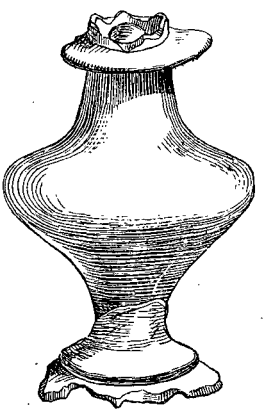
IV.

ACCOUNT OF THE EXAMINATION OF THE CONTENTS OF AN ANCIENT HERMETICALLY-SEALED GLASS VESSEL.[1] By GEORGE WILSON, M.D., F.R.S.E.

The vessel in question is the property of the Society of Antiquaries of Scotland, to whom it was presented by the late Dr Samuel Hibbert Ware, who brought it from Pompeii in 1828. It was placed in my hands by the Council of the Society, with the request that I should examine its contents, which I removed and analysed in May 1853. The results of this examination were as follow:—



The vessel—which is figured here in what is assumed to be the position which it occupied when entire—is in the form of an unsymmetrical, irregular, double cone, such as would result from the union at their bases of two unequal hollow cones; and the greater part of its internal cavity was originally occupied by a limpid, colourless liquid. Its length is about two inches, and its circumference at the widest part four inches. One of the cones is larger than the other, and the whole vessel may be compared to a small turnip, the truncated tail of which has been planted in a foot or pedestal, whilst the root-leaves have been cut across near the bulb, and supplied with a cover resembling a roofless low-crowned broad-brimmed hat. I use this comparison for the sake of rendering subsequent references clearer. At both extremities the glass is broken, so as to make it uncertain how they originally terminated. From some appearances it has seemed to several who have seen the vessel, that it once formed part of the stem of a much larger one; with which opinion I am strongly disposed to concur.

On a cursory examination, one is puzzled to discover in what way a liquid had been introduced into the cavity of the vessel. At the extremity corresponding

[1] "I regret that I cannot give you any very minute information relative to the small glass vessel you mention in your letter. About fifteen or sixteen years ago I remember my father shewing it to me, and telling me that it was a lachrymatory which he found, or purchased, when at Pompeii in the year 1827-8."—*Extract from a letter by Titus Hibbert Ware, Esq. of Hale Barns, Altringham, Cheshire, to Dr Daniel Wilson, dated 28th May* 1853.

to the apex of the smaller (or upper) cone, which would be the top if the vessel were placed in the position of a growing turnip, there is a small glass knob, somewhat resembling the head of a stopper, which might have been hermetically sealed into an aperture through which the liquid was introduced. But a little examination shews that the knob in question does not fill or cover an aperture, but is simply attached to an unperforated plate of glass.

There can be little question that the vessel was filled from the apex of the larger (or lower) cone. Mr P. Stevenson, the philosophical instrument maker, has drawn my attention to the appearance of the glass there, as indicating that the vessel originally terminated in a narrow tube, which was closed by melting the glass after the liquid had been introduced. The closed extremity of the tube (which I have already compared to the truncated tail of a turnip) was then fused into the pedestal or foot, probably by means of the blowpipe. In the woodcut (which is from a drawing kindly made by James Drummond, Esq., R.S.A.), the point of junction is shewn, and the upper part of the foot will be seen to surround the narrow extremity of the cone. Such a piece of manipulation could have been practised only by a skilful glassworker, even with a readily fusible glass, such as I find that of the vessel to be.

The vessel, filled with liquid, would contain about 100 grains of such a substance as water. It was only partially filled, however, so that it did not contain more than some sixty grains of fluid.

My friend, Mr A. Bryson, undertook the opening of the vessel, which was effected by drilling a small hole with a steel graver through one side, at a place where the glass had already been chipped, or had scaled off, and left a weak point. The softness of the glass allowed the boring to be effected without the employment of turpentine, or any other lubricating agent, which would have contaminated the inclosed liquid; and without injuring the vessel, otherwise than by making a single small perforation in one side. Through this aperture, the liquid was withdrawn by a pipette, and the examination of its properties proceeded with.

The first point inquired into was the density of the liquid. This was ascertained by means of a weighing-bottle which contained at 60° F., 47·30 grains of distilled water, and at the same temperature, 47·55 grains of the liquid under examination; so that if the specific gravity of water be reckoned 1000, that of the liquid would be 1005·28. It is thus a little denser than water.

Arrangements had been made for taking the refractive index of the liquid, should its specific gravity materially differ from that of water; but it differed so slightly that the variation in refractive power between the fluids would certainly have been too small to be distinguishable.

The other physical characters were as follow. The liquid was colourless, and slightly opalescent from the presence of a small amount of sediment, apparently consisting of thin flakes of glass separated from the inside of the vessel, and in part also of the powder produced during the perforation of the glass. This powder, however, certainly formed the smaller portion of the sediment, for, before the vessel was opened, flakes of semi-transparent matter were visible in the liquid.

No distinct odour could be perceived on opening the glass. Mr Bryson, indeed, thought that he could faintly discern an odour like that experienced on the seashore, and familiarly known as the "smell of the sea;" but as the majority of those present, although in the daily practice of distinguishing chemical substances by their smell, failed to recognise an odour, the liquid may be regarded as having been odourless. It is quite possible, however, that an odour might be discernible at the moment of completing the perforation of the glass, although not afterwards, owing to the escape of volatile matter previously imprisoned. A trace of free chlorine would suffice to produce the sea-smell, and such may have been evolved, for it will presently appear that the liquid contained chlorides.

The taste of the liquid was faintly saltish. It was not inflammable. It retained its transparency when heated in a glass tube; and when evaporated on platina-foil, left a small white residue which on further heating became slightly charred, betraying the presence of organic matter. Turmeric paper was rendered permanently brown by a drop of the liquid, implying the presence of a free, or slightly neutralized fixed alkali. From the subsequent examination it appeared that this alkali was soda.

From the characters described it was apparent that the liquid was a weak aqueous saline solution. It was accordingly tested for all the important acids and bases, with the following results, which I state somewhat fully for the sake of those who have not made chemistry a special study. The name of the test, and its action, whether positive or negative, are first given, and thereafter the conclusion which its deportment warrants, as to the presence or absence of particular bases, metals, and acids.

Examination for Bases.

1. Hydrochloric acid gave *no* precipitate. Absence of silver, and of black oxide of mercury.

2. Hydrochloric acid and sulphuretted hydrogen, taken together, gave *no* precipitate. Absence of red oxide of mercury, and peroxide of iron; and of lead, copper, bismuth, cadmium, arsenic, antimony, tin, gold, and platinum.

3. Hydrosulphuret of ammonia gave *no* precipitate. Absence of iron (protoxide), manganese, nickel, cobalt, zinc, aluminum, and chromium.

4. Oxalate of ammonia gave slowly a white precipitate, whilst sulphate of lime gave no precipitate. Absence of baryta and strontia, presence of lime. Magnesia, of which at best only a trace can have been present, was not tested for.

5. Bichloride of platinum gave no precipitate; and caustic potass occasioned no evolution of the odour of hartshorn. Absence of potass and ammonia.

6. The residue obtained by evaporating a portion of the liquid to dryness, was moistened with alcohol, and the alcohol set fire to. It burned with a clear yellow flame, proving the presence of soda.

It thus appears that so far as bases and metals are concerned, none of the poisonous, the markedly medicinal, or the ordinary heavy metals were present; and that soda and lime, neither in very large quantity, are the only bases which were discovered. Magnesia and potass may also have been present, but only in minute quantity. The liquid was then tested for acids.

Examination for Acids.

1. Nitrate of baryta gave no precipitate even after twelve hours, and as already stated, sulphate of lime gave no precipitate. Absence of sulphuric, carbonic, oxalic, boracic, silicic, and phosphoric acids. The last-named acid, however, was present in small quantity, for the new and highly sensitive test for phosphoric acid, molybdate of ammonia, along with hydrochloric acid, distinctly demonstrated its presence.

2. Nitrate of silver gave a copious white precipitate soluble in ammonia. Chlorine therefore was present, probably in combination with sodium as common salt. Iodine was specially sought for, but none was detected.

3. Acid sulphate of indigo was not bleached when boiled with the liquid. Nitric acid and chloric acid were therefore absent.

This completed the chemical examination. The conclusion to which it leads, is, that the liquid in the glass vessel consisted, at the period of its analysis, of water holding in solution a small amount of common salt, of soda (in the form probably of alkaline carbonate), of a salt of lime, and of phosphoric acid, as well as a little organic matter.

Before, however, any general inference can be drawn as to the original characters of the liquid, three contingencies must be considered: 1*st*, The liquid may have lost certain of the substances which were contained in it at the period of it inclusion; 2*d*, It may have acquired from the walls of the vessel, matters

originally foreign to it; 3*d*, It may have altered, alike by the loss of substances originally present, and by the gain of substances originally absent.

The probability of such changes having happened is very great, for the sealed vessel is understood to have been brought from Pompeii, and the liquid and the glass have thus been in contact with each other for more than a thousand years, whilst the partial occupation of the vessel by liquid, left a space filled with air, which, in the long lapse of centuries, would infallibly effect a more or less perfect decomposition of vegetable or animal matter originally present. Thus, it is not likely that any scented water such as rose or cinnamon or peppermint water, or any weak infusion or solution of vegetable or animal matter, would retain its original characters for even a small portion of the time during which the liquid under notice has been preserved; and we may confidently affirm, that in the course of a thousand years a liquid originally possessed of a marked colour, odour, and taste, due to the presence of organic matter, might become colourless, odourless, and tasteless.

This fact must be kept in view in speculating on the motives which led to the original inclusion of the liquid; but as the organic matter possibly present in it, would not be destroyed in the sense of annihilated, but would undergo conversion into new chemical compounds admitting of detection, the metamorphosed relics of such primary colouring, odorous, or sapid matter would remain and be recognised.

The amount of organic matter, however, found in the liquid was exceedingly small, and ammonia was altogether absent, so that we may be certain that no very large amount of organic matter which subsequently underwent decomposition was originally present in the liquid.

On the other hand, there can be no question that a soft glass such as the vessel consists of, which exhibits on its external and internal surface marks of decomposition, must have parted with a portion of its more soluble constituents to the liquid which wetted it internally. The best glass, if long in contact with water, is robbed by it of a portion of its constituents, and the alkalinity of the liquid in the vessel must doubtless be, in part at least, ascribed to soda which has been derived from the glass.

It becomes indeed a grave question, whether the whole of the saline matter present in the liquid, may not have been dissolved out of the glass; for distilled water acts even more quickly on that substance than many saline solutions do, and in the absence of precise knowledge as to the constituents of the glass, which I was not at liberty to test otherwise than by the blow-pipe, I cannot dispose of the question decisively. It must be acknowledged, however, that all the substances present in the liquid may have been derived from the glass.

Again, supposing the glass to have yielded only a portion of the saline matter found in the liquid, still the substances present in it so much resemble those occurring in natural waters, that it may originally have been nothing more than what in ordinary language we should call common water.

It differs, however, from any natural water with which I am acquainted, in exhibiting together the following characters: 1. Marked alkalinity: 2. The absence of sulphates: 3. The presence of phosphates: 4. The presence in comparatively large quantity of chlorides; but distilled water might acquire those characters by long contact with glass, although it is more consonant with our experience to find sulphates present, and phosphates absent, than the reversal of this state of matters, which occurred in the liquid under notice.

Such, then, are the data which chemistry supplies towards the determination of the original nature of the contents of the sealed vessel. I may be allowed, in conclusion, to offer the following remarks on the general questions, What was the original quality of the liquid? and with what purpose was it shut up within the vessel? Three suggestions on these points have reached me, to which I shall first refer.

1. It has been suggested that the liquid was an eyewash or other lotion or medicinal solution. The analysis, however, does not favour this idea, for all the important metallic salts which were known to the Greek and Roman physicians, and are employed at the present day medicinally, are absent from the contents of the vessel. It is quite true that such an eyewash as rose water would become in the course of much fewer than ten or twelve centuries, a scentless liquid such as the vessel contained; and it may be pleaded that the ancient physicians were not behind their successors in prescribing medicines, whose potency lay in their appeal to the faith of the patient, not in their embodiment of heroic remedies; but plainly the *onus probandi* lies on those who would convert a negative conclusion like this into a positive one.

2. A second suggestion was, that the vessel might be a lachrymatory, and its contents tears. Were there evidence of another kind to justify this opinion, it would in some respects be confirmed by the results of analysis. Recent tears, according to the latest researches, contain about 99 per cent. of water, and 1 per cent. of matter in solution. This soluble matter consists of common salt, alkaline and earthy phosphates, and organic matter (albumen, epithelium, mucus, and fat).[1] Struck by the similarity in characters and in composition, so far as the inorganic constituents are concerned, between tears and the liquid under notice, I placed a portion at the disposal of the Members of the Edinburgh

[1] Frerichs, in Wagner's Handwörterbuch der Physiologie, vol. iii.

Physiological Society, skilled in the use of the microscope, by whom it was examined, but no organised bodies (such as epithelial scales) could be detected. It is doubtful, however, if tears always contains these, and even if they do, when it is remembered that organic matter forms but $\frac{1}{200}$th part by weight of this secretion, and that it rapidly undergoes decomposition, the fact that albumen *e. g.* could not be detected in the liquid, although organic matter was, cannot be considered as any formidable objection to the supposition that the original contents of the sealed vessel may have been tears. More than this it would be unwise to affirm, for tears have no very marked positive characters, by which, even if not altered by time, they can be certainly identified.

3. The third suggestion was that the liquid was a portion of natural water such as a lake, river, or fountain, which religious, personal, or patriotic considerations invested with an interest, such, for example, as attaches to the Jordan at the present day, and which led to its being preserved, as Jordan water now is. I do not know that there is any evidence of a general kind to support this opinion, and the chemical characters of the liquid are rather unfavourable than otherwise to such a view.

Many similar suggestions might be made, but it is not worth while multiplying them. I would offer but one remark, which may be connected with each of the opinions referred to, and with many others; namely, that whatever was the origin or nature of the liquid, one object, and perhaps the only one which was contemplated in inclosing it in a vessel, was to prove the dexterity of the glass-worker, who has in all ages been fond of proving his manipulative skill by inclosing foreign bodies in the plastic material of his art. This notion will acquire additional probability if it shall appear that the vessel was not a small detached bottle, but was attached to the stem of a larger vessel.

Since writing the above, I have received a communication from my friend Mr Charles Tomlinson of London, which, in one respect, adds confirmation to the suggestion contained in the close of the preceding paragraph. The British Museum possesses a glass vessel similar to that under notice, but known to be Venetian, and "containing a liquid, apparently water." "It had evidently" says my informant "been blown into a mould, the surface being covered with small projections in the form of half beads . . . the two extremities are broken off, shewing by the fracture that the vessel formed part of something else."

The skilful Venetian glass-blowers are not likely to have had any motive but an artistic one, in inclosing a liquid in a ball blown on the stem of a vessel; but from the Pompeian origin of the bulb before us, it should seem that in practising this device they have only been imitators of their Italian predecessors.

In the Museum of the Society of Antiquaries of Scotland there are two small vessels greatly resembling that which is the subject of this paper. Both are empty; but the smaller of them, which most resembles that figured above, has a small aperture at one side, through which any liquid originally inclosed in it would escape. It is difficult to determine whether this aperture is the result of an accidental fracture, or has been deliberately made; but from its smoothness and roundness I incline to the conclusion that it has been purposely drilled to tap the vessel. The remaining vial is entire. The history of both, I am informed, is unknown, but they have evidently formed portions of larger vessels.

Subsequent to the reading of this paper, Prof. J. Y. Simpson has drawn my attention to the following account of a vessel similar to the one figured above, contained in the *Archæological Journal*, Vol. iii., p. 69; and the publisher of the Journal, J. H. Parker, Esq., Oxford, has kindly given me the loan of the accompanying woodcut to illustrate the description.

"Mr Samuel Tymms, of Bury St Edmunds, communicated for examination a fragment of a glass vessel, supposed to be of Roman date, discovered at Lavenham in Suffolk. The annexed representation shews its demensions; in the central part was inclosed a small quantity of liquid, half filling the cavity; it was slightly tinged with a pinkish colour, and seemed to deposit a whitish sediment. The glass was of a pure white crystalline texture. Stow relates that amongst numerous Roman remains found when the field anciently called Solesworth, now Spittlefield, was broken up about the year 1576 to make bricks, 'there were found divers vials, and other fashioned glasses, some mots curiously wrought and some of chrystall, all which had water in them, nothing differing in clearness, taste, or savour from common spring water, whatever it was at the first. Some of these glasses had oyle in them very thick, and earthy in savour.' (*Survey of Lond.*, B. ii., c. 5, p. 177, ed. 1633.) In the Museum of Antiquities at Rouen a small glass vial, accounted to be Roman, is preserved, hermetically sealed and half full of liquid."