had felt the diſorder. The returning heat of ſummer gave him ſome eaſe. He began in *July* to drink the water. The heat returned gradually into his extremities. In ſix weeks he could walk to and from the well, could write, and had the full uſe of his tongue and internal faculties. During his cure he paſſed a great quantity of a ſandy-like ſubſtance. He had during his life ſome touches of the gravel. Was that ſubſtance, pre-exiſting in the blood under another ſhape, the cauſe of his diſtemper, when depoſited on the nerves? It might be ſo.

Alexander

Alexander Wedderſpoon of *Preſtonpans*, ſeventy five years of age, was ſeized with a paralytic diſorder in *January* laſt. From his loins downwards he had a ſhaking, want of feeling, and weakneſs. When he came he could ſcarcely creep down to the well. I ſaw him four weeks after he had drunk the water; and, then, he was quite recovered.

IN chronic rheumatiſms it has been tried, ſometimes with ſucceſs, ſometimes without. *John Henderſon* troubled with rheumatic pains in his ſhoulders and joints was cured in three weeks.

ITS effects in the gout has, ſcarcely, been yet tried. Mr. *Fordyce* had ſome irregular attacks of it before he began the uſe of this water. A month after he was attacked with a regular fit of the gout. After the fit was over he began the uſe of the water again; during which time he continued well.

IN old coughs with tough viſcid defluxion this water appears to be of ſervice. But in recent colds it has been found prejudicial.

IN an atrophy it had no effect. A young woman, about twenty years of age, of a pale habit, had nightly ſweatings, and a ſwelling of her legs, with a general waſting. She drank the water for a fortnight without any effect.

IN dropſical caſes mineral waters are accounted pernicious. The following inſtance is, therefore, very remarkable.------*Brown* of *Millerſton* was ſeized with an ague laſt harveſt, which was ſucceeded with a dropſical ſwelling in his belly and legs. His belly was very much ſwelled when he came to the well. I ſaw him about a month after he had drunk the water. The ſwelling of his legs was then quite gone, and his belly ſomewhat ſofter. The fluctuation was plainly felt. I ſaw him at different times; and found the ſwelling leſs and leſs every time. He

continued the uſe of the water for four months, and went away cured, as I was informed, for I did not, then, ſee him. He drunk the water twice a day; and thought that he evacuated more than he drunk.

IT has done conſiderable ſervice in the ſtone and gravel. The reverend Mr. *Carliſle* of *Preſtonpans* was ſeized, in *November* 1748, with a violent pain in one kidney, and a vomiting. He took great quantities of ſoap without ſucceſs. In that kidney there was a conſtant dull pain, that increaſed on any fatigue. In 1749 he began to uſe *Dunſe*-water twice a day. The ſecond day he paſſed a white ſharp ſand, and ſo was delivered from the long continued pain.

Robert Norrie of *Dunſe* had been troubled with nephritic ſymptoms for five and twenty years. He had ſuffered much pain. He was carried to the well, and the firſt three days paſſed three ſtones: after this he was eaſy and walked down on foot. A fortnight after

after he had a ſevere fit. In the whole he has been much eaſier ſince.

SERJEANT *Weir* of *Dunſe* had been aſthmatic for many years, and troubled with the gravel for eighteen months. At firſt he was ſcarcely able to walk to the well, but in three weeks was able to walk three miles. He paſſed ſeveral ſtones. His aſthma was much relieved too.

SERJEANT *MacQuin* of *Dunſe*, being reduced very low by the flux in *Germany*, was obliged to ly, for twenty days, on his back. After this he felt a dull heavy pain in his right kidney, with clear urine, tho' often bloody after fatigue, ſevere reachings and twitchings of his belly. In 1747 he rode down to the well every day. He, then, perceived much ſandy ſediment and ſome ſmall ſtones. In five weeks he could walk with eaſe. The ſymptoms have never troubled him ſince, except on coughing or any ſevere motion; then the place feels ſore.

IN

IN diſeaſes of children it has been found of uſe. It has been tried with ſucceſs for worms. The * experiment mentioned before ſhews it has a ſpecific quality in this diſeaſe. The abſorbent earth muſt, likewiſe, be of advantage in correcting the acidity formed in their weak ſtomachs. Children fifteen months old have drunk it with ſucceſs.

THIS water ſeems a medicine well calculated for thoſe who have loſt appetite, ſtrength, and ſpirits from ſevere ſtudy, too cloſe an attention to buſineſs, or the ſedentary life of a populous city.

IF we reaſon from analogy, this water ſhould be hurtful to thoſe who have great and old ſchirrous obſtructions in any of the *viſcera*; to the pthiſical; the hectic; or the coſtive. Time and experience can alone confirm theſe ſuſpicions.

THE water outwardly applied dries all ſcabby eruptions. As there is no bath, its effects

* Vide ſect. 2. part 1.

effects are but little known in this way. The ſcum has been of ſervice to weak eyes, and watry ſwellings of the legs: it ſeems to have a penetrating aſtringent quality.

WHEN I look back on theſe few caſes, I cannot but think, that they contain many remarkable cures; too remarkable, indeed, to lie buried in ſilence. They are facts that ſpeak for themſelves; that argue with moſt convincing rhetoric; that ſtand in need of no embelliſhing theory; and, therefore, had none.

SECT. III.

EVERY art and profeſſion has not only its inſtruments, but its rules for the management of them. The pipe cannot alone make the muſic. The ſtops muſt be managed in the manner laid down by the proficient of the art, e're harmony can ariſe. Rules, then, my lord, are abſolutely neceſſary to attain the ſalutary effects of mineral waters.

waters. There is a certain preparation, a certain quantity, a certain time, and a certain method of life that will make the patient reap the greateſt advantage. In whatever ſide we err, we miſs our mark.

THE preparatory method to waters ſeems, in general, too ſevere; eſpecially to the ſteely ſort. To enfeeble, by repeated purgatives, when the water operates by bracing and ſtrengthening, is ſurely againſt common ſenſe. A gentle preparation, however, is neceſſary.

IF the perſon has too great a fulneſs of the veſſels; a youthful ſanguinary conſtitution; a ſuppreſſion of natural diſcharges; a full, or hard pulſe; ſwelling of his veins; if he has eat, or drunk too plentifully before, and uſed but little exerciſe; if troubled with ſevere pains in any place; in theſe circumſtances he ought to loſe ſome blood. For, as the circulation is quickened by the water, there is danger leaſt the veſſels be choked up, and a fever follow. Beſides, in this ſtate of the fluids, the ſecretions never go well on.

on. If bleeding is neceſſary in theſe circumſtances, it is bad for the weak; pale; thoſe that have a low ſoft pulſe; and the old.

A VOMIT ſeems in all caſes abſolutely neceſſary. The viſcid matter in the ſtomach ſtops the operation of the water, and, being carried along with it into the circulation, contaminates the fluids. A vomit is, therefore, neceſſary. Without it a ſickneſs and giddineſs attends the drinking. So ſtrongly does nature point out this medicine.

FOR the ſame reaſon the inteſtines demand to be cleaned. But here we may anſwer two intentions. As the water is to operate in the diuretic way, it is neceſſary that the reinal paſſages ſhould be cleared, to give it a free exit. Both theſe deſigns may be anſwered at once by manna and cream tartar, or Glauber ſalt. But if the conſtitution be very low, or the inteſtines weak, rhubarb is more adviſable. If too great a quantity of bile abounds, tamarinds are preferable to either.

This

This ſhews how ridiculous it is to make one purgative ſerve all conſtitutions and all deſigns. One doſe, in general, will be found ſufficient. All ſevere purges ought to be ſhunned; for they pervert the tone of the inteſtines; and are, in every ſhape, unfit to precede mineral waters.

THE morning is the proper time for the uſe of mineral waters. The ſtomach and inteſtines are freer from contents, and the veſſels emptier, at that time, than at any other. They have, likewiſe, little labour, the chyle being already changed. The water muſt, therefore, act more powerfully on the firſt paſſages and veſſels.

THE experiments on the water muſt make every one ſenſible, that its genuine effects are only to be had at the fountain-head. It is loſing, every moment, its moſt valuable parts, and that ſmall degree of heat it has. The ſea ſalt, abſorbent earth, and water remain, but the volatile ſteely ſpirit cannot be retained.

ed. Beſides, ſhaking appears by experiment to aſſiſt its eſcape. Whoever has drunk it at the fountain, and at a diſtance, muſt be ſenſible of a great difference in its lightneſs on the ſtomach.

As the human body does not agree with ſudden changes, 'tis proper to begin with ſmall quantities, and to ariſe, by degrees, to the juſt doſe. This muſt, always, be proportioned to the conſtitution. The young and robuſt demand a greater quantity, than the old, the tender, or thoſe of delicate nerves. Men, in general, can bear more than women. So far as a rule can be given in ſuch a varying ſubject; four *Engliſh* pints are ſufficient for the ſtrongeſt man, and three for a woman.

GENTLE exerciſe, during the drinking, is requiſite to aſſiſt its operation. Walking, riding in any vehicle, or on horſeback, are proper. The laſt is preferable to the others. All violent motion, that may raiſe a heat,

ought to be ſhunned: for the tumult diſturbs ſecretion.

THAT its chilneſs and wind may have no bad effect, it is cuſtomary to uſe carvy, ginger-tablet, or confected orange-peel. This may be neceſſary to thoſe of delicate nerves, but is only a matter of form to the ſtrong, as the water is neither cold, nor windy. A little may, however, aſſiſt the ſtomach in the expulſion of the water, but a great deal is by no means adviſable. Some, on account of too delicate nerves, cannot bear mineral waters cold, and therefore have been in uſe to warm them. But as this has, of itſelf, a degree of warmth, few will find any inconvenience from it. If there be any ſuch to whom the coldneſs gives pains in the ſtomach, they may heat it quickly, by putting the glaſs in ſome warm water. But it will always be the worſe for this.

THERE is nothing more neceſſary than an attention to the way of life, during a courſe

of

of mineral waters. A great quantity of victuals give the firſt paſſages and veſſels too much fatigue to receive any benefit from the water. And too great a quantity of fermented liquors, by thickening and inflaming the blood, counteract its effects. Moderation, in both theſe points, appears, to common ſenſe, very requiſite. An exceſs in eating muſt be guarded againſt; for the ſtomach ſeems to be ſtrengthened, by the immediate application of the water, more than the reſt of the body; and, therefore demands and digeſts more, than the veſſels are able to bear, or expel. Thus a plethora will ſoon ſucceed if no moderation is uſed. The quality muſt, likewiſe, be conſidered. Whatever of vegetables, fiſh, or fleſh is heavy, fat, tough, viſcid, windy, ſalted, or ſmoaked, muſt be ſhunned; that the ſtomach and veſſels may have as little trouble with the formation of chyle as poſſible. The lighteſt food is the beſt. Moſt people, from their own experience, are judges of that.

IF I adviſe moderation in the uſe of ſtrong liquors, I am far from recommending total abſtinence. Regard ought always to be had to the uſual way of life. Cuſtom is ſo prevailing, that nature cannot want what ſhe has been uſed to. A ſudden change would be very improper under this courſe. The ſtomach might be apt to fail. Punch appears not to be the propereſt liquor, as it contains an acid, that will join directly to the abſorbent earth, and ſtop its effects on the body. White wines, that have no acidity, are the beſt.

THE management of the paſſions is to be conſidered in this ſcheme. What effects theſe powers of the mind have over the body, every one muſt have obſerved. It is, indeed, only the unſociable paſſions that we are to dread. The ſociable muſt be carried to a great exceſs, e'er they can do any harm. When anger, envy, jealouſy, or any of that unruly tribe once take poſſeſſion of our breaſts, the body ſuffers with the mind, and

ſoon

ſoon becomes as irritable. Every ſlight ſmart, each breath of wind, which, at another time, would have paſſed unheeded, is now felt, and agonizes the whole frame. This ſeems a puniſhment fixt to them by the author of nature: and affords no bad argument for their general moderation; but more eſpecially at the preſent time, when they may ſhake the frame, ſo as to undo all that the mineral water has done. Eaſe of mind, and chearfulneſs of temper, promote the ſalutary effects of mineral waters.

IT is cuſtomary, in uſing the *German*-waters, to take purgatives frequently. I would by no means recommend ſuch a practiſe here. If any perſon is uneaſy under the natural effects of the water, a gentle laxative may be uſed.

THERE can be no time fixt for the courſe. That depends entirely on the varying circumſtances of conſtitution and diſeaſe. This much

much, however, may be ſaid, that the uſe of the water ought to be continued, for ſome time, after the cure is ſeemingly performed.

IT is a common cuſtom, after a courſe of mineral waters, to take ſome purgatives. *Hoffman* alledges that the *German* waters are apt to remain, for many days, in the folds of the inteſtines, if not carry'd off in this way. I could never obſerve this in *Dunſe*-water. No neceſſity, therefore, appears for ſuch a courſe. If any, however, chuſes, from preconceiv'd opinions, to conclude in this manner, rhubarb will deſtroy the good effects of the water, leſs than any other medicine.

IF from cold, feveriſhneſs, or any other cauſe, the water does not paſs freely, the perſon is to abſtain from it directly. Purgative waters force their own way along the inteſtines, and a great ſhare of them is never mixed with the blood. But the diuretic, before they are evacuated, muſt entirely mix with the

the blood. They have but one exit; and if they are denied that, the veſſels muſt be ſwelled and choaked up. A new addition every day may prove dangerous. In this caſe bleeding is neceſſary. It will empty the veſſels, and aſſiſt the ſecretion. Glauber ſalts will force a paſſage, and open the urinary ducts.

MINERAL waters ought never to be drunk about the time of any critical evacuation. Nature, then, is eaſily diverted from her work, and may take a wrong courſe, if another outlet be opened.

IT merits conſideration, whether the water might not be uſed, in ſeveral caſes, with greater ſucceſs, if mixt with milk, or whey. This method is followed in ſeveral of the *German* waters with great advantage. Where the nerves are delicate and irritable; where the lungs are touched with cough, or aſthma; where there is a tendency to an univerſal conſumption; a languid pulſe; ſpaſmodic,

or

or hyſteric affections; loſs of ſtrength; vitiated digeſtion; gout; ſcurvy; gravel; this method ſeems reaſonable. Future trial, and experience muſt determine theſe points.

WE are now come to a concluſion. If I have detained your lordſhip too long from the intereſts of mankind, it is, my lord, by endeavouring to ſerve them. This may, in ſome meaſure, alleviate my fault. But that a deſign to benefit particulars may not injure the whole, I ſhall take leave of your lordſhip, and own myſelf with the higheſt reſpect,

My Lord,

Your Lordſhips, &c.