XXII. *Experiments and Obſervations on the Matter of Cancer, and on the aërial Fluids extricated from animal Subſtances by Diſtillation and Putrefaction; together with ſome Remarks on ſulphureous hepatic Air.* By Adair Crawford, *M. D. F. R. S.*

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THERE are ſeveral varieties in the colour and conſiſtence of the matter diſcharged by cancerous ulcers. It is in ſome caſes of a pale aſh colour; in others, it has a reddiſh caſt; and in many inſtances it has more or leſs of a brown tinge, ſometimes approaching nearly to black. Its conſiſtence is for the moſt part thin; but in the cancerous, as well as in other malignant ulcers, we frequently meet with a white ſordes, which cloſely adheres to the ſurface of the ſore, and which appears to be ſcarcely miſcible with water. In the ſame patient the appearance of the diſcharge is frequently varied by internal remedies, or by external applications; but if we except the temporary variations produced by accidental circumſtances, the cancerous ulcer is, in its advanced ſtage, very generally accompanied with a peculiar odour more highly fetid and offenſive than that which is emitted by other malignant ulcers.

It is well known, that the cancerous matter occaſions by its abſorption ſchirrous tumors of the lymphatic glands contiguous to the parts affected; and that it gradually corrodes the branches

branches of the larger blood-veſſels, which have a peculiar power of reſiſting the action of other purulent diſcharges.

Apprehending that ſome light might poſſibly be thrown upon the nature of cancerous diſeaſes, by enquiring into the properties of this ſubſtance, I procured a portion of it from a patient who had for ſeveral years been afflicted with a cancer in the breaſt. Having diffuſed it through pure water, I divided it into three parts, which were put into ſmall glaſs veſſels. To one of theſe I added a ſolution of vegetable fixed alkali; to the ſecond, a little concentrated vitriolic acid; and to the third, ſyrup of violets. By the vegetable fixed alkali no ſenſible change was produced: upon the addition of the vitriolic acid, the liquor in the ſecond glaſs acquired a deep brown colour, a briſk effervescence took place, and at the ſame time the peculiar odour of the cancerous matter was greatly encreaſed, and diffuſed itſelf to a conſiderable diſtance through the ſurrounding air. The ſyrup of violets communicated to the liquor in the third glaſs a faint green colour.

The cancerous matter uſed in theſe experiments had a browniſh caſt. It had been imbibed by cotton, and kept for ſome days before the trials were made.

Mr. GEBER has ſhewn, that animal ſubſtances upon their firſt putrefaction do not effervesce with acids; that, after the proceſs has continued for ſome time, a manifeſt effervescence takes place; and that this effect again diſappears before the putrefaction has ceaſed.

Suſpecting that the effervescence in the preceding experiment might have ariſen from a change which the matter underwent, in conſequence of its having been kept ſome days before the trial was made, I repeated the experiment with a portion of reddiſh matter recently obtained from a cancerous penis. Upon

the addition of the acid, the liquor, as before, acquired a brown colour, its fetor was much increaſed, and a manifeſt effervescence took place, although it was not ſo conſiderable as in the former inſtance. A portion of the ſame matter diffuſed through diſtilled water communicated a blue tinge to tincture of litmus, and a greeniſh caſt to ſyrup of violets.

It is proper to obſerve, that when ſyrup of violets was mixed with portions of cancerous matter from a variety of different ſubjects, the change produced was in ſome caſes ſcarcely perceptible; but in every inſtance the preſence of an alkali was detected by dipping into the matter a ſlip of paper that had been previouſly tinged blue by tincture of litmus, and afterwards ſlightly reddened by acetous acid. The red colour was invariably in the courſe of a few minutes aboliſhed, and the blue reſtored.

The cancerous matter, as has been already remarked, acquired, upon the addition of the vitriolic acid, a brown hue. It is well known, that this acid, when it is highly concentrated, communicates a brown or black colour to all animal and vegetable ſubſtances. Being deſirous of learning whether the change which took place upon the addition of the acid to the cancerous matter in this experiment, was different from that which would be produced by the ſame acid in other animal ſubſtances, and particularly in recent healthy pus; I took equal quantities of the latter, and of aſh-coloured cancerous matter, and having diffuſed each of them through thrice its weight of diſtilled water, I added to them equal quantities of concentrated vitriolic acid; the weight of the acid being nearly the ſame with that of the matter uſed in the experiment. The mixture containing the pus acquired from the acid a faint brown colour; but that which contained the cancerous matter, was

ſuddenly changed to a deep brown, approaching to black. When theſe mixtures were diluted with about twice their weight of diſtilled water, the brown tinge of the former entirely diſappeared; but the latter ſtill retained its brown colour, although it was ſomewhat fainter than it had been upon the firſt addition of the acid.

The aërial fluid which was diſengaged in the foregoing trials from the matter of cancer, by the vitriolic acid, appeared from its odour to have a nearer reſemblance to hepatic than to any other ſpecies of air. As it ſeemed, from its ſenſible qualities, to be a very active, and probably a deleterious principle, I endeavoured more particularly to enquire into its nature, and to compare it with common hepatic air. But before I relate the trials which were made with that view, it may not be improper briefly to mention the characters by which common hepatic air is diſtinguiſhed.

It has a ſmell reſembling that of rotten eggs; it is inflammable, and during its combuſtion in the open air, ſulphur is depoſited; it communicates a black colour to ſilver and copper, and a browniſh tinge to lead and iron; it is ſoluble in water, and when a ſolution of nitrated ſilver is dropped into water impregnated with it, the mixture becomes turbid, and a dark-coloured precipitate falls to the bottom; by the addition of the nitrated ſilver, the odour of the hepatic air is rendered much fainter; and it is entirely deſtroyed by concentrated nitrous, or by dephlogiſticated marine acid.

To determine whether the aërial fluid contained in the cancerous matter poſſeſſed theſe properties, a portion of this ſubſtance was diffuſed through diſtilled water. The mixture being filtered, a ſmall quantity of nitrated ſilver was dropped into it. In a little time, an aſh-coloured cloud was produced, which

which ſoon afterwards acquired a browniſh purple hue, and at the end of two hours the colour of the mixture was changed to a deep brown. The fetid ſmell was now rendered much fainter than that of a ſimilar mixture of cancerous matter, and of diſtilled water, to which nitrated ſilver had not been added. When a little concentrated nitrous acid was dropped into the mixture which had been thus altered by the addition of nitrated ſilver, a ſlight efferveſcence took place, the brown hue was inſtantly changed to an orange colour, and the fetid ſmell was aboliſhed. The fetor was likewiſe entirely deſtroyed, when dephlogiſticated marine acid was added either to cancerous matter in its ſeparate ſtate, or to a portion of that ſubſtance which had been previouſly mixed with nitrated ſilver.

By the foregoing properties the cancerous virus is diſtinguiſhed from common pus: for when dilute vitriolic acid is added to common pus, no efferveſcence is produced; and when a ſolution of nitrated ſilver is dropped into this ſubſtance previouſly diffuſed through diſtilled water, the mixture does not acquire a brown colour; nor does any ſenſible precipitation take place for ſeveral hours. It appeared, however, that when the laſt experiment was repeated with matter obtained from a venereal bubo, the mixture upon the addition of the nitrated ſilver became ſlightly turbid, and, at the end of two hours, it acquired a browniſh caſt. The ſame effects were perceived when the trial was made with matter obtained from a carious bone. But in theſe inſtances the precipitation was much leſs conſiderable than that which was produced by the cancerous matter.

I next endeavoured to procure, in its ſeparate ſtate, a portion of the air which is extricated from the matter of cancer by the vitriolic acid. With this intention a quantity of reddiſh cancerous matter was mixed in a ſmall proof, with about

thrice its weight of diſtilled water. To this mixture a little vitriolic acid was added; upon which an efferveſcence took place, and the air that was diſengaged was received in a phial over mercury. When one half of the mercury was expelled from the phial, the latter was inverted over diſtilled water, and the portion of the mercury that remained in it being ſuffered to deſcend, and the water to riſe into its place, the phial was cloſely corked. The air and water were then briſkly agitated together, and the phial being a ſecond time inverted over diſtilled water, the cork was removed; when it appeared by the heighth to which the water roſe, that a part of the air had been abſorbed. The water contained in the phial was now found to be ſtrongly impregnated with the odour of the cancerous matter, and a little nitrated ſilver being dropped into it, a purpliſh cloud, inclining to red, was produced. It is proper to obſerve, that the change of colour upon the addition of the nitrated ſilver, in this experiment, was at firſt ſcarcely perceptible; but in the courſe of a few minutes it became very diſtinct. As it might perhaps be doubtful, whether this alteration would not be produced in the nitrated ſilver by expoſure to the air alone, the colour of the mixture was compared with that of a ſimilar mixture of nitrated ſilver and of pure diſtilled water, which had remained expoſed to the open air for an equal length of time. Although a ſlight change of colour was produced in the latter inſtance, yet it was much leſs conſiderable than that which took place in the former.

In the above recited experiment, the air came over mixed with the common air that was contained in the proof. The quantity of aërial fluid that can be thus extricated by the addition of the acid without the aſſiſtance of heat, is not very conſiderable.

If

If heat be applied, a larger portion of fetid air, having the odour of cancerous matter, may be diſengaged; but in that caſe it will be found to be mixed with vitriolic acid air.

With a view to obtain the former of theſe fluids in as pure a ſtate as poſſible, the experiment was repeated in the following manner. A portion of the cancerous virus, diffuſed through diſtilled water, was introduced into a ſmall proof; a little vitriolic acid was added; the veſſel was filled with diſtilled water, and a crooked tube, alſo filled with that fluid, was fixed to its neck. The extremity of the tube being then introduced into the mouth of an inverted bottle containing water, and the flame of a candle being applied to the bottom of the proof, a quantity of air was expelled, which was received in the bottle. This air, when it was firſt diſengaged, roſe in the form of white bubbles; it had a very fetid ſmell, ſimilar to that of the cancerous matter; and the water which was impregnated with it occaſioned a dark-brown precipitate in a ſolution of nitrated ſilver. The crooked tube being ſeparated from the proof, a very offenſive white vapour, reſembling in its odour the air extricated during the experiment, aroſe from the mixture, and continued to aſcend for nearly half an hour. When to a portion of this ſmoking liquor, previouſly filtered, a little concentrated nitrous acid was added, the fetid ſmell was entirely deſtroyed, a ſlight effervеſcence took place, and a flaky ſubſtance that floated through the mixture was diſengaged.

The foregoing experiments prove, in general, that the fetid odour of the matter of cancer is increaſed by the vitriolic, but entirely deſtroyed by the concentrated nitrous and dephlogiſticated marine acids; that the aërial fluid, which is diſengaged by the vitriolic acid, is ſoluble in water; and that the ſolution

tion depoſits a reddiſh brown precipitate upon the addition of nitrated ſilver. Whence it follows, that the cancerous matter contains a principle which has many of the properties of hepatic air, and which may perhaps not improperly be termed animal hepatic air.

It has moreover been ſhewn, that the matter of cancer is impregnated with an alkali which is in ſuch a ſtate as to change the colour of vegetable tinctures. I had very little doubt that this was the volatile alkali: for it is well known, that putrid animal ſubſtances frequently abound with that ſalt; but have never, I believe, been found to contain a fixed alkali in a diſengaged ſtate. With a view, however, more deciſively to determine this point, I tried the following experiment. A quantity of cancerous matter, diffuſed through diſtilled water, was introduced into a glaſs retort to which a receiver was adapted. The mixture was ſlowly diſtilled by means of a ſand heat; and a ſmall quantity of the liquor which came over into the receiver being poured into an infuſion of Brazil wood, inſtantly imparted to it a deep red colour.

Hence it clearly appears, that the alkali contained in the cancerous matter was the volatile, becauſe it was ſeparated by diſtillation with a heat which did not exceed that of boiling water.

It ſeemed extremely probable, that the above-mentioned alkali was united to the aërial fluid with which the matter of cancer is impregnated. Of the truth of this fact I was perſuaded by obſerving, that the ſmell of the cancerous matter was greatly increaſed by the addition of the vitriolic acid: for I could ſcarcely avoid concluding, that this phænomenon aroſe from an union between the acid and alkali, in conſequence of which the odoriferous principle was extricated by a ſuperior attraction.

attraction. This concluſion will be confirmed by experiments to be recited in the ſequel, which prove, that the volatile alkali is capable of entering into a chemical combination with the aërial fluid contained in the matter of cancer.

Of the air extricated from cancerous matter, and from other animal ſubſtances, by diſtillation.

A portion of matter from a cancerous breaſt was diffuſed through diſtilled water, and introduced into a ſmall coated glaſs retort, which was gradually expoſed to heat in a ſand bath till the bottom of the retort became red-hot. The neck of the latter was introduced below an inverted jar filled with water, and a quantity of air was received in the jar, which was found to conſiſt of the common air contained in the retort. Two meaſures of it, mixed with one of nitrous air, occupied the ſpace of a little leſs than two meaſures. This portion of air was ſtrongly impregnated with the peculiar ſmell of the cancerous matter.

The heat continuing to increaſe, the water began to boil, and a large quantity of aqueous vapour aroſe; which, as ſoon as it came into contact with the common air, produced a white ſmoke. The ſmell that was now perceived was remarked by thoſe who were preſent to be ſimilar to that of freſh animal ſubſtances when they are boiled. The aqueous vapour in this part of the proceſs was not mixed with any permanently elaſtic fluid.

When the greater part of the water was evaporated, the jar containing the firſt portion of air was removed, and the neck of the retort was introduced beneath an inverted veſſel filled with mercury. Soon after this, a conſiderable quantity of air, having a fetid ſmell ſimilar to that of burned bones, was extri-

cated. This aërial fluid was mixed with a yellow empyreumatic oil. A portion of it being agitated with water was found to be partly imbibed by that fluid; and nitrated ſilver, dropped into the water thus impregnated, produced a reddiſh precipitate.

One meaſure of the air, obtained in the foregoing experiment, being mixed over mercury with an equal bulk of alkaline air, the volume of the mixture was found gradually to decreaſe; and, at the end of three hours, the air in the tube occupied the ſpace of only one meaſure and two tenths. An oily depoſit was now made upon the inner ſurface of the tube. At the expiration of eight days, the interior ſurface of the tube was covered with ſlender films, which had a yellowiſh caſt, and which were irregularly ſpread upon it. The upper ſurface of the mercury within the tube was corroded; in ſome places it had a reddiſh burniſhed appearance; in others, it was changed into an aſh-coloured powder, interſperſed with brown ſpots. The tube was now removed from the mercury, and the air that remained in it had a ſtrong fetid ſmell, reſembling that of burned bones.

It has been already obſerved, that before the water was entirely evaporated, the vapour had loſt the odour of the cancerous matter, and had acquired that of animal ſubſtances recently boiled. Hence it appears, that the matter upon which the peculiar ſmell of cancerous ulcers depends, is a very volatile ſubſtance, for it eſcaped at the beginning of the proceſs. It alſo appears, that this volatile ſubſtance, which is probably the active principle in the matter of cancer, is not changed, by ſimple expoſure to heat, into a permanently elaſtic fluid; for the air that eſcaped at the beginning of the proceſs, although it ſmelled ſtrongly of the cancerous matter, was found by Dr.

PRIESTLEY's teſt to be as pure as common air; and it was evident, that the aqueous vapour which came over in the middle of the proceſs was not mixed with any permanently elaſtic fluid; becauſe, when this vapour was received in an inverted bottle filled with mercury, it was condenſed into water, without any admixture of air. Indeed, if the odoriferous principle in the matter of cancer conſiſt of volatile alkali combined with animal hepatic air, it could not be expected that it ſhould acquire a permanently elaſtic form by ſimple expoſure to heat; becauſe when alkaline and animal hepatic air unite together, they form a non-elaſtic ſubſtance that condenſes upon the inner ſurface of the veſſel in which they are mixed.

To diſcover whether other animal ſubſtances yield an aërial fluid, ſimilar to that which was extricated in the foregoing experiment from the matter of cancer by means of heat, a portion of the fleſh of the neck of a chicken was introduced into a ſmall coated glaſs retort, which was gradually expoſed to heat in a ſand bath till it became red-hot. A thin phlegm, of a yellowiſh colour, firſt came over: this was ſoon ſucceeded by a yellow empyreumatic oil, and at the ſame time a permanently elaſtic fluid, having an odour reſembling that of burned feathers, began to be diſengaged. A ſlip of paper, tinged with litmus and reddened by acetous acid, being held over this fluid, became blue. The neck of the retort was now introduced below an inverted jar filled with mercury, and a conſiderable quantity of air, together with a fetid empyreumatic oil, were received in the jar. This air was highly inflammable: it had a very fetid odour. When a bottle, containing a portion of it, was agitated with diſtilled water, nearly one-half of it was abſorbed. The reſidue was inflammable, and burned firſt with a ſlight exploſion, and afterwards with a blue lambent flame. A little nitrated ſilver being dropped into the

water with which the air had been agitated, the mixture inſtantly acquired a reddiſh brown colour; after ſome time it became turbid, and a brown precipitate fell to the bottom. When two meaſures of the air, extricated in this experiment, were mixed with one of alkaline air, they occupied the ſpace of a little more than one meaſure and an half. A ſecond meaſure of alkaline air being added, and the airs being ſuffered to remain together for three days, at the end of that time the reſidue occupied the ſpace of two meaſures and one-eighth. Soon after they were mixed, an oily fluid, of a pale colour, was depoſited on the internal ſurface of the jar. At the end of the third day this ſubſtance had acquired a light olive colour. It was collected in globules, irregularly diſtributed over the interior ſurface of the jar. Theſe globules were nearly of a ſolid conſiſtence. When the jar was removed from the mercury, the air contained in it at firſt ſmelled ſtrongly of volatile alkali. After a little time the ſmell of the alkali diſappeared, and the odour of empyreumatic oil was diſtinctly perceived. A ſmall quantity of diſtilled water, which was now agitated in the jar, acquired a brown colour, but did not entirely diſſolve the viſcid ſubſtance that adhered to its ſurface. The water, thus coloured, was divided into two portions. To one of theſe was added a little ſtrong vitriolic acid, by which the ſmell was exalted, and a ſlight effervеſcence was produced. Concentrated nitrous acid being added to the other portion, the ſmell and colour were deſtroyed, and a briſk effervеſcence took place.

When a portion of the ſolid ſubſtance that adhered to the interior ſurface of the jar was ſeparated, it felt viſcid and adheſive between the fingers, and ſmelled ſtrongly of empyreumatic oil. A little ſpirit of wine being introduced into the

jar, this viſcid ſubſtance was diſſolved; the ſpirit acquired a yellow colour and empyreumatic ſmell, and upon adding to it diſtilled water the mixture became whitiſh and ſlightly turbid.

I next examined the air extricated from putrid veal by diſtillation. A portion of the latter ſubſtance being introduced into a coated glaſs retort was expoſed to a red heat, and the air diſengaged was received in a jar over mercury. This aërial fluid was found to poſſeſs nearly the ſame properties with that which was obtained in the preceding experiments. It was very inflammable; about one-half of it was ſoluble in diſtilled water. The water, thus impregnated, became turbid upon the addition of nitrated ſilver, and a brown precipitate fell to the bottom. To another portion of diſtilled water ſaturated with this fluid, dephlogiſticated marine acid being added, the fetid ſmell was deſtroyed, a briſk effervescence took place, and a whitiſh gelatinous ſubſtance was ſeparated. This ſubſtance being evaporated to dryneſs, became black upon the addition of concentrated vitriolic acid. When a quantity of the air obtained in the experiment was agitated with diſtilled water until no more was abſorbed, the reſidue took fire upon the application of an ignited body, and burned with a lambent flame. It is proper to obſerve, that the air extricated from the putrid veal had leſs of the empyreumatic ſmell than that which was diſengaged from freſh animal ſubſtances. Its odour indeed was nearly ſimilar to that of animal ſubſtances in a ſtate of putrefaction.

We learn from theſe experiments that the aërial fluids, which are extricated from freſh as well as from putrid animal ſubſtances by diſtillation, have nearly the ſame properties with that which is diſengaged, by a ſimilar proceſs, from the matter of cancer. Each of them appears to conſiſt of two diſtinct fluids; one of which is ſoluble, and the other inſoluble, in

water. The portion that is inſoluble burns with a lambent flame, and has all the characters of heavy inflammable air; whereas the ſoluble part reſembles the fluid which is extricated from cancerous matter by the vitriolic acid: it has a fetid odour, it decompoſes nitrated ſilver, combines with cauſtic volatile alkali, and poſſeſſes many of the properties of common hepatic air.

There are ſeveral particulars, however, in which the animal and common hepatic air materially differ from each other. Although they are both fetid, yet their odours are not exactly ſimilar. When common hepatic air is decompoſed by the concentrated nitrous or dephlogiſticated marine acid, ſulphur is ſeparated; but when animal hepatic air is decompoſed by theſe acids, a white flaky matter is diſengaged which is evidently an animal ſubſtance, becauſe it becomes black by the addition of concentrated vitriolic acid. Sulphur is moreover ſeparated during the combuſtion of common hepatic with atmoſpherical air; but when the air from animal ſubſtances is burned with atmoſpherical air, no precipitation of ſulphur takes place. Indeed, that animal hepatic air does not contain ſulphur will be apparent from the following experiment.

Equal parts of pure air and of air extricated from freſh beef by diſtillation, were fired by the electric ſhock in a ſtrong glaſs tube over mercury. A little diſtilled water was then introduced through the mercury into the tube, and was agitated with the air which it contained. A portion of this water being filtered, and a ſmall quantity of muriated barytes being dropped into it, the mixture remained perfectly tranſparent. Hence it appears, that the air extricated from freſh beef by diſtillation does not contain ſulphur; for, if it had contained that ſubſtance, the ſulphur, by its combuſtion with the pure air, would have been

changed into the vitriolic acid, and the muriated barytes would have been decompoſed.

I frequently repeated the preceding experiment with the air extricated, by diſtillation, from the putrid as well as from the freſh muſcular fibres of animals; but I could not, in any inſtance, diſcover the leaſt veſtige of the vitriolic acid.

The following experiments were made with a view more accurately to analyſe the airs which are diſengaged from animal ſubſtances by heat, and to determine the products reſulting from the union of theſe fluids with pure air.

About an ounce of the lean of freſh mutton was introduced into a ſmall coated glaſs retort, and expoſed to a red heat. The air that was extricated towards the end of the diſtillation was received over mercury; and ſoon after its production, being agitated with water, very nearly one half of it was abſorbed. A ſimilar experiment being made with the air diſengaged towards the middle of the diſtillation, the part of it which was ſoluble in water was found to be to the part not ſoluble in that fluid as 2 to 3. Having ſuffered a ſeparate portion of the air diſengaged towards the end of the diſtillation to remain over mercury for ſeven hours, it was found gradually to diminiſh in bulk, and a fluid, which had the colour and the odour of a thin empyreumatic oil, was collected at the bottom of the jar *. The air being now agitated with water, only one-eighth of it was abſorbed. Hence it appears, that a portion of the air, extricated from animal ſubſtances by heat, reſembles a ſpecies of hepatic air which was firſt diſcovered by Mr. KIRWAN, and which exiſts in an intermediate ſtate between the aërial and the vaporous; this fluid not being permanently elaſtic like

* The above-mentioned appearance is not conſtant. The air when placed over mercury ſometimes diminiſhes, and at other times it retains its original bulk. I have not as yet diſcovered the cauſe of this difference.

air,

air, nor immediately condenſed by cold like vapour, but gradually aſſuming the non-elaſtic form, in conſequence probably of the tendency of its ſeveral parts to unite with each other.

The air produced in the foregoing experiment rendered lime-water turbid; it therefore contained a quantity of fixed air; and towards the end of the diſtillation a little volatile alkaline air came over, agreeably to the obſervation of M. BERTHOLLET: for, when a portion of the air received during this part of the proceſs was mixed with an equal quantity of marine acid air, a white vapour was produced, and a diminution of about one twenty-fifth of the whole took place.

I endeavoured, by the following experiment, to aſcertain the proportion of fixed air contained in the aërial fluid which is diſengaged from the lean of animal ſubſtances by heat.

A quantity of air, extricated from the lean of freſh mutton, was received over mercury in a large phial which had a narrow neck. When the phial was a little more than half filled, the remaining portion of the mercury was diſplaced by introducing water that had been previouſly boiled. The phial being then cloſely corked, the air and water were briſkly agitated together; and the liquor, thus impregnated with the ſoluble part of the animal air, was put into a proof, to the bottom of which heat was applied. By this means a portion of the air was again diſengaged, which was received in a tube inverted over mercury. The proceſs was continued till the liquor in the proof no longer rendered lime-water turbid. As the air received in the tube contained the fixed air that had been extricated from the liquor, together with a quantity of common air expelled from the proof, it was a ſecond time agitated with water; and the exact meaſure of the fixed air was known by the portion which the water imbibed. The fixed air, thus aſcertained, being compared with the entire quantity of air that had been originally abſorbed, it appeared,

that

that the former was to the latter in bulk as 1 to 4. One-fourth therefore of the volume of the ſoluble part of animal air conſiſts of fixed air, and the remaining three-fourths of hepatic, mixed with a very ſmall proportion of alkaline air *.

It appeared from the experiment, that animal hepatic air, when it was abſorbed by water, was not capable of being again diſengaged by a heat which raiſed the water to the boiling temperature; for, after the fixed air was expelled, the liquor in the proof was made to boil nearly half an hour, but no permanently elaſtic fluid could be diſengaged. The portion of the liquor which now remained had a faint yellow colour; it ſmelled ſtrongly of animal hepatic air, and depoſited a brown precipitate upon the addition of nitrated ſilver.

It appears, therefore, that the ſoluble part of the air which is diſengaged from the lean of animal ſubſtances by heat, conſiſts of three diſtinct fluids; of alkaline air, fixed air, and animal hepatic air. It ſeemed extremely probable, that theſe three aërial fluids, ſlowly combining together, formed the oily empyreumatic ſubſtance which was collected at the bottom of the jar, while the air was undergoing the diminution deſcribed above. In this concluſion I was confirmed by trials that were made with the empyreumatic oil that came over during the latter part of the diſtillation: for when it was examined by chemical teſts, ſoon after it was obtained, it was found to contain fixed air, volatile alkali, and animal hepatic air.

* It is proper to remark, that, in ſome experiments, the relative quantity of animal hepatic air was found to be leſs than that which has been ſtated above. I do not as yet know, with certainty, the cauſes to which this difference is to be attributed; but I believe it principally depends upon the period of the diſtillation in which the air is received, the degree of heat applied to the bottom of the retort, and the nature of the animal ſubſtance employed in the experiment.

I next endeavoured to determine the products which reſult from the combuſtion of pure air, with animal air, or with the compound aërial fluid extricated from the lean of animal ſubſtances by heat. With this intention I expoſed the lean of freſh mutton, in a ſmall coated glaſs retort, to a red heat. The air which was received over mercury towards the end of the diſtillation was divided into two ſeparate portions; one of which was agitated with water till the ſoluble part was abſorbed; the other was not agitated with that fluid. One meaſure of the former was introduced, over mercury, into a ſtrong glaſs tube adapted for the purpoſe of firing aërial fluids by the electric ſhock. This was mixed with one meaſure and an half of pure air. The portion of the tube occupied by the mixture was one inch and two-tenths. A ſmall ſhock being made to paſs through it, a violent exploſion took place, and the ſpace occupied by the reſidue was nine-tenths of an inch. The height of the mercury in the tube, previouſly to the combuſtion, was 4.8 inches. After the airs were fired, its height was 5.1 inches. Allowance being made for the difference of expanſion produced by this cauſe, it appeared, that the volumes of the airs, previouſly to the combuſtion, and ſubſequent to it, were as 100 to 75 nearly. The reſidue being agitated with water, ſix-tenths were abſorbed; and the portion which was thus abſorbed was found, by the precipitation which it produced in lime water, to be fixed air. Of the inſoluble remainder, five parts being mixed with five of nitrous air, a diminution of three parts took place; whence it follows, that one-fifth of the inſoluble reſidue was pure air.

The pure air which was uſed in this experiment had been previouſly agitated with water, to free it entirely from fixed air, and the inflammable air had undergone a ſimilar agitation.

It

It is therefore manifeſt, that, by the combuſtion of the pure and inflammable air in the foregoing trial, fixed air was produced; the phlogiſticated air, found in the reſidue, being that which was contained in the pure air before the inflammation took place.

I next examined the products reſulting from the combuſtion of pure air with that portion of the animal air which had not been previouſly agitated with water. One meaſure of this fluid, at the expiration of three-fourths of an hour after it had been obtained, was mixed over mercury with one meaſure and an half of pure air, and fired by the electric ſhock. The portion of the tube occupied by the mixture, previouſly to the deflagration, was one inch and $\frac{15}{100}$; after the deflagration, it occupied the ſpace of one inch and one-tenth. Being agitated with lime-water, very nearly one-third was abſorbed. A portion of the inſoluble reſidue was expoſed to a lighted taper, and burned with a faint blue flame *.

The dephlogiſticated air uſed in this experiment had been previouſly agitated with water, to free it entirely from fixed air. It was the pureſt dephlogiſticated air I had ever ſeen: for when one meaſure of it was mixed with one meaſure and nine-tenths of nitrous air, the reſidue occupied the ſpace of only one-fortieth of a meaſure. From the foregoing trial it was evident, that $1\frac{1}{2}$ parts of pure air were inſufficient to ſaturate one of the animal air that had not been previouſly agitated with water. The experiment was therefore repeated as follows. Two

* When I firſt made the above experiment, the reſidue did not appear to be inflammable. It had been tried by applying an inflamed ſlip of paper to the mouth of a phial which was filled with it; but, upon repeating the experiment, when the phial containing the reſiduary air was carried into a dark room, and an ignited wax taper was applied to its mouth, an evident inflammation took place.

parts of pure air being mixed with one of animal air, occupied .8 of an inch. The mixture being fired by the electrical ſhock, the reſidue ſtood at a little leſs than .5. When this reſidue was agitated with lime-water, it was almoſt wholly abſorbed. By a ſubſequent trial it was found, that nearly one-half of the animal air uſed in this experiment was ſoluble in water.

Hence it appears, that the quantity of pure air required to ſaturate the inſoluble part of the animal air is ſomewhat leſs than that required to ſaturate the compound fluid which had not been previouſly agitated with water. But the latter fluid has been ſhewn to conſiſt almoſt entirely of heavy inflammable, animal hepatic, and fixed air; and as the laſt of theſe is already ſaturated with pure air, it is manifeſt, that the above-mentioned difference muſt depend upon the animal hepatic air. Whence it follows, that the latter contains a large portion of the inflammable principle. From the quantity of fixed air produced in the laſt of the preceding experiments, there is, moreover, the utmoſt reaſon to believe, that the baſis of heavy inflammable forms one of the conſtituent parts of animal hepatic air.

When equal parts of pure and animal air were burned together, a conſiderable increaſe of bulk almoſt invariably took place; and when the proportion of the animal was to that of pure air as 21 to 15, the bulk of the mixture was increaſed one half. The air that remained after the combuſtion in the laſt mentioned experiments was inflammable: for a portion of it being introduced into a ſmall phial, and expoſed to a lighted candle, it firſt exploded, and then burned with a blue lambent flame.

Being deſirous of learning the cauſe of the increaſe of bulk in the foregoing experiments, the following trials were made.

Three meaſures of animal were mixed with two of pure air, and ſeveral ſtrong electrical ſhocks were made to paſs through the mixture, but it would not take fire. Half a meaſure of pure air was then added, and the mixture being fired, its bulk was encreaſed from .9 of an inch to 1 inch and .3.

Three meaſures of this reſiduary air were then mixed with three of pure air, and fired by the electric ſhock. The bulk of the mixture was reduced from 1 inch to .56. This being agitated with lime-water, two-thirds were abſorbed, and the remainder conſiſted almoſt wholly of pure air. From theſe facts it ſeems probable, that animal hepatic air conſiſts of a combination of heavy and light inflammable air; and that when it is fired with a quantity of pure air not ſufficient to ſaturate it, a portion of the animal air is reſolved into its elementary principles, in conſequence of which its bulk is encreaſed.

It was before obſerved, that three parts of animal mixed with two of pure air would not take fire. In ſome experiments it was found, that when the animal air was mixed with a ſtill ſmaller proportion of pure air, an increaſe of bulk was produced by the electric ſhock, although no deflagration took place; but when the electric ſhock was repeatedly taken through animal air *alone*, it did not in any inſtance, as far as I could perceive, produce the ſmalleſt increaſe of ſize.

I was next deſirous of learning whether an increaſe of ſize would be produced by making the electric ſhock paſs through a mixture of pure and alkaline air. Having firſt accidentally taken two or three ſmall ſhocks through a little alkaline air, and not obſerving a ſenſible augmentation of bulk, I then mixed it with an equal volume of pure air; and, as I ſuppoſed that no decompoſition had taken place, I was not apprehenſive

of an exploſion. Contrary, however, to my expectation, the airs, when the electric ſhock was made to paſs through them, entered rapidly into an union with each other. The jar which I held looſely in my hand, as it was inverted over the mercury, was carried obliquely upwards with great violence. Having broken the ſtand of the prime conductor in its paſſage, it forced its way through the cylinder of the electrical machine, which it ſhivered to a thouſand pieces.

I afterwards repeated this experiment with a very ſtrong apparatus, the jar being preſſed down by a plate of iron, for the purpoſe of retaining it in its place.

It appeared, that when the alkaline and pure air were immediately mixed together, and a ſmall ſhock was made to paſs through them, they would not take fire; but when three or four ſhocks were previouſly taken through the alkaline air, and the latter was afterwards mixed with an equal bulk of pure air, they exploded with great violence. The reſidue, having cooled to the temperature of the ſurrounding air, was reduced to half the original bulk of the mixture. Of this reſidue one-ſixth was undecompoſed alkaline air. The remainder was phlogiſticated air.

Of the products which reſult from the combuſtion of ſulphureous hepatic with pure air.

The hepatic air employed in the following experiments was procured, agreeably to the method which Mr. KIRWAN has recommended, by adding marine acid to an artificial combination of ſulphur and iron. Three meaſures of the air thus obtained were mixed in a ſtrong glaſs tube over mercury, with four of pure air, and fired by the electric ſhock.

The pure air was previouſly agitated with lime-water to free it from fixed air, and a portion of the hepatic air, having been likewiſe agitated with lime-water, was found not to occaſion any precipitation in that fluid. The airs were reduced by the exploſion to one-fourth of their original bulk. The reſidue was then tranſferred over mercury into a ſlender graduated tube, and diſtilled water being admitted, eight-tenths were abſorbed. To a portion of this water, when filtered, vitriolated ſilver was added, which inſtantly occaſioned a copious precipitate. To a ſecond portion was added muriated barytes, which occaſioned a ſlight white precipitate not re-diſſolvable in a large quantity of water; lime-water being added to a third portion, did not produce any ſenſible precipitation. From the laſt fact it does not follow, that no fixed air exiſted in the reſidue, becauſe the marine acid, which it evidently contained, would diſſolve the calcareous earth of the lime-water. As a great diminution, however, reſulted from the combuſtion; and as it appeared, from chemical teſts, that the reſidue was moſtly compoſed of marine and vitriolic acid airs, it is manifeſt, that, if any fixed air was produced, its quantity muſt have been very inconſiderable.

It has been already obſerved, that a ſlight precipitation took place upon the addition of the muriated barytes. The precipitate was much more conſiderable when, upon repeating the experiment, the reſidue after the exploſion was not tranſferred into a graduated tube previouſly to the admiſſion of the diſtilled water; but the latter was immediately introduced into the veſſel in which the airs were fired. The reaſon of this difference is evident. The ſlight precipitate by the muriated barytes, in the firſt inſtance, depended upon the exiſtence of a ſmall quantity of vitriolic acid in an aërial form, or in the

ſtate

ſtate of volatile vitriolic acid, which was transferred together with the phlogiſticated and marine acid air into the ſecond tube; but the greater part of the vitriolic acid produced by the combuſtion adhered, in a fixed ſtate, to the ſurface of the tube in which the airs were fired; and therefore, when the diſtilled water was immediately introduced into this tube, a copious precipitate was depoſited upon the addition of muriated barytes.

Hence it appears, that when pure air and ſulphureous hepatic air, obtained from artificial pyrites by the marine acid, are fired together in the above proportions, the products are fixed vitriolic acid, together with a ſmall quantity of the volatile vitriolic, and marine acids, in an aërial form. The reſidue, which the diſtilled water did not abſorb, was the phlogiſticated air that exiſted in the pure air previouſly to the combuſtion.

From ſubſequent trials it appeared, that, when hepatic and pure air were fired in equal bulks, the reſidue had a ſtrong odour of volatile vitriolic acid, and moreover contained a ſmall proportion of undecompoſed hepatic air. Theſe facts ſeem to prove, that the converſion of ſulphur into volatile or fixed vitriolic acid depends upon the quantity of pure air with which it is ſupplied.

The marine acid air, found in this experiment, did not appear to form one of the conſtituent principles of the hepatic air, but to be merely diffuſed through it; for it was almoſt wholly ſeparated, by means of diſtilled water, from a different portion of the ſame air, which was placed in a tube inverted over mercury; the water having a ſtronger attraction to the marine acid than to the hepatic air.

By the following experiment I endeavoured to determine whether

whether vitriolic acid be produced by the combuſtion of hepatic with atmoſpherical air. One meaſure of hepatic air, obtained from artificial pyrites, was mixed over mercury with about ſix meaſures of atmoſpherical air, and fired by the electric ſhock. A copious precipitation of ſulphur took place, the remaining air was then agitated with diſtilled water, the latter was filtered, and muriated barytes was added, which produced a white precipitate not diſſoluble in a large quantity of water.

From this, and the foregoing experiment, it appears, that when ſulphureous hepatic is burned with atmoſpherical air, a part of the ſulphur is changed into vitriolic acid, and the reſt is precipitated; but when it is burned with a ſufficient quantity of pure air, the ſulphur is wholly converted into vitriolic acid. Agreeably to this concluſion, I have found that the odour of the volatile vitriolic acid conſtantly accompanies the combuſtion of hepatic with common air in open veſſels; and that when concentrated nitrous acid is added to water impregnated with hepatic air, the filtered liquor becomes turbid upon the addition of muriated barytes.

The quantity of pure air required to ſaturate ſulphureous hepatic air, does not appear to correſpond with the ſuppoſition that the laſt of theſe fluids conſiſts of ſulphur diſſolved in light inflammable air: for ſulphur, in order to its complete ſaturation, requires only 1.43 times its weight of pure air; but light inflammable air requires for its ſaturation at leaſt ſix times its weight of that fluid. The ſpecific gravity of hepatic air, as determined by Mr. KIRWAN, is nearly equal to that of pure air. If, therefore, one-ſixth of the weight of hepatic conſiſted of light inflammable air, that fluid would require for its ſaturation 2.26 times its bulk of pure air: for the portion

of

of it which conſiſted of light inflammable air would require a quantity of pure air equal in bulk to the hepatic; and the remaining portion, conſiſting of ſulphur, would require a quantity equal to 1.26 of the hepatic. The entire quantity of pure air would therefore be to that of the hepatic as 2.26 to 1. If the hepatic contained one-twelfth of its weight of light inflammable air, it would require for its ſaturation 1.64 of its bulk of pure air. But from the foregoing experiments it appears, that the quantity of pure air, neceſſary to ſaturate one meaſure of hepatic air, is only 1.33 meaſures. Hence it is probable, that this fluid does not conſiſt of ſulphur diſſolved in light inflammable air.

If we make allowance for the marine acid which was diffuſed through the hepatic air, it will be found, that the quantity of pure air required to ſaturate it is nearly the ſame with that which would be required to change an equal weight of ſulphur into vitriolic acid. Whence it may be inferred, agreeably to the opinion of Mr. KIRWAN, that hepatic air is ſulphur which has acquired an aërial form by the application of heat. This concluſion is, I think, confirmed by the following experiment.

A little pure ſulphur was introduced into an inverted tube, which had been previouſly filled with mercury, and the flame of a candle was applied to the extremity of the tube. In a ſhort time a permanently elaſtic fluid was produced, which was found to have all the characters of hepatic air. It is probable, however, that ſome degree of moiſture is neceſſary to the ſucceſs of this experiment, becauſe the quantity of hepatic air which was thus obtained was not very conſiderable.

It has been already ſhewn, that an oily matter was produced by the union between fixed air, volatile alkali, and animal

hepatic

hepatic air. The following experiment proves, that a ſubſtance, which has very much the appearance of oil, is formed by the combination of *ſulphureous* hepatic air with fixed air and volatile alkali.

A quantity of impure hepatic air was obtained by adding vitriolic acid to common liver of ſulphur. When this fluid was agitated with lime-water, it produced a copious precipitation. It therefore contained a conſiderable proportion of fixed air. One meaſure of it was now introduced into a ſlender graduated tube, inverted over mercury, and was mixed with an equal bulk of alkaline air. As ſoon as the airs came into contact with each other, a white cloud was produced, the mercury began gradually to riſe in the tube, and at the end of ſix hours the air that remained occupied the ſpace of only one meaſure and one-third. The ſurface of the mercury within the tube firſt became black, and a part of it afterwards acquired a red colour reſembling cinnabar. In the courſe of the experiment, a yellowiſh oleaginous ſubſtance was depoſited upon the interior ſurface of the tube. This ſubſtance, in ſome parts of the ſurface, formed itſelf into globules; in others, it was extended into ramifications, having the reſemblance of trees in miniature, and it gradually aſſumed a deeper colour, till at length it acquired a greeniſh caſt. The ſubſtance, thus obtained, had a very fetid odour: it appeared to have a near reſemblance to an animal oil which had become green by putrefaction. It was, however, ſoluble in water, and the odour of the ſolution was increaſed by the vitriolic, and deſtroyed by the concentrated nitrous and dephlogiſticated marine acids.

Mr. CRUIKSHANK, who aſſiſted me in moſt of the foregoing experiments, and on whoſe accuracy I could place the greateſt reliance, examined, in my abſence, the red and black

powders which were formed by the action of the hepatic air upon the ſurface of the mercury, and found them to be æthiops mineral, and cinnabar.

Of the air extricated from animal ſubſtances by putrefaction.

In the beginning of July, 1789, about two ounces of veal, ſlightly putrid, was introduced into a large phial, which was filled with diſtilled water, and inverted over a quantity of the ſame fluid. At the end of three days a few bubbles of air had appeared at the bottom of the phial; the water had acquired a light brown colour, and emitted a fetid ſmell. At the expiration of ſeven days we could perceive that the quantity of air at the bottom of the phial was manifeſtly increaſed, although its progreſs was very ſlow. The water, by the diſſolution of a part of the veal, had now acquired the conſiſtence of a thin mucus, its brown colour was ſomewhat deepened, and it emitted a highly fetid ſmell. A little nitrated ſilver being dropped into a portion of this water, previouſly filtered, a dark brown precipitate was immediately produced. Lime-water, mixed with another portion of it, occaſioned an aſh-coloured precipitate; and when concentrated nitrous acid was added to a third portion, the fetid ſmell was deſtroyed, a ſlight effervescence took place, and a yellow flaky matter was diſengaged. At the end of ſeven weeks, a quantity of air, amounting to two and one-ſixth dram meaſures was collected in the phial. This air had a fetid odour. Being agitated with water, ſix-tenths of it was abſorbed. The reſidue extinguiſhed flame.

I next examined the air extricated from veal which was ſuffered to putrefy over mercury.

On

On the 28th of July, 1789, two drams and twenty-four grains of the lean of freſh veal was introduced into a narrow jar, which was filled with mercury, and inverted over that fluid. At the end of eight days the air, which was ſlowly extricated, had communicated a brown colour to the ſurface of the mercury. On the 13th of September, the quantity of air diſengaged was a little more than two ounce meaſures. This fluid had a very fetid ſmell. Two ſeparate portions of diſtilled water being ſaturated with it, the firſt, upon the addition of nitrated ſilver, depoſited a brown precipitate; and the laſt, when it was mixed with lime-water, produced a browniſh aſh-coloured cloud. A third portion of the air being ſtrongly agitated with diſtilled water, was reduced to one-ſixteenth of its original bulk. The reſidue extinguiſhed flame.

The veal which had remained ſo long in contact with the mercury had not loſt its firm texture. Its ſmell was putrid, but not very offenſive.

The quantity of elaſtic fluid collected in this experiment was much greater than in the preceding one; becauſe in the preceding experiment, although the putrefaction advanced more rapidly, yet the fixed and hepatic air were abſorbed by the water nearly as faſt as they were diſengaged from the putrid ſubſtance.

Hence it appears, that the aërial fluids, which are extricated from the muſcular fibres of animals by putrefaction, conſiſt of fixed and animal hepatic, mixed with a very ſmall proportion of phlogiſticated air *.

* It may be proper to remark, that I have obtained, by diſtillation from the green leaves of a cabbage, an aërial fluid, which, in moſt of its properties, reſembles animal hepatic air.

Of the effects produced by expoſing freſh animal ſubſtances to atmoſpherical, hepatic, and pure air.

Two tubes, of nearly the ſame ſize, were inverted over mercury. Into one of theſe was introduced common air, and into the other an equal bulk of hepatic air, obtained from liver of ſulphur by the vitriolic acid. Equal quantities of freſh veal, conſiſting of a mixture of muſcular fibres and of fat, and weighing each one dram, were then expoſed to theſe airs. At the end of three days the piece that was in contact with the common air had not altered its colour or conſiſtence, but ſmelled a little putrid. The colour of the fatty parts of the piece that was expoſed to the hepatic air was changed to a dark green, the muſcular fibres were cracked and ſhrivelled on the ſurface as if they had been ſeared with a hot iron, and the whole had acquired a ſoft conſiſtence.

Similar trials were made with two pieces of freſh veal, one of which was expoſed over mercury to common air, and the other to air extricated from putrid veal by diſtillation. The former in three days had not changed its appearance; the latter had become green round the edges, and was interſperſed with green ſpots. The ſurface of the mercury in the jar which contained the laſt had acquired a brown colour; whereas that of the mercury in the jar which contained the common air was clear and bright. The pieces of veal were ſuffered to remain in this ſituation for ſix weeks. After a few days had expired, *that* which was expoſed to the animal air did not appear to ſuffer any farther change. Its colour, which in the courſe of a week had become brown, continued unaltered, and no diſſolution took place. The air at the laſt was very fetid; it occaſioned

ſioned a copious precipitate in lime-water; it was highly inflammable, and burned with a blue lambent flame.

The piece, on the contrary, which was expoſed to the common air, did not, as has been already obſerved, ſo ſoon loſe its fibrous texture, nor ſo ſpeedily acquire a dark colour, as that which was in contact with the animal air. But the progreſs of its putrefaction did not appear to ſtop at the end of a few days, as in the latter inſtance. It advanced ſlowly, and at the expiration of ſix weeks a conſiderable part of the muſcular fibres had run down to a brown liquid. The air in which it was placed now occaſioned a copious precipitation in lime-water, and the brown liquid was found to be impregnated with animal hepatic and fixed air; the exiſtence of the latter being known by means of lime-water, and that of the former by its occaſioning a dark precipitate in a ſolution of nitrated ſilver, as well as by its fetid odour, which was increaſed by the vitriolic, and deſtroyed by the concentrated nitrous and dephlogiſticated marine acids.

The following experiment was made with a view to determine whether pure air accelerates the progreſs of putrefaction in animal ſubſtances.

In the month of December, 1789, equal portions of pure and of common air were introduced into two equal jars over mercury, in each of which was placed about two drams of freſh beef. At the end of a week, the beef which was expoſed to the pure air had become highly putrid; but very little change was produced in that which was expoſed to the common air.

The facts which have been aſcertained by the preceding experiments, appear to lead to the following concluſions reſpecting the proceſs of putrefaction in the lean of animal ſubſtances.

The muſcular fibres of animals contain fixed and phlogiſticated air, the inflammable principle in the ſtate of heavy and of light inflammable air, and a ſubſtance which, by means of heat or of putrefaction, is capable of being converted into animal hepatic air*. When the muſcular fibre, after the death of the animal, is expoſed to the pure air of the atmoſphere; the latter, by a ſuperior attraction, combining with the heavy inflammable air, produces fixed air, and at the ſame time furniſhes the quantity of heat neceſſary to the formation of animal hepatic air. The coheſion of the fibre being thus deſtroyed, the fixed, as well as the light inflammable and phlogiſticated air, which enter into its compoſition, are diſengaged, and the two latter fluids uniting with each other produce the volatile alkali.

The alterations which take place in putrefaction are in moſt reſpects ſimilar to thoſe which ariſe from deſtructive diſtillation. By expoſure to heat the fixed air of the animal fibre is extricated, hepatic air and volatile alkali are produced, and the inflammable principle not coming into contact with the pure air of the atmoſphere, is raiſed in the form of heavy inflammable air.

I have found, that the fetid odour of animal hepatic air is deſtroyed by mixing it with pure air, and ſuffering it to remain in contact with that fluid for ſeveral weeks. When it was placed in this ſituation, it acquired an odour which was not exactly ſimilar to any that I had ever before perceived, but which bore ſome reſemblance to that of inflammable air obtained by diſſolving iron in ſpirit of vitriol.

* It is ſcarcely neceſſary to obſerve, that the exiſtence of fixed, inflammable, and phlogiſticated air in animal ſubſtances, and the compoſition of volatile alkali, were diſcovered before I began to give particular attention to this ſubject.

The peculiar ſmell of animal hepatic air is likewiſe deſtroyed by agitating it with vinegar, or with the concentrated vitriolic acid. But the fluids which moſt ſpeedily produce this effect, are the concentrated nitrous and dephlogiſticated marine acids; and theſe fluids are known to abound with pure air. It is therefore extremely probable, that this alteration depends upon an union between the pure air of the latter ſubſtances and the animal hepatic air, or ſome of its conſtituent parts.

It appears from the experiments which have been recited above, that in cancerous and other malignant ulcers, the animal fibres undergo nearly the ſame changes which are produced in them by putrefaction, or by deſtructive diſtillation. The purulent matter prepared for the purpoſe of healing the ulcer is, in ſuch caſes, mixed with animal hepatic air and volatile alkali. The compound formed by the union of theſe ſubſtances, which may perhaps not improperly be termed hepatiſed ammonia, decompoſes metallic ſalts, and acts upon metals: for we have ſeen, that when it was placed in a jar over mercury for ſeveral days, the ſurface of the mercury acquired a black colour; and that it inſtantly occaſioned a dark precipitate in a ſolution of nitrated ſilver. Theſe facts ſeem to afford an explanation of the changes produced in metallic ſalts, when they are applied to malignant ulcers. The volatile alkali combines with the acid of the metallic ſalt, and the animal hepatic air revives the metal, either by imparting to it the inflammable principle, or by uniting with the pure air which the calx is ſuppoſed to contain. The metal, thus revived, is probably in ſome caſes again corroded by the hepatiſed ammonia, which communicates to it a black colour. Thus we may account for the dark incruſtation frequently formed upon the tongue

tongue and internal fauces, when venereal ulcers of the throat are waſhed with a ſolution of corroſive ſublimate. And hence alſo the dark tinge which is frequently communicated by ill-conditioned ulcers to poultices made with a ſolution of ſugar of lead. The action of the hepatiſed ammonia likewiſe explains the reaſon why the probes are frequently corroded when they are introduced into ſinuous ulcers, or applied to the ſurfaces of carious bones. To the ſame cauſe it is probably owing, that poliſhed metallic veſſels are quickly tarniſhed, when they are expoſed to the effluvia of putrid animal ſubſtances.

From the foregoing experiments it moreover appears, that animal hepatic air imparts to the fat of animals recently killed a green colour; that it renders the muſcular fibres ſoft and flaccid, and increaſes the tendency to putrefaction. It is therefore a ſeptic principle; and hence it is extremely probable, that the compound of this fluid with volatile alkali, which is found in the matter diſcharged by the open cancer, produces deleterious effects: for although the miſchief in cancerous ulcers ſeems principally to depend upon a morbid action of the veſſels, whence the unhealthy ſtate of the matter diſcharged by ſuch ulcers is ſuppoſed to derive its origin, yet from the corroſion of the coats of the larger blood-veſſels, and the obſtructions in the contiguous glands, there can be little doubt that this matter aggravates the diſeaſe. The experiments recited above appear to prove, that the hepatiſed ammonia is the ingredient which communicates to the cancerous matter its putrid ſmell, its greater thinneſs, and, in a word, all the peculiar properties by which it differs from healthy pus.

From theſe conſiderations it was inferred, that a medicine which would decompoſe the hepatiſed ammonia, and deſtroy the fetor of the animal hepatic air, without at the ſame time

increaſing

increaſing the morbid action of the veſſels, would be productive of ſalutary effects. The nitrous acid does not deſtroy the fetor of hepatic air, unleſs it be highly concentrated; and in this ſtate it is well known that it ſpeedily corrodes animal ſubſtances. But the fetor of hepatic air quickly diſappears when it is mixed with the dephlogiſticated marine acid, even though the latter be ſo much diluted with water as to render it a very mild application. I have found that this acid, diluted with thrice its weight of water, gives but little pain when it is applied to ulcers that are not very irritable; and in ſeveral caſes of cancer it appeared to correct the fetor, and to produce a thicker and more healthy pus. It is proper, however, to remark, that other caſes occurred in which it did not ſeem to be attended with the ſame ſalutary effects. Indeed, ſome cancerous ulcers are ſo extremely irritable, that applications which are at all of a ſtimulating nature cannot be ventured upon with ſafety. And hence if the obſervations, which I have made on the efficacy of this acid as an external application, ſhould be confirmed by future experience, it muſt be left to the judgement of the ſurgeon to determine both the degree of its dilution, and the caſes in which it may be employed with advantage.

The dephlogiſticated marine acid, as is generally known, has the power of deſtroying the colour, the ſmell, and perhaps the taſte, of the greater part of animal and vegetable ſubſtances. We have ſeen that it corrects the fetor of putrid fleſh. And I have found, that, when it is poured in ſufficient quantity upon hemlock and opium, theſe narcotics ſpeedily loſe their ſenſible qualities. As it appears, therefore, to poſſeſs the power of correcting the vegetable, and probably many of the animal poiſons, it ſeemed not unlikely, that it might be uſeful as an internal medicine. Conceiving that its exhibition

would be perfectly ſafe, I once took twenty drops of it diluted with water. I ſoon afterwards, however, felt an obtuſe pain, with a ſenſe of conſtriction, in my ſtomach and bowels. This uneaſineſs, notwithſtanding the uſe of emetics and laxatives, laſted for ſeveral days, and was at length removed by drinking water impregnated with ſulphureous hepatic air. I afterwards found, that the manganeſe, which had been uſed in the diſtillation of the acid, contained a ſmall portion of lead.

Dr. INGEN-HOUSZ informed me, that a Dutchman of his acquaintance, ſome time ago, drank a conſiderable quantity of the dephlogiſticated marine acid: the effects which it produced were ſo extremely violent, that he narrowly eſcaped with his life. If therefore this acid ſhould hereafter be employed as an internal medicine, it would be neceſſary to prepare it by means of manganeſe that has been previouſly ſeparated, by a chemical proceſs, from the lead and the other metals with which that ſubſtance is uſually contaminated.