

ON
DETECTING THE PRESENCE
OF
ARSENIC,
PARTICULARLY IN REFERENCE TO THE EMPLOYMENT
OF "MARSH'S TEST."

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(Received February 2nd—Read February 9th, 1841.)

IN cases of poisoning by arsenic, it frequently happens that, after death, adhering to the stomach, or interspersed in the contents of the stomach, are to be found portions of a heavy white powder, in quantity so great that it can be collected and submitted to the process of reduction by carbonaceous matter, as well as part of it exposed to the action of those other chemical operations usually resorted to on such occasions:—in these instances, there is no difficulty in arriving at a positive conclusion, that the white powder operated upon is oxide of arsenic. It is not always,

however, that so much of the powder can be collected separately from the rest of the contents of the stomach as is required for its reduction by carbonaceous matter to the metallic state, or for the distinct exhibition by that agent of the characteristic alliaceous smell of the heated metal; owing to the oxide having been administered in the state of solution, or, if administered in powder, to its having become dissolved by the liquid contained in the stomach, or to its having got intimately diffused and mixed among the other undissolved matter in the stomach. In such instances, without applying a mode of testing published in the year 1836, we cannot so readily conclude as to its presence; but then have to operate upon a fluid by the application of certain tests capable of effecting known chemical changes with arsenious acid, by the power which they possess of acting upon it when in solution. Some of these tests are incapable of giving satisfactory results when the solution of arsenious acid is accompanied by one or more of many ingredients which often form a part of the contents of the stomach; and however strong our suspicions may be, it is not safe to conclude decidedly that arsenic is present when only one of the tests alluded to produces that apparent action which it ought to produce

with a solution of arsenic ; the least that is required is, that several of the tests should in the results of their action corroborate each other in the most full and satisfactory manner, unless by the action of one of them alone a precipitate is obtained which can be collected, and which is so free from the objectionable part of the matter from which it has been caused to deposit, that it can be decomposed, and the arsenic contained in it be reduced to, and exhibited in, the metallic state ; or, its quantity being sufficient, it be capable of being caused to undergo those changes, whereby such a solution may be formed from it as will completely give all the appearances which are expected from a pure solution of arsenious acid, by the application of those tests which gave unsatisfactory results when applied directly to the fluid contents of the stomach : and it is far from being extravagant to suppose that in cases of poisoning by arsenic it may happen, or that it not seldom does happen, that the alimentary canal of the individual to whom the arsenic was administered, has become evacuated to such a degree before the occurrence of death, that, on *post mortem* examination, the quantity of matter found whereupon to operate, is at most not greater than to allow of the exhibition, to the most skilful

analyst, of a mere trace of the poison sought for.

From these remarks it will be in some degree apparent how much before the year 1836 we were wanting, in regard to our known means of testing for arsenic, a method by which we could not fail in detecting and exhibiting it, when present in very minute quantity, in such complex organic materials as we might have to make the subject of investigation.

In the year mentioned, Mr. James Marsh, of the Royal Arsenal, Woolwich, published a mode of operating which appeared in a great degree to supply what was wanting : and, in viewing his discovery, whether we look upon the principle upon which it is based, or upon the apparatus which he used in carrying it into effect, we cannot but admire its beauty ; both the principle and the apparatus being such as for simplicity will not readily be superseded, and the principle one which forbids its actions to be frustrated by the impediments offered by organic substances.*

* The large gold medal of the Society of Arts of London was awarded to Mr. Marsh, for his discovery. His communication is printed in the 51st volume of the Transactions of the Society of Arts, and in the 21st volume of Jameson's Edinburgh New Philosophical Journal.

If diluted sulphuric acid or hydro-chloric acid be allowed to act upon zinc combined with arsenic, or upon zinc in contact with a solution of arsenious acid, or other compound of arsenic, the gas generated is arsenuretted hydrogen—hydrogen holding arsenic in combination. When, therefore, Mr. Marsh has a liquor for examination which is suspected to contain arsenic, and which could not easily be made sufficiently clear, and free from objectionable matter, to admit of being tested by the other usual means, or when he has solid matter, such as pastry, pudding, or the like, which, on being treated with water, gives such a liquor, he mixes the liquor with diluted sulphuric acid, and allows the mixture to act upon pure zinc, whereby hydrogen gas is produced, to which the arsenic is transferred, if any was present in the matter the subject of examination. The gas collected he causes to burn from a jet; and in contact with the flame holds a piece of cold window glass, or the like, on the surface of which a thin film of metallic arsenic immediately deposits when that metal was present in the matter suspected to contain it; or, having set fire to the gas as it issues from the jet, he receives the flame within a glass tube open at the ends, which becomes dimmed by a white powder, if arsenic be present.

With one drop of Fowler's solution of arsenic, which only contains about the one 120th part of a grain, he is able to obtain distinct metallic films. When arsenic is present in large quantity in the matter suspected to contain it, he can separate sufficient in the form of arsenious acid to enable him to form a pure solution from it, the identity of which he can then verify by the several tests usually employed, and which I have before alluded to: but, though his plan of operating is generally applicable, yet it is only indispensable to adopt it, when the poison is present in very minute quantity. Great as is the value at which we are compelled to estimate it in reference to its application where the quantity of poison present is but minute, and entangled with organic matter, there is still reason why it may have been considered incomplete, and viewed as dangerous to have been resorted to by the inexperienced operator, or even by one accustomed to general chemical practice but hasty in arriving at conclusions from mere superficial resemblances.

Had it been the fact that arsenic is the only metal which enters into combination with hydrogen, and which is capable of being deposited upon cold surfaces, when the gas is allowed to undergo

combustion, we might with propriety have concluded that when, on adopting Mr. Marsh's plan, we happened to get a metallic deposit or crust, arsenic was present in the matter under examination ; but in the number for May, 1837, of the *London and Edinburgh Philosophical Magazine, and Journal of Science*, Mr. Lewis Thompson directs our attention to a combination of antimony with hydrogen, which he calls antimonuretted hydrogen, and points out the near resemblance which it bears to arsenuretted hydrogen. This combination is procured under circumstances similar to those under which arsenuretted hydrogen is formed ; antimony, of course, being substituted for arsenic. The smell of antimonuretted hydrogen in a great degree resembles that of arsenuretted hydrogen ; and the two gases are much like each other in their general properties, as I find in corroboration of Mr. Thompson, who says, that when a piece of cold window glass is held in the flame of antimonuretted hydrogen, a metallic crust is deposited, and when a glass tube is used, the metallic film is formed on that part of the tube nearest the flame, and the white oxide around and above it, which appearances coincide in a very remarkable manner with those produced by arsenuretted hydrogen under similar circum-

stances; and although a practised eye may discern some difference between the crusts, that from antimony being more silvery and metallic; yet the line of demarcation is not easily drawn; for a thin film of antimony looks like arsenic, and a thick crust of arsenic has the metallic appearance of antimony: and, after showing the similarity of appearances produced by sulphuretted hydrogen upon the oxides of the two metals, and the fallacious results likely to be arrived at in endeavouring to determine which of the two is present by the ammoniacal sulphate of copper, he states that they may be distinguished by adding a drop of nitric acid to the crusts, which will dissolve them, and on evaporation to dryness a white powder be left in each instance: a little of a dilute solution of nitrate of silver being added, and the whole then exposed to the fumes arising from a stopper moistened with ammonia, the antimonial solution will deposit a dense white precipitate, whereas that from arsenic will give the well known canary yellow flocculi: he prefers this mode of using silver to the ammoniacal nitrate of that metal, because the slightest excess of ammonia destroys the colour, but by watching the effect of the vapour, the exact quantity requisite is easily

obtained. This plan, which Mr. Thompson suggests of determining of which of the two metals a crust consists, is ingenious, and should be adopted in all suitable instances ; but from experiments which I have made, I am forced to conclude that it does not always prove satisfactory—that by it indubitable results can only be obtained when the crust is very thick, or when its surface is extensive, or, in other words, when the quantity of metal deposited is considerable. When the crust operated upon is arsenic, and only a thin one, or sparing in quantity, the colour of the flocculent precipitate cannot so distinctly be perceived to be yellow as to warrant us in coming to that decision, neither can its flocculent appearance be distinctly perceived, and we cannot certify that the metal in question is not antimony ; the plan, therefore, is in a great measure liable to the same kind of objections which are to be urged against the sulphuretted hydrogen, and the sulphate of copper tests ; and I may add, that in this alleged instance of only a slight crust, there seems reason to doubt whether the result of the silver test alone applied as described should be allowed more forcibly to govern our decision, than the distinction to be perceived between the appearances of the

crusts of the two metals under some circumstances, and particularly when they are examined by a practised eye. Indeed, Mr. Thompson concludes his communication by stating, that he fears we can only regard Mr. Marsh's very ingenious test as furnishing good collateral evidence, capable, in scientific hands, of giving very correct indications, but wholly unfit to be entrusted to those unaccustomed to careful chemical manipulation: he says this with a thorough conviction of the great utility of the test, and is only sorry that its evidence is not unequivocal.

This announcement of Mr. Thompson was the cause of a subsequent paper by Mr. Marsh, appearing in the *Phil. Magazine* for Oct., 1839, in which he said he was happy in being able to lay before the readers of that journal, a very simple distinguishing test for arsenic and antimony; and stated it to be as follows:

After the common arrangements have been made for testing for the metals in question, the piece of glass or porcelain, on which the metallic crusts are generally received, is to have a drop of distilled water placed on it; it is then to be inverted, so that the drop of water is suspended

undermost. The gas as it issues from the jet is to be inflamed in the usual manner, but the piece of glass with its drop of water is to be held about an inch above the jet, or just above the apex of the cone of flame : the arsenic by this arrangement is oxidised at the same time that hydrogen is undergoing combustion, and coming in contact with the drop of water held above, forms a solution of arsenious acid, should arsenic have been in the mixture submitted to examination : a minute drop of ammoniacal nitrate of silver being dropped on the solution so obtained, if arsenic be present, the well known characteristic lemon yellow colour produced by this test, when used for testing for that substance, is immediately produced, viz., the insoluble arsenite of silver ; antimony under the same circumstances produces no change. He hopes that the process will be found to possess all the delicacy and precision necessary for distinguishing the two metals from each other, and that it will be the means of removing every doubt from the minds of experimentalists in future. I should have been glad to have been able to say Mr. Marsh's hopes are realized ; it happens on the contrary, however, that I must give my decided opinion, that the results obtained by his mode of testing ought not to be considered

indubitable, since it is a well known fact that *phosphoric acid* gives with ammoniacal nitrate of silver, a yellow precipitate not easily distinguishable when in small quantity from that produced by arsenious acid ; and, I find that by putting into Mr. Marsh's apparatus a little of a solution of antimony, and a little phosphuret of lime (or other substance capable of yielding phosphuretted hydrogen) along with the usual pure sulphuric acid and pure zinc, and without arsenic in any form, gas is produced, from the flame of which a metallic film, or crust, may be obtained ; and which gas, by being allowed to burn under a drop of water, as recommended by Mr. Marsh, gives the water the property of depositing a yellow precipitate when the ammoniacal nitrate of silver is added ; and, in addition to this, the gas possesses a smell resembling, in a high degree, that of arsenuretted hydrogen.

Reflecting upon the characteristic distinctions which exist between arsenic and antimony, and participating in the anxiety to remove any embarrassments prevailing against the perfection of a method of operating which presents such conveniences as Mr. Marsh's original discovery does, I have been induced to conceive that the effect

of the application of heat might with success be had recourse to in enabling us more positively to conclude of which of the two metals any crust or deposit we may have obtained is formed: and during the months of November and December last, I made repeated experiments, which, I think, proved the accuracy of the notion I entertained. Considering the readiness with which metallic arsenic volatilizes, and that it is said to be fusible at or below 400° of Fahr., while antimony requires about 800° for fusion, I thought it probable that there might be a wide thermometric range between the points at which the two metals were volatile or evaporable, and I commenced experimenting as follows. Having procured a number of slips of window glass, each about the 1-10th or the 1-8th of an inch wide, and several inches long, I, by the aid of Marsh's apparatus, caused metallic films, or crusts, of arsenic, to be deposited upon some of them, and of antimony upon others. I then provided a number of thin glass tubes, sealed at one end, and only about wide enough to admit the slips of window glass into them. Into one tube I put a slip of the window glass, coated *thickly* with arsenic, and into another a slip coated *very thinly* with antimony—in each case the slip being shorter than the tube,

and then hermetically sealed, with a blow-pipe flame, the orifice of the tubes. Thus arranged, the tubes enclosing the slips were immersed to a little more than the depth of the coated part of the slips, ($2\frac{1}{2}$ inches, the length of the tubes being about five inches,) in a bulb containing rape oil in a state of ebullition. In one minute the arsenic had entirely disappeared from that part of the slip surrounded by the hot oil; but the antimony did not entirely disappear before the expiration of seven minutes. Other subsequent experiments of the same kind, corroborated the conclusion arrived at in this instance, that a very thin film of antimony was very much longer in evaporating away, by the heat given by boiling oil than a very thick crust of arsenic. The next object was to endeavour to find a temperature lower than that of boiling oil, at which arsenic would entirely volatilize, and antimony remain permanently fixed; and about the beginning of November I made numerous experiments, similar to the above, but taking care that the oil from which the heat was communicated was kept at a temperature ranging from 490° to 500° , a thermometer being all the time kept immersed in it. In some instances thick crusts of arsenic were entirely volatilized in about fourteen minutes,

and, in other instances, crusts less thick disappeared in about eight minutes ; the length of time required for the entire volatilization depending upon the thickness of the crust ; but *very thin* films of antimony stood the temperature for an hour, without volatilization taking place in any perceptible degree. I next conducted similar experiments at a temperature ranging only from 355° to 365° , and found *very thick* crusts of arsenic to be volatilized in three or four hours, thin ones disappearing in half an hour or less ; those formed from gas produced by acting upon zinc with 400 gr. mea. of diluted sulphuric acid, (one volume concentrated acid to seven water) containing one drop of a solution of arsenious acid, sp. gr. 1.026, disappeared in half an hour, while those of antimony, apparently of the same density, did not diminish in the slightest perceptible degree in twenty hours ; and it did not seem probable that they would have diminished, however long they had been submitted to the same temperature, that being lower than the point at which antimony begins to volatilize.*

* From the eleventh edition of Dr. Henry's Elements of Chemistry, Vol. II, page 81, it is to be found that Thenard asserts that antimony is not volatile, when exposed to heat in closed vessels, if atmospheric air be carefully excluded, and no

About the time I was making these experiments, I communicated my ideas to my friend, Dr. Haworth, of this town (Bolton); and, in several weeks afterwards, he informed me that a number of the *Lancet*, just published, stated that M. Orfila had been describing in France different processes which might be adopted in distinguishing of which of the two metals a crust consisted, and amongst them he mentioned the application of heat; I, however, did not get to see the *Lancet*, nor did I learn the particulars of what was said regarding the application of heat, but about the beginning of this month my friend kindly put into my hands the *British and Foreign Medical*

gaseous matter be generated during the process. This, if true, would have been exceedingly favourable to my mode of distinguishing between arsenic and antimony; but the assertion is not to be relied upon. I took a narrow tube, sealed at one end, nearly filled it with cold silex in very fine powder, which had only a few minutes before been exposed to a red heat, and then pushed into it, through the powder, a slip of glass, having crusts of antimony upon it. By this management the metal was secluded from air of every kind, and confined in a medium for which it possessed no chemical affinity. Thus prepared, the tube was immersed to about half its depth in boiling oil, and the antimony volatilized, and left that part of the slip surrounded by the hot oil in as short a time as if atmospheric air had been present.

I submitted a slip having arsenic upon it, to a similar experiment, and obtained a corresponding result.

Review, for Jan., 1841, which contains a review of M. Orfila's *Memoirs on Poisoning*, printed in the *Memoirs of the Royal Academy of Medicine*, Vol. VIII., *Paris*, 1840; by this I find that the agency of heat spoken of by Orfila, is through the direct application of *flame* to the metal under examination. He says, that an arsenical stain, of whatever thickness, is entirely volatilized in from half a minute to a minute, when exposed to the flame of hydrogen gas, as in the common philosophical lamp; the antimonial stain, on the contrary, even when thin, is not volatilized until after the lapse of five or six minutes. This application of heat by flame is so indefinite in degree, and so wanting of that precision without which we greatly risk the danger of deciding erroneously, that I hesitate not at announcing my mode of applying heat, as one in which we may with more safety confide.

It will be observed, that I enclose and hermetically confine the metallic crusts in a tube, so that no portion can escape, although a volatile tendency be given them by the heat, which is an advantage not possessed when flame is directly applied to them unconfined, the metal then being dissipated and lost. When the temperature has

caused the crust, if of arsenic, to be volatilized from that part of the slip of glass on which it was deposited, small crystals are to be observed adhering to that part of the slip and of the interior of the tube, which was not immersed in the hot oil, chiefly to that part which was from $\frac{1}{4}$ to $\frac{1}{2}$ an inch above the surface of the oil. It will be perceived, too, that I do not lose the chance of trying the action of the other usual tests, but that I have an opportunity of testing in a two-fold manner the character of any crust in question: having cut off with a file one end of the tube, the metal or its oxide can be operated upon with nitric acid and the ammoniacal nitrate of silver, or with such other tests as we may choose to apply.

The greatest objection against my mode of operating is the tediousness attending the having to wait so long for the conclusion of an experiment, and the great care required in watching the range of the thermometer; but, I hope, this may be alleviated by substituting for oil as the heating medium, some other liquid whose boiling point is stable within the range of the temperature required: probably a *saturated* solution of some salt may answer, but, at present, I am not aware of any that will.

Mr. Marsh's original discovery, *per se*, is invaluable in enabling us with ease and certainty to bring out from among organic materials arsenic, when present in very minute quantity, and in giving us the power of submitting it to ocular demonstration; but it is wanting in the capability of convincing us that what we separate, from suspected matter, having the superficial appearance of arsenic, is most decidedly in every instance that metal; it leaves us to find out by other means whether the metallic looking substance is arsenic, or antimony, or something else. Though there may be other substances besides arsenic and antimony capable of combining with hydrogen, and of giving the flame of that gas the property of depositing upon cold surfaces dark coloured films or crusts having more or less of a metallic lustre, yet, I think it is not probable that any substance besides antimony will cause a film or crust, so nearly resembling one of arsenic in appearance and chemical properties, as to settle strong doubt upon the mind of an experimentalist accustomed to investigations, such as the one under consideration. Orfila states, that he has observed stains to result even from organic matter only; but these differed from arsenic in being less volatile, and in having none of the chemical

less volatile, and in having none of the chemical characters of that metal. Then, since the question is only likely to be whether or not a given metallic deposit is arsenic or antimony, I trust that my mode of applying heat, particularly in addition to the method of testing recommended by Mr. Thompson, will tend to make Mr. Marsh's discovery as perfect as it probably ever will be; and, I doubt not, that "Marsh's test" will continue to be regarded as a valuable assistant in a chemical laboratory. I have myself often applied it successfully in determining the presence of arsenic, in small quantity, in minerals I have had under examination; in such instances, I venture to suppose no one will dispute its utility; but, in cases of poisoning, unless a large quantity of the suspected arsenical ingredient can, by direct means, be produced, it ought not to be regarded in a stronger light than capable of furnishing good collateral evidence; it must, indeed, be lamentable to consider that so much confidence should be placed upon appearances produced by its operation, as to cause a positive conclusion to be arrived at that death was caused by arsenic, when it had been needful to resort to intricate manipulation in order to detect the requisite characteristics, and when, at length, only a slight crust or film could be obtained. In cases of poisoning, no man,

however high his reputation as a chemical analyst, or as a toxicologist, has a right to be satisfied that any metallic looking substance is arsenic, which, by the apparatus in question, he may have separated from matter suspected to contain it, unless the quantity is so great that he can verify his suspicions, not only by ascertaining the temperature at which it is volatile, but by the application of other indubitable tests.

Before concluding, I must not neglect to mention the great necessity which exists, in the application of "Marsh's Test," previously to examine with the utmost care the purity of the articles to be used. It is requisite to see that the apparatus is entirely free from arsenic; and that not only the zinc is pure, but particularly the *sulphuric acid*; for, at present, the sulphuric acid of commerce, as ordinarily produced from pyrites, is *strongly impregnated with arsenious acid*.^{*} And from facts which have come under my observation, I may add that hydro-chloric acid (muriatic acid) produced through the agency of such sulphuric acid is also impregnated with arsenic. I have not yet

^{*} Since this paper was read, I have found 1000 grains, by weight, of a commercial sample of concentrated sulphuric acid, to contain $5\frac{1}{2}$ grains of arsenious acid.

seen any nitric acid produced through the agency of the impure sulphuric ; but, probably, in such, arsenic would likewise be found.

Before using any one of the three acids, we cannot be too careful in minutely examining its purity.

In Mr. Marsh's communication to the Society of Arts, he suggests determining the purity of the zinc by putting a bit of it into the apparatus, with some diluted sulphuric acid only ; and if the gas obtained on being set fire to, as it issues from the jet, will deposit no metallic film on a bit of flat glass submitted to the flame, and yield no white sublimate within an open tube ; the zinc may be regarded as in a fit state for use. The purity of the zinc being known, the like process might, of course, be resorted to in determining the fitness of the sulphuric acid for use ; but, I will remark as a caution, that in determining the freedom of either the zinc, or the acid, or the apparatus from arsenic, it is much preferable to hold a cold substance of *large bulk* to the flame, from a small jet, instead of a *bit* of glass, for I have found that when the gas contains only an exceedingly minute quantity of arsenic, a distinct metallic deposit

cannot be obtained upon a small bit, or thin piece, of glass, and the result of the experiment is such as would lead one to suppose that the materials are fit to be used in an investigation of poisoning ; but when a cold solid substance of the bulk of several cubic inches, as, for instance, the thick end of a Wedgwood's ware pestle, is held to the flame, a dense metallic crust may be obtained : the reason of this is easily explained,—the heat communicated to a small bit, or thin piece, of glass, by the combustion of the hydrogen, soon becomes so great as to keep the arsenic in a volatile state ; but a large solid substance is a long time in becoming hot, and, consequently, upon it the metal continuously, though slowly, and by little and little, deposits, until ultimately a very distinct and even dense crust is obtained. It is obvious, that if this precaution of holding a large cold substance to the flame be not attended to in testing the purity of the materials, and if then, by the application of such large substance to the flame of gas produced after the introduction, into the apparatus, of any matter suspected to contain arsenic, a deposit of that metal be obtained, a very great risk is run of forming an erroneous and dangerous decision.

In consequence of the sulphuric acid of com-

merce containing arsenic, it cannot but be expected that many of the ingredients or compounds into which that acid enters as a constituent, as well as some of those of which it is not a constituent, but in the formation of which it has been employed as an agent, will be liable to be more or less contaminated with arsenic. I have detected arsenic in the sulphate of potash (commonly known in chemical manufactories under the name of "*sal enixum*"), though in the formation of this salt a considerably high temperature had been employed, which many persons probably might suppose would have had the effect of expelling all the arsenic. There is reason to expect its presence in alum, not only since such sulphate of potash as I have mentioned is used in alum making, but also as sulphuric acid is directly applied in the formation of the sulphate of alumina used.* And, the probability arises, that food may in some instances be contaminated with it; alum being an article which bakers often use in admixture with the other usual constituents in the mak-

* Since writing the above, I have obtained a commercial sample of alum, which had been produced by the aid of pyrites sulphuric acid, and found it to be accompanied by a trace of arsenic.

ing of bread.* Hence, in investigating whether or not, in any instance, poison has been intentionally and maliciously administered ; it is indispensable, when, on testing, we certainly detect the presence of arsenic, to ascertain completely that what we detect has not had its introduction from some accidental source ; no less is it the duty of a court of judicature to receive with the most scrupulous examination all evidence tendered on the subject, particularly when the quantity of arsenic detected is but small ; and, from the facts and probabilities to be gathered from what I have adduced in this paper, together with the circumstance of the great lack of chemical science among the generality of the members of the bar, I feel that I may, without hesitation, express my strong belief, that a person standing accused of having wilfully caused the death of another by poison, is far from being sure to have that fair treatment which he has a right to expect from a court whose only object is to deal out impartial justice,

* It is very likely, that vinegar may hereafter (when pyrites acid has got into more general use than at present) be found to contain arsenic ; the manufacturers of vinegar being in the habit of adulterating it with sulphuric acid, which the law allows them to do to a limited extent.

if the counsel employed for his defence be not assisted by the evidence, or instruction, of some one skilled in the principles and practice of chemistry.

BOLTON-LE-MOORS,

Jan. 25th, 1841.

APPENDIX TO THE FOREGOING PAPER.

In the London and Edinburgh Philosophical Magazine, published yesterday, I find a communication from Mr. Marsh, "*On testing for Arsenic and Antimony, by Hume's Process*," in which he submits to the readers of that journal, a modification of the mode of applying Hume's test (the ammoniacal nitrate of silver) which he described in the said journal, published October, 1839. Instead of the drop of water, suspended to the inverted glass, being held over the flame of gas, and the ammoniacal nitrate of silver being afterwards applied, he, at once, having moistened one side of a piece of glass with the test solution, holds it, with the moistened side downwards, over the flame, when, if arsenic be present, the characteristic yellow precipitate is produced, and, if

antimony be present, a white precipitate is obtained, while, if neither arsenic nor antimony be present, the silver of the test liquor is reduced to the metallic state.

In this modification of the application of Hume's test, there is nothing whereby any of the doubt can be removed, as to whether a yellow precipitate produced is the consequence of the action of arsenious acid, or of phosphoric acid upon the test. *See pages 600 and 601, of this volume.*

H. H. WATSON.

June 2nd, 1841.



Watson, Henry Hough. 1842. "On Detecting the Presence of Arsenic, Particularly in Reference to the Employment of " Marsh's Test."." *Memoirs of the Literary and Philosophical Society of Manchester* 6, 590–616.

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