

PYTHAGOREAN THEORY AND DIONYSIAN PRACTICE: THE CULTIC AND PRACTICAL BACKGROUND TO CHEMICAL EXPERIMENTATION IN HELLENISTIC EGYPT**

By C. ANNE WILSON*

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The purpose of the experiments is claimed in c.15 to be 'a healing for the soul and its release from all hardship'. They are thus linked to the same objectives as were the rituals of the ancient Greek mystery religions. But the author of the text is said to be Democritus, the philosopher, and c.3 contains a narrative in which he tells how he learned the secret of physical matter from an unnamed teacher, recently dead, and from that teacher's unnamed pupil.

The Greek text of *Phusika kai Mustika* was first published in 1887-8 by Marcellin Berthelot, along with many similar chemical recipe texts dating from the first century AD to Byzantine times. Thereafter a significant emendation was made to the narrative in c.3 by Herman Diels. The text tells how the vital information was found hidden inside a broken column in the temple, and a comment follows which reads (in translation): 'No-one said that books would be stored there.' Diels emended 'No-one' (*out' an tis* in Greek) to 'Ostanes'. Some later editors have followed his emendation, giving the impression that Persian ideas and the inspiration of a Persian 'wise man', Ostanes, led to the founding of the chemical art in Egypt.

But Berthelot's original text, based on the tenth-century AD manuscript Marcianus 299, collated with texts in other European libraries, does not support this reading; neither do the texts in his *Collection des anciens alchimistes grecs* contain anything to suggest that a link was established between Ostanes and chemical experiments prior to the third century AD. The clues within *Phusika*

* Brotherton Library, University of Leeds, Leeds LS2 9JT.

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In *Phusika kai Mustika* c.3, where Democritus, the supposed author gives the account of his efforts to learn 'how to harmonize the natures', he discovers that the answer lies in three phrases: 'One nature delights in another nature; one nature conquers another nature; one nature overrules another nature.' 'I came to Egypt', Democritus continues, 'bringing the natures.' The gold-tinting and silver-tinting recipes follow, and after each recipe appears one of the three phrases, literally as 'the nature overrules the nature,' etc., but usually translated as 'one nature overrules another nature,' etc.

So much for the mystical side. In chemical terms what happened was that the silver and gold colorations were achieved, as Joseph Needham explained, 'by altering the composition of the surface layers (of the base metal), or by depositing microscopically-thin films.'⁵ This was accomplished by causing a reaction between the exterior of the base metal, usually a small piece named a *petalon*, and various other substances, both mineral and organic, through processes of heating, steeping, application of pastes, or simply prolonged contact. Two of the techniques known to the experimenters were sublimation, called 'the raising of the vapour' (*arsis nepheles* in Greek), and distillation, called 'the raising of the water' (*arsis hudatos*). Both are named at the end of *Phusika kai Mustika* (c.29) with the tantalizing remark that they are not described here because they have already been dealt with in other works of the author. Those works have not come down to us.

What were the real aims of the experimenters, and what was the theoretical basis for their practical chemistry? Their chemical art was established in Egypt before the mid-second century BC when the phrase about one nature conquering another nature was re-used in an astrological treatise known as *The Revelation of Nechepso and Petosiris*.⁶ Bolos of Mendes was involved somehow in the earliest phase; and Columella later claimed that Bolos wrote a book called *Cheirokmeta* 'under the false name of Democritus'.⁷ Bolos also wrote a book on sympathies and antipathies which he claimed existed between certain plants,

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animals and minerals; and some modern scholars believe he was the true author of *Phusika kai Mustika*. The Bolos question is a complicated one which has been treated elsewhere.⁸ But the enigma attached to his possible contribution to the development of chemistry is apparent from his entry in the *Suidas*, the biographical dictionary, where he is recorded twice, as Bolos Demokritos and as Bolos of Mendes, the Pythagorean.

PYTHAGOREANS AND THE FOUR ELEMENTS

Pythagorean ideas can be found in *Phusika kai Mustika*. In c.15 the *neoi* (newcomers) are attacked for their failure to appreciate the significance of the chemical changes because 'they do not understand the natures, how one form transforms ten'. The 'ten' must refer to the Pythagorean tetraktys, the fundamental formula of $1 + 2 + 3 + 4 = 10$, first brought by Pythagoras himself to his followers, and honoured thereafter in their most sacred oath. The other system of ideas linked unquestionably with Pythagoras is metempsychosis, or the transmigration of souls, which were thought to live through many lives, inhabiting plants, animals, birds, fish, children, women and finally men, before they could pass to the ultimate fiery realm. I would suggest that the numbers of the tetraktys, which later were equated with the four elements,⁹ were originally introduced to represent the four realms of the cosmos.

The idea of the four realms was very old. Hesiod in his *Theogony* (808–10) wrote about the sources and limits of the four realms of heaven, earth, sea and 'misty Tartarus'; and Homer's gods themselves swore solemn oaths by three of the four realms, giving a divine precedent for the underlying theme of the tetraktys oath.¹⁰ The Pythagorean realms were slightly different, but still four in number. Whereas Hesiod had recognized 'misty Tartarus' (the deepest part of Hades) as a realm, the Pythagoreans had the realm of air—the Greek word is *aer*, which meant mist in Hesiod's day, but changed its meaning through the sixth and fifth centuries to that of the ordinary lower air which is subject to clouds and mist.

For them the 1 would have been the number of the heavenly realm filled with light and fire, which was also a place of stillness where the soul could find rest after having been buffeted through its lives in the other three realms of air (symbolized by the number 2), water (symbolized by the 3) and earth (symbolized by the 4). A very old concept, going back to Mycenaean times, made the 1 and the 3 male numbers, and the 2 and the 4 female numbers;¹¹ so 4, which is both $2 + 2$ and 2×2 , was an appropriate symbol for fertile earth.

The Pythagoreans believed their souls, having fulfilled their spans of life in the bodies of plants, animals, children and women, were finally reborn into the men who would become Pythagoreans, would live ascetic lives and carry out required rituals so that they (the souls) would pass after the body's death to their rest in the heavenly light and their release from grief and hardship. The tetraktys was laid out on the ground as a pebble figure, with one pebble at the apex and four at the base.¹² In this form it may have had a role in initiation

ceremonies, since it has the interesting characteristic that the relationship between the 1 and the 4 depends on the position of the viewer; the pebble at either end of the line of four representing earth could become the apex if seen from one of the other two sides. The tetraktys could have represented a bridge from earth to the fiery heaven of the Pythagoreans.¹³

Empedocles first defined the elements as four: earth, water, air and fire, moving endlessly together and apart through the operation of love and strife. This new definition of the nature of matter, formulated in the middle years of the fifth century BC, was to influence European thought for the next two thousand years. The Pythagoreans added a second line to their oath, which defined the tetraktys as 'holding the fountain and roots of ever-flowing nature'. The verse could not have predated Empedocles, as Burkert recognised;¹⁴ but it would not have been added at all if the Pythagoreans had not accepted Empedocles' four 'roots' (his word for the elements) and his concept of them flowing constantly together and apart.¹⁵ Once they had acknowledged the four elements of earth, water, air and fire, it would not have been difficult for them to take the further step of equating those elements with the tetraktys numbers for the four realms, since the names of three of the elements corresponded to the names of the three lower realms, and the 1, the number of the fiery heaven, could be transferred without difficulty to the element fire.

The earliest surviving record of the tetraktys of the elements is in Theon of Smyrna's list of tetraktyses compiled in the early second century AD, but the underlying idea must have emerged hundreds of years before.¹⁶ It is referred to in *Phusika kai Mustika* in the phrase 'one form transforms ten' (c.15). Other Pythagorean themes are also present, but their source lies in the Platonic theories adopted by Pythagoreans of the Hellenistic age.

PLATO AND THE FOUR ELEMENTS

The chemistry of the recipes in *Phusika kai Mustika* derives not directly from the tetraktys, but from Plato's reworking of it in *Timaeus*,¹⁷ where he assigned three-dimensional shapes to the basic particles of the elements: the four-sided pyramid to fire; the eight-sided octahedron to air; the twenty-sided icosahedron to water; and the six-sided cube to earth.¹⁸ The three-dimensionality accorded to these particles is a counterpart to the atomic system of Leucippus and Democritus developed shortly before; but their atoms, by contrast, were of an infinite number of different shapes. In Plato's particles of fire, of air and of water, the surfaces were made up in each case from triangles identical in shape, *i.e.* the halves of an equilateral triangle. The cube, the most stable of the solids, was assigned to earth; but the surfaces of the cube were formed from isosceles triangles, incompatible with the triangles of the other three elements. Plato argued that the upper three elements could break up and change into one another because of their identical triangles, but the particles of earth, although they could be united temporarily with the others, would eventually dissolve out of their compounds and become earth again.

The changes of the elements begin in *Timaëus* 56D-E with the upward cycle, with one particle of water broken up to form two of air plus one of fire, and then one particle of air forming two of fire. The downward cycle begins when a small quantity of fire is enclosed by a large quantity of air and water, and it is conquered (*nikēthen*) so that two particles of fire unite to make one of air. And when air is overruled (*kratēthen*), then two and a half particles of air form one of water. The author of *Phusika kai Mustika* took those two verbs, *nikan* (to conquer) and *kratein* (to overrule) and applied them to the upward changes of the elements: 'the nature conquers the nature'; 'the nature overrules the nature'.

Plato was regarded by Pythagoreans who came after him as the transmitter of true Pythagorean ideas.¹⁹ Whoever coined the three phrases about the natures, which are attached to each recipe in *Phusika kai Mustika*, was following Plato's version of the Pythagorean theory of the elements. By 'nature' he meant 'elemental nature'; and it is very likely that he was a Pythagorean in Hellenistic Egypt, who adopted this usage of the word 'nature' from the Pythagorean oath which stated that the tetraktys held 'the fountain and roots of everflowing nature'.

Plato's *Timaëus* 59B accounts for the choice of copper, or the amalgam of four base metals including copper found in early chemical texts other than *Phusika kai Mustika* (four was the tetraktys number for earth), as the starting point for the cultic chemical experiments. Copper is described there as having particles resembling those of gold, but as containing also small and fine portions of earth; so it is composed partially of earth. But it is also a metal, and metals, because they liquefy at high temperatures, are defined at *Timaëus* 58D as 'fusible water'. Using copper as their primary material, the experimenters in Hellenistic Egypt believed they could change its watery nature to that of air, and then to the nature of fire, because the particles of each of the three upper elements had the potential to interchange their natures. The close connection between the tetraktys of the elements and the earlier tetraktys of the four realms led them to believe also that by creating those changes they were practising a redemption ritual, both for the copper and for the soul of the experimenter.

Copper represented earth on its way to becoming water. The people who compiled the chemical recipes knew how to obtain mercury and arsenic from their sulphides by vaporization processes which demonstrated that a gaseous or airy nature was concealed within the sulphide. They heated their copper *petalon* with mercury or arsenic in a sublimation vessel, and it emerged with a silvery appearance, thus representing water on its way to becoming air. It was then tinted gold by means of sulphur, sulphur water, yellow minerals and plant dyes in various combinations, and at this point may have represented air on its way to becoming fire, but not yet fully fire, since the gold tint was not finally fixed. Further treatment, or the passage of an interval of time sufficient to prove that the tint was not evanescent, brought the copper to its final gold state when the element fire became its predominant 'nature'. Some recipes in

*Phusika kai Mustika*²⁰ and in a few other early treatises in Berthelot's *Collection* indicate that the final process made the golden copper reactive, able to tint gold an untreated piece of copper. This could have been achieved by a sublimation process in cases where the preceding silver colour had been produced via mercury or arsenic; but where other ingredients were used, that outcome may not have been obtainable.

When the final gold had been reached, the metal was described as becoming *ios*,²¹ a process also called *iosis*. *Ios* is a Greek word with several meanings, including that of verdigris. The experimenters may have viewed the gold colour of the treated copper as a fiery verdigris, in total contrast to the earthy verdigris which emerged eventually from ordinary copper. But *ios* was also an ancient word meaning 'one', which continued in use among Pythagoreans;²² so *iosis* may have been for the experimenters the attainment of the One, the number of the element fire. If the tetraktys was originally employed in Pythagorean rituals to symbolize the passage of the soul from earth to fiery heaven, as I have suggested, and if that tetraktys had later become a symbol for the four elements, then it is possible to see how the experimenters came to view their series of experiments, which brought copper from 'earth' to 'fire', as rituals for the healing of the soul and its release from hardship.

There is a good deal of ancient evidence, gathered together by Walter Burkert in his *Lore and Science in Ancient Pythagoreanism*, to show that in Hellenistic times Pythagoreans regarded Plato as the transmitter of true Pythagorean lore;²³ hence the adoption of the theory of matter in *Timaeus* to underpin the practical chemistry of *Phusika kai Mustika*. If we return to c.3, we can now identify the unnamed dead teacher, said there to be guided by a *daimon* or spirit and to have died after taking a drug. He is Socrates who did claim to have such a guiding spirit, and who died as a result of taking hemlock. His unnamed pupil is Plato, from whose book *Timaeus* the author of *Phusika kai Mustika*, in the version that has come down to us, derived his theory of the 'natures' or elements, and how they 'overrule' and 'conquer' one another.

So why did Diels introduce the name of Ostanes into the text? The answer lies in the controversial authorship of the book titled *On Sympathies and Antipathies of Plants, Animals and Stones*. Modern scholars accept that this book, which was tremendously influential in Hellenistic times, was by Bolos of Mendes; but ancient writers ascribed it variously to Democritus, to Bolos the Democritean and to Bolos the Pythagorean.²⁴ It drew on lore about plants, animals and minerals from the pseudo-Zoroasterian texts in the Library at Alexandria, and was a sourcebook for later authors. When Pliny referred to Democritus and Pythagoras as eager followers of the Magi in his *Natural History* (24.156 and 160; 25.13–14; 26.19) he supplied in each case details of strange properties of certain plants taken from *On Sympathies*. Even when Tatian wrote about 150 AD (*Ad Graecos*, 17) that Democritus, 'having boasted of the Magus Ostanes will be delivered on the day of consummation as fuel for the eternal fire', he was referring to the supposed author of *On Sympathies*, on which book he delivered a sharp attack.

Diels was lulled by the links made by Pliny, Tatian and others between Democritus and the Persian magi into believing that the earliest Greek chemical texts must also be founded on Persian ideas. But in fact there is no evidence of a connection between Ostanes and the chemical art before the time, probably in the later second century AD, when the followers of Basilides the gnostic forged chemical texts under the name of Ostanes.²⁵ Later still, in the fourth century, Synesius went on to claim that Ostanes himself initiated Democritus into the mysteries of chemistry. Herman Diels (1848–1922) was a great scholar of his time, but in recent years some of his emendations have come into question; he was attacked by Peter Kingsley in 1994 for ‘altering ancient texts to make them say what he wanted them to say.’²⁶ His addition of Ostanes’ name to *Phusika kai Mustika* appears to be an example.

But the question remains, if the chemistry of *Timaieus* underpins the experiments described in *Phusika kai Mustika*, why was its authorship ascribed to Democritus whose theory of atoms was substantially different from Plato’s theory of the elements? The answer may be clearer when we have taken a closer look at the origins of distillation and sublimation.

DISTILLATION IN THE EARLY GREEK CHEMICAL TEXTS

Although the invention of distillation was almost certainly earlier than that of sublimation, the first clear view of the technique comes from chemical recipe texts a little later than *Phusika kai Mustika*. *Theion hudor* (sulphur water) was produced by distillation not only from eggs, and from powdered sulphur with lime and vinegar, but also from various liquids and minerals whose colour or other properties caused the experimenters to believe they were firebearing. The distillates were then employed to tint silvered metal gold.

Stills were described in a few Greek chemical texts, and also depicted in drawings which once accompanied the descriptions, and were later recopied into the tenth-century manuscript Marcianus 299 from which Berthelot produced his edition. There we can see the outlines of the *dibikos* of Cleopatra, with a globular stillhead with two outlet tubes and receivers; and the *tribikos*, which has a similar stillhead with three outlet tubes and was said to have been invented by Maria the Jewess in the first century AD. There is also a still without a stillhead, in the form of a tube shaped as an inverted ‘L’, joined at the lower end to its base and at the upper end to a receiver. The globular stillhead was sometimes called *phiale* (cup); it was also sometimes called ‘the bronze’ from the metal of which it was made.²⁷

Nearer to the form of a cup was the glass *mastarion* or breast-shaped stillhead, described but not pictured, which had a single outlet tube and receiver.²⁸ It is likely to be older than the *dibikos* or *tribikos* which were presumably developed from a single-outlet predecessor. Glassblowing was not invented until the first century BC,²⁹ so before that time the *mastarion* stillhead, too, would have been of bronze.

The complete distillation apparatus was sometimes called an *organon* (organ); and the term for the operation itself was either ‘to raise the water’ or

‘to boil’. Both the last two phrases suggest the possibility of an earlier stage when simpler apparatus was used, a stage when the vapour was condensed directly on lids or the inside of inverted cups, and then collected by tipping the lids or turning the cups upright.

Wine-distilling is not mentioned in the chemical recipe texts, and Edmund von Lippmann, R. J. Forbes and others therefore dated its origin to the twelfth century AD.³⁰ There is evidence, however, that wine-distilling was known in the ancient Greek world, and the distillate was treated not as a drink, but as the source of a fire for secret pagan and gnostic cultic rituals.

WINE-DISTILLING IN EARLY Gnostic CULTS

The earliest surviving recipe for wine-distilling is in a Greek text, written about 200 AD by a Christian author, and usually known nowadays under the Latin title, *Refutationes omnium haeresium*. In book 4 the author transcribed several recipes for magic fires and lamps, which he claimed were ‘tricks of the gnostics and magi’, and which modern scholars believe came from a lost book by Anaxilaus of Thessaly. At *Refutationes* 4.31 Diels recognized a recipe for wine-distilling.³¹ Wine, with sea-salt added, was to be ‘boiled’ (the term that meant ‘distil’ in the chemical recipe texts). The product was then reheated and a flaming oil lamp brought close, whereupon ‘seizing the fire it sets itself alight, and if poured upon the head it does not burn it at all.’ The addition of ‘manna’—a scented resinous sap—was recommended, and ‘it does better still if you put to it some sulphur.’

The recipe encapsulates not only the distilling of wine (ordinary boiling would have caused most of the alcohol to evaporate, making it virtually impossible to ignite the liquid), but also the ritual use of the distillate as a safe-burning fire on the head. Furthermore, the mention of sulphur at the end hints at another necessary part of the preparation: the sulphur test. The testing of the distillate of wine with lighted sulphur is mentioned at the end of two or three of the earliest medieval wine-distilling recipes. This led Hermann Degering to have tests carried out in a laboratory, and he published the result in 1917.³² Experiments proved that lighted sulphur plunged into strong spirits of wine will continue to burn until the alcohol content is reduced to 35%, when the sulphur is extinguished. If spirits at that strength are poured onto cloth or hair, they will flame and burn away safely without leaving any trace.

This test, which remained a secret almost to the end of the history of ritual wine-distilling, could in fact be very old. If the original object of distilling was to increase the fieriness of wine, then the earliest distillers could well have tried plunging lighted sulphur into their distillate to add extra fire. Accidental spillage afterwards onto someone’s clothing or hair in the vicinity of a naked flame would have revealed the safe-burning fire. Whatever the original fire ritual was, it would then have become possible to use flaming alcohol for personal initiation ceremonies.

Diels identified the recipe, and this time his instinct was sound. We know from Tertullian and other Christian writers that the gnostic heretics baptized

initiates on the head.³³ Tertullian also claimed that it was possible for the gnostics 'by human ingenuity to summon a spirit into the water and to animate their incorporated nature through hands held above with another spirit of such brightness (*taetae claritatis*).’ He was probably aware that the implement used for this purpose was a ‘fire-organ’ (‘organ’ was the word for a still in the early chemical recipe texts), for he continued his curious statement with praise for the water-organ on which God could modulate the music of spiritual sublimity, the water-organ here standing as a simile for the water-baptism of the Christians.³⁴

The followers of Marcus the gnostic were said by St. Irenaeus to baptize initiates upon the head with oil and water, or sometimes with balsam and water. Here ‘water’ may have carried the meaning of ‘distillate’; in the chemical texts the word for distillate was always ‘water’, as it still is today in such terms as rosewater, eau de Cologne, Kirschwasser. The balsam corresponds to the scented manna of the recipe in *Refutationes*, and may have been added to symbolize the fragrance of the Holy Spirit. St. Irenaeus may also have been aware of Anaxilaus’ book of recipes for fires and lamps, since he claimed that Marcus combined the tricks of Anaxilaus with the skulduggery of the magi.³⁵

Anaxilaus was named, too, by another Christian writer in the context of the initiation ceremony of the followers of Simon Magus, who developed his own gnostic sect from a combination of Greek, Jewish and Zoroasterian ideas. He instituted a baptism whereby, as soon as the initiand stepped into the water (as for baptism by immersion), ‘fire appears straight away upon the water.’ The last-mentioned ‘water’ was probably the distillate of wine, for the text continues: ‘whether this is done by some trick which, as many of them affirm, is a trick of Anaxilaus . . . or whether it is the work of a malign being and the magic *virus* that can express fire from the water.’³⁶ *Virus* is Latin for poison, and poison is one of the meanings of the Greek *ios*. But *ios* had several meanings, and in the chemical recipes it signifies the ultimate fiery state of the base metal which had been transformed to ‘gold’ by the experimenters. This linking of the word with the fire in the distillate could have arisen because wine-distilling was practised by those who carried out the chemical experiments in metal transformation; (although their recipe has not survived in the canon of recipes gathered into ms Marc. 299, it may have been the one known to Anaxilaus and copied into his book of fires and lamps; elsewhere he transmitted a ‘lost’ recipe of Democritus for silvermaking).³⁷

Another witness to the use by the gnostics of the safe-burning fire from distilled wine is St. Augustine. He wrote about the Messalians (‘praying people’), a gnostic sect which emerged in the fourth century AD, and their ceremony for driving out the sins of new initiates, adding, ‘and at the same time there entered into the initiate, in a visible form, a fire which does not consume.’³⁸ Other cultic groups who apparently knew about wine-distilling were the Sethians; and the Isis group of chemical experimenters.³⁹

A third-century Coptic manuscript from Egypt, now available in a good

recent English translation titled *The Books of Jeu*, describes actual gnostic rituals based upon wine-distilling.⁴⁰ Here three baptisms are recorded in due order: that of the Water of Life, of Fire and of the Holy Spirit. They show that the concept of the upper three elements was still attached to wine-distilling rituals, but the order has been Christianized and changed from water, air, and fire at the apex to the new order of water, fire, and pneuma (meaning air, breath or wind) in the ultimate position as *Hagion Pneuma*, the Holy Spirit. For each baptism the disciples bring fire and the 'vinewood', and the gnostic Jesus-figure places one wine-pitcher on the right and one on the left, with incense offerings above. He then recites long prayers including many magic words, and calls on Zorokothora to bring forth the water of the baptism of life in one of the wine pitchers. 'And at that moment', says the text, 'the wine which was on the right of the offering became water.'⁴¹

The critical piece of apparatus is the vinewood, a long undulating cooling-tube through which the distillate passed. It worked on the same principle as the L-shaped tube still, described above. In the medieval West it was to become known as the *vitis* (Latin for 'vine'), and the distillate was sometimes called *aqua vitis* (water of the vine);⁴² but the name 'serpentine tube' became more usual for the tube itself. The disciples in the second *Book of Jeu* were baptized with each of the three 'waters' in turn, and signed upon the forehead, after which their souls were guaranteed immortality.

WINE-DISTILLING IN THE DIONYSUS CULT

The vocabulary of distilling in the chemical texts, and especially the terms 'to raise the water' and 'to boil', both meaning 'to distil', suggests an earlier phase of the technology, when liquid was heated in a vessel and the vapour simply collected on a lid or the inner surface of a cup inverted over the mouth of the vessel. The addition of an outlet tube to the cup (*phiale*, the Greek word for a drinking-cup which came to be used for a stillhead) was a technical advance which may not have been made for some time.

The Greeks recognized the fire in wine at a very early stage, through noticing that it sputtered and flamed briefly when poured in libation upon an altar fire. But if they boiled wine (perhaps with herbs or honey to try to improve a poor, weak vintage), its fire, which was also its inebriating quality, disappeared into the air. Spirits of wine could have been discovered at an early period when someone heated wine in a vessel with an inverted cup over its mouth in an attempt to capture the fiery principle. If the operation was carried out slowly and carefully, very small amounts of alcohol-rich spirits would have condensed on the inside of the cup, and would have run to the bottom if it was quickly turned upright again. By using a series of cups it would have been possible to collect more of the spirits.

The discovery of the fire in the liquid thus collected would have been welcomed as a revelation from Dionysus, god of wine, and perhaps even as an epiphany of the god himself. The most appropriate usage for the spirits would have been in the rituals of the cult of Dionysus, but because the rituals of Greek

mystery religions were ‘unspeakable’, *i.e.* not permitted to be divulged to the uninitiated, very little evidence for the distilling of wine has survived in the Greek literary texts. Nevertheless, some hints that spirits of wine were collected, either by distilling or by the more primitive method described above, can be gleaned from the appearance of the vocabulary of distilling in special Dionysian contexts.

When Nonnus of Panopolis, a Christian author, wrote his long poem *Dionysiaca* based upon the myths of Dionysus, he drew upon lost works by Callimachus, Euphorion and other pagan writers of the Hellenistic age and later. *Dionysiaca* 9 contains a description of how Mystis taught the infant Dionysus about the mystic objects carried by maenads of historic times when they performed their cultic mountain dancing in honour of the god.⁴³ Mystis first thought of fitting bronze *phialai* (cups) over her naked breasts (*Dion.* 9. 125f.). There is no other evidence for this practice either in literature or in art; but Nonnus’ source could have said that the maenads carried the *phialai* (in Greek *pherein* can mean either ‘to carry’ or ‘to wear’), adding that a *phiale* was a *mastarion*. As we know from the Greek chemical texts, the *mastarion* was a breast-shaped stillhead. But Nonnus, knowing nothing of the chemical art, could have taken the word to mean a breast-shaped object intended to be worn over the breast.

Another verbal conundrum which could conceal a reference to the use of the stillhead or cup over wine heated in a cauldron is found in a single-line fragment from a lost poem by the Hellenistic poet Euphorion. The poem told how the Titans killed the Cretan Dionysus, dismembered his body, put his limbs into a cauldron, and gave it to his brother Apollo at Delphi. Then followed the line: ‘On the fire godly Bacchus over a *phiale* they threw.’⁴⁴ It makes no sense as it stands; but it is grammatically possible, by poetic hyperbaton, for ‘over’ to follow the noun it governs. The text could then be read with the meaning: ‘on the fire over godly Bacchus a *phiale* they threw.’⁴⁵ The name of Dionysus or Bacchus is used elsewhere as a synonym for wine, and the verse could therefore be interpreted as hinting obliquely at a wine-distilling ritual at Delphi. Dionysus was the winter god, who ruled there through the four months when Apollo was absent, but afterwards went away. If wine was distilled in the spring, just before his departure, the distillate could have been stored in the tomb of Dionysus (known to have existed at Delphi in the fourth century BC, and still there in Roman times) until the god’s return in November when it could have been flared for his epiphany.⁴⁶

Various Athenian authors referred to ‘boiling’ in connection with rebirth into a better life. Demus in Aristophanes’ *Knights* (1321) is boiled to make him young. Plato in *Euthydemus* (285C) used the simile of submitting to a special instructor as though to Medea to be destroyed and boiled, so as to be reborn as a good man with true knowledge. Most strikingly, the hypothesis to Euripides’ play *Medea* records that in Aeschylus’ lost play *The Nurses*, Medea boiled the nurses of Dionysus, that is the maenads, and made them young again. Some modern interpreters have seen all these examples of ‘boiling’ as

allusions to a Dionysian 'rite of regeneration'.⁴⁷ Maenads were followers of Dionysus not only in mythology but also in historic times; and in Macedonia, Thrace and northern Greece in every second year the historic maenads danced for Dionysus in the mountains where they carried out secret rituals likely to have included initiation rites to mark the entry of initiates into their new life. Athenian soldiers in Thrace for the Eion campaign of 476–5 BC (Aeschylus may have been among them) could have picked up rumours about secret rituals of Thracian and Macedonian maenads which involved 'boiling' and led to initiation or rebirth into a new life.⁴⁸

A more direct connection between Macedonian maenads and wine-distilling may be present in Euripides' play *Bacchae*, written in Macedonia about 408 BC and intended for a Macedonian audience. At lines 755–8 he described maenads who carry objects named as 'the bronze' and 'the iron' on their shoulders, while fire burns harmlessly on their curls.⁴⁹ They are not in a ritual setting, for they have rushed down the mountainside in fury after local herdsmen have attempted to spy on their hidden rites high on the mountain. In my view the models for Euripides' herdsmen were Macedonian men who had actually spied on the nocturnal mountain rites of contemporary maenads, and had passed onto other men the secret that the safe-burning fire on the women's hair was somehow associated with the cups they called 'the bronze' (one of the later names for a stillhead). Euripides' maenads are no longer engaged in secret rituals at *Bacchae* 755–8, so he respected the requirement not to divulge ritual practices; but he included the bronze and the safe-burning fire at this point because his audience would recognize them as symbols of Dionysus' power.

The uniqueness of this early reference to safe-burning fire on the hair, the fact that it cannot be tied in with any mythological event (the usual source material for Greek tragedies), and, finally, the later use of the fire from distilled wine on the head in gnostic baptismal rituals, all point to a strong probability that spirits of wine were prepared and used ritually in the Dionysus cult as early as the fifth century BC.⁵⁰ Because of the persistence of religious rituals over centuries, the usage would have continued, and would have reached Egypt with the early Ptolemies who introduced there the Dionysus cult from Macedonia. At some stage the simple inverted bronze cup was replaced by the true stillhead with an outlet tube. The adoption of the initiation ritual of the flaming of the distillate upon the hair by the gnostics suggests that it may already have been well established in the Dionysus cult, where it no doubt continued until the cult was overthrown by Christianity.

THE ORIGINS OF SUBLIMATION

Sublimation was invented as a technique for extracting mercury from its red sulphide, cinnabar. Theophrastus knew of two kinds: sandy cinnabar from near Ephesus, from which mercury could be extracted manually by a tedious process using a bronze mortar and pestle; and a 'hard and stony' kind from the uplands of Colchis and Iberia, that is, a region in the foothills of the Caucasian

mountains.⁵¹ The hardness of the second kind could well have provided an incentive for seeking a new method of separation.

By the first century AD that method had become more widely known, and Dioscorides described it: 'For putting an iron saucer containing cinnabar upon an earthenware dish, they fit onto the latter an *ambix*, luting it round with clay; then they heat it over charcoal. For the vapour adhering to the *ambix*, when scraped off and cooled, becomes mercury.'⁵² The *ambix* was an earthenware cup tapering towards its brim; and it is tempting to believe that the technology was first devised by people already aware of the use of the *phiale* in wine-distilling. In the Greek recipe texts both techniques have similar vocabulary: 'the raising of the water' parallels 'the raising of the vapour', and elsewhere the verb 'to boil' can sometimes indicate the heating of materials in a closed vessel, and at other times mean 'to distil', according to its context.

If cinnabar were heated in a pottery-base vessel fitted with a bronze cup (a combination often used in wine-distilling), then some part of the mercury displaced from its sulphide by the copper would have adhered to the upper walls of the pottery base. Further experiment would have produced the optimum combination of earthenware base, earthenware cup or *ambix*, and a copper saucer to hold the cinnabar. Before Dioscorides wrote his account, someone had already discovered that an iron saucer, cheaper than a copper one, would yield the same result.

A hint that the experimental work was first carried out on the cinnabar from Colchis and Iberia, at the Scythian end of the Black Sea, can be gleaned from the secret name for mercury in a word-list of cryptic terms preserved alongside the Greek chemical texts: Scythian water.⁵³ Possibly it was coined by those in the Greek world who first extracted mercury from the 'hard and stony' cinnabar by the new method, among them the metal-workers of Macedonia and Thrace who could have been applying a type of technology already known to them from wine-distilling.

The earliest Greek author to refer to mercury was Aristotle. He reported a story told by Democritus about Daedalus, who made a hollow wooden statue of Aphrodite and poured mercury into it to make it move (just as the human soul was believed to move the body).⁵⁴ Elsewhere Democritus said that fire and soul were formed from the most mobile atoms, those that were spherical in shape.⁵⁵

Democritus' home was Abdera in Thrace. His ideas would therefore have been familiar to the metal-workers in Macedonia and Thrace who served the cult of Dionysus, making the delicate wreaths of gold leaves for initiates and other objects of precious metal. When the first Ptolemies introduced the Dionysus cult from the Macedonian homeland into Egypt, it is very likely that some of the northern metal-workers arrived in their wake, to provide the cultic objects required for Egyptian initiates to that cult and to other newer cults such as that of Serapis. The craftsmen could have brought with them, in addition to the traditional goldsmiths' skills, the techniques of distillation and sublimation, as well as ideas about those techniques releasing the fire-soul of wine and

the mercury-soul of cinnabar, and other teachings of Democritus about the nature of matter. The Democritus who 'came to Egypt' according to *Phusika kai Mustika* c.3 would then have been the body of teachings of Democritus introduced by those craftsmen who from a combination of their beliefs about matter and their practical techniques set up their own metal-workers' cult. But in time the Democritean philosophy was destined to be overtaken by other ideas.

CHEMICAL TECHNOLOGY IN HELLENISTIC AND ROMAN TIMES

How far were sublimation and distillation put to practical use in the outside world? The discovery of new deposits of cinnabar (notably in Spain under the Roman Empire; it was exported to Rome for processing) increased the availability of mercury, and new applications were found for it. Recipes in an Egyptian goldsmith's notebook of the third century AD show that it was used in gilding and in comparable procedures such as silver-coating copper with tin. The mercury was combined with the coating metal, and the operation was completed by heating the object to volatilize the mercury and leave behind a bright surface of gold or tin.⁵⁶ Mercury could also form an amalgam with fine particles of gold, and Vitruvius described a technique for recovering gold from embroideries on old discarded clothing which relied on this property.⁵⁷ The mercury-gold amalgam was also made the basis for gold ink, employed in illuminated lettering.

As for distilling, there is no evidence that stills of the elaborate kind described and pictured in the Greek chemical texts were ever used in Graeco-Roman times to produce liquids other than spirits of wine (for cultic purposes) and 'sulphur water' of various kinds for the experiments of the goldmakers. Alexander of Aphrodisias, commenting on Aristotle's *Meteorologia* 358b in the third century AD, reported that sailors on long voyages made fires on deck to heat cauldrons of seawater with lids over them; and the steam which condensed on the underside of the lids became drinkable water.⁵⁸ But this is a very simple technique, comparable to that which I have suggested for the collection of spirits of wine (via a cup inverted over the mouth of a vessel in which wine was heated) prior to the invention of the true stillhead.⁵⁹

The goldmakers in Egypt devised more elaborate methods of distillation for the purposes of their experiments. The *mastarion* stillhead equipped with an outlet tube was perfected (it was probably made originally in bronze, but from the late first century BC onwards in blown glass), and was used to produce divine sulphur water from repeated distillations of eggs.⁶⁰ Later the dibikos and tribikos were created, and recipes for the divine water became more complex, requiring separate 'waters' to be distilled not only from eggs, but also from yellow earths and other ingredients, with the 'waters' then combined and redistilled over yellow dyeplants.⁶¹ The distillates were applied to silvered base metal to bring out its goldenness. In the eyes of the experimenters colour was a very important component of physical matter, and the gold colour signified the presence of the light or fire in the agent and in the metal itself.⁶²

Colour also probably influenced the metal-workers' choice of minerals to be treated by sublimation in the presence of other minerals or vegetable substances. The arsenical sulphides attracted their attention, and they learned to transform red realgar into yellow orpiment, to treat orpiment by sublimation in the presence of natron (a form of soda occurring as a deposit on dried lake-beds in Egypt, and already exploited for other purposes by the Egyptians), and to put it through a further sublimation to extract elemental arsenic. This result could not have been achieved except by means of sublimation.⁶³ The product was heated again in a closed vessel with copper, to which it imparted a silvery appearance. The recipes are often rather vague, including some redundant ingredients and instructing the user to 'operate as usual' or 'as you know how'. But it is clear from several of the Greek texts in Berthelot's *Collection* that the experimenters were capable of isolating elemental arsenic.

CHEMICAL EXPERIMENTS, PHILOSOPHY AND CULT

Those carrying out the experiments recognized that their extraction methods could reveal hidden aspects of the materials under treatment: the fire in the 'water' distilled from wine, the mobile shining mercury within the red earth cinnabar. Interest in these hidden properties is clear from the terms used in *Phusika kai Mustika* and some of the other recipe texts where mercury is sometimes called 'cinnabar turned outwards', and arsenic is called either 'the mercury of orpiment' or 'the mercury of realgar' or 'orpiment turned outwards'.

The craftsmen may even have regarded the hidden nature as a form of soul—certainly in the case of the fire in the 'water' distilled from wine. Democritus said that both fire and soul were formed from the most mobile atoms, those that were spherical in shape.⁶⁴ For Democritus, as for Socrates, the soul was a physical entity, made however from finer material than any other physical thing except perhaps fire.

Against this background we can reconstruct three distinct phases in the practical work and underlying beliefs which led to the production of *Phusika kai Mustika* in its final version. The initial period began while wine-distilling was a cultic secret, but one known nevertheless to metal-workers attached to the cult of Dionysus in the northern Greek world. They went on to invent the sublimation technique for extracting mercury from cinnabar, or at least were among the first to use the technique if it was in fact devised further east within the Scythian realm. Their views on the nature of matter were built on the ideas of Democritus, the philosopher of Abdera, who developed his theories during the later part of the fifth century.

The second phase began when some of the craftsmen skilled in working with precious metals migrated from Macedonia and Thrace to Egypt to provide cultic objects for the worshippers of Dionysus and other deities in that country. As a group or guild they continued their private experiments in eliciting

hidden properties from minerals and liquids using the techniques of sublimation and distillation, alongside simpler methods such as steeping solids in a fluid medium or cooking ingredients together in open vessels.

Bolos of Mendes was probably the key figure in transforming the pursuit of chemical experiments for changing the appearance of metal into a fully cultic activity. His book on sympathies,⁶⁵ now lost except for a few fragments, promoted the theory that various pairs of objects in the natural world could exert influence upon one another because both had in common one or more specific qualities. Through contact with Bolos himself or with his writings, the experimenters could have been led to believe that by releasing the mobile, fiery, Democritean atoms hidden within base metal to turn it into 'gold', they could through the action of sympathy draw out the most fiery and mobile atoms of their own souls and thereby grant those souls passage to the heavenly place of fire or light after the death of the earthly body. *Phusika kai Mustika* c.15 makes it clear that the chemical experiments described in the recipes were carried out as a healing for the soul. (The soteriological concept that underlies much of the purificatory work carried out by medieval alchemists could well have had its origins in Bolos' influence on the cult of the metal-workers in Egypt.)

At this stage their cult could still be called Democritean in that the changes brought about by the chemical experiments are likely to have been interpreted in terms relating to Democritus' atomic theory. Hence arose the view, still held by Zosimus as late as 300 AD, that Democritus was the founder of the chemical art.

The third phase in the evolution of the theoretical basis for that art came before the middle years of the second century BC,⁶⁶ with the introduction of the Pythagorean-Platonic theory of the four elements from Plato's *Timaeus*. Plato explained there how one element could turn into another, using verbs which reappear in the phrases 'one nature conquers/overrules another nature' in *Phusika kai Mustika*. This interchangeability allowed the self-styled 'philosophers' who practised the chemical art to reach the conclusion that All is One (*Hen to pan*).⁶⁷

Older Pythagorean ideas were also introduced. The tetrasomata (four bodies), an amalgam of four base metals, including copper, which sometimes replaced copper itself as the starting material for the goldmaking experiments, derives its name from the fact that 4 was the number for earth in the Pythagorean tetraktys of the elements. The idea that a series of chemical experiments in metal-tinting represented a ritual for the welfare of the soul, founded upon a perception of sympathy between 'fire' in the ennobled base metal and the fiery part of the soul, could be accommodated without too much difficulty into a ritual pattern of Pythagorean origin. The soul of the Pythagorean had to be symbolically translated, I have suggested, from 4, the tetraktys number for earth, to 1, the number for fiery heaven and also the number for the element fire. The Platonic re-interpretation of the 'natures' of the four elements in *Timaeus* showed how this could be done for base metal by

a series of chemical experiments which brought the natures of water, air, and finally fire into the ascendancy.

Democritus was by then too well established as the founder of the art to be abandoned, so he was credited with bringing the 'natures' to Egypt. But the riddling chapter 3 was added to *Phusika kai Mustika* which made him the disciple of Socrates and Plato from whom he had learned 'how to harmonize the natures'.⁶⁸

DISTILLATION AND SUBLIMATION THROUGH THE FIRST MILLENNIUM AD

The practice of chemical technology was destined to remain a secret activity through the first four centuries of the Roman Empire, conducted by various religious groups who attached meanings to the results of experiments far beyond the simple recognition of the chemical reactions which took place. The experimental work was regarded as dangerous magic by the early Church, and when the Roman Empire became Christian it ceased. But the chemical texts were preserved and read as allegories for the redemption of the Christian soul.

Unconverted gnostics went into exile beyond the eastern borders of the Empire, and continued to carry out experiments directed towards finding new ways to elicit the elemental fire. It was probably they who discovered how to distil crude petroleum, using a suitable filler to weigh down the highly volatile distillate so that it could be flamed and discharged through siphons. That secret was passed to the Byzantines at the time of the Arab expansion; and they used it in sea battles to defend Constantinople. Their name for it was 'seafire'; the western Crusaders later called it 'Greek fire'.⁶⁹

The Persians and later their Arab conquerors learned the techniques of distillation and sublimation from some of the gnostic exiles. The Arabs gained access to the Greek chemical texts as well as to the practical technology, and they carried experimental work in chemistry forward into its next phase to create their own science of alchemy.

NOTES AND REFERENCES

1. M. Berthelot, *Collection des anciens alchimistes grecs*, 4 vols. (Paris: Steinheil, 1887–8), reprinted London, Holland Press, 1963, as 3 parts in 1 vol. Part 1 is an introduction; parts 2 and 3 are the Greek texts and the fairly free French translation of each. The texts and translations are numbered identically, and will be cited here as 'texts', followed by section and part numbers. *Phusika kai Mustika* is at texts, 2.1.
2. M. Wellmann believed that the original author was 'Bolos Demokritos', who lived about 200 BC, and that the Democritean school was active during the second century BC; "Die Phusika des Bolos Demokritos und der Magien Anaxilaos aus Larissa," *Abh. preuss. Akad. Wiss., phil.-hist. Kl.*, 7 (1928), 1–80 on p. 9; and "Die Georgika des Demokritos," *Abh. preuss. Akad. Wiss., phil.-hist. Kl.*, 4 (1921), 1–58 on p. 16. Wellmann (1928) on pp. 68–9 claimed that the earlier work was titled *Phusikai baphai*, but there is no ancient evidence for that title; see R. Halleux, *Les alchimistes grecs*, tome 1 (Paris: Belles Lettres, 1981), p. 68.
3. Halleux, *op. cit.* (2), p. 73, placed it 'towards the beginning of our era', i.e. the beginning of the first century AD.
4. ps.-Hippolytus, *Refutationes omnium haeresium*, 5.21 for the Sethians. Berthelot, *op. cit.* (1), texts, 3.49.1–12 contains gnostic material in association with descriptions of apparatus and chemical recipes.

5. J. Needham, *Science and Civilization in China*, 6 vols. (Cambridge: Cambridge University Press, 1954–86), vol. 5, pt. 2, p. 253.
6. A. J. Festugière, *La Révélation d'Hermès Trismégiste*, 4 vols. (Paris: Gabalda, 1944–54), vol. 1, pp. 76–7, 232. The words used are: 'One nature is conquered by another.'
7. Columella, *De re rustica*, 7.5.11.
8. Discussed by Wellmann, *op. cit.* (2), 1928, pp. 1–69, and by Halleux, *op. cit.* (2), pp. 62–74.
9. Theon of Smyrna, *Expositio rerum mathematicarum*, ed. E. Hille (Leipzig: Teubner, 1878), p. 97.
10. Homer, *Iliad*, 15, 36–8; *Odyssey*, 5, 185–7. The oath is by earth, heaven and the water of the River Styx, representing the underworld. Hesiod recognized four realms, earth, heaven, the underworld (as 'misty Tartarus') and the sea.
11. See J. Chadwick, *The Decipherment of Linear B*, 2nd ed. (Cambridge: Cambridge University Press, 1967), p. 45 for the depiction of a male horse or pig as an animal head at the top of a single stroke, and a mare or sow as a head above two strokes, or above one stroke with two short crossbars. In the table of the Pythagorean pairs of opposites in Aristotle, *Metaphysica*, 986A22f., male appears in the same column as the 'odd' (of number), light, etc., and female appears in the other column with the 'even', darkness, etc.
12. W. Burkert, *Lore and Science in Ancient Pythagoreanism*, tr. E. L. Minar (Cambridge, MA: Harvard University Press, 1972), p. 72.
13. cf. The Orphic gold tablets with their verse: 'I am the child of earth and starry heaven, But my race is of heaven . . .' in G. Zuntz, *Persephone* (Oxford: Clarendon Press, 1971), pp. 358–62.
14. Burkert, *op. cit.* (12), p. 186.
15. G. Kirk, J. E. Raven and M. Schofield, *The Presocratic Philosophers*, 2nd ed. (Cambridge: Cambridge University Press, 1983), pp. 286–7, fragments 346–8.
16. Theon of Smyrna, *op. cit.* (9), pp. 96–7.
17. Plato was later accused of taking the subject matter of *Timaeus* from a book by the Pythagorean Philolaus; for the ancient evidence, see Burkert, *op. cit.* (12), p. 251. It is possible that the idea arose because the development from the 'two dimensional' numerical elements of the tetraktys into the 'three dimensional' elements described in *Timaeus* has already been worked out by Pythagoreans of the late fifth century before Plato adopted the scheme.
18. Plato, *Timaeus* 53A–56C.
19. Burkert, *op. cit.* (12), pp. 28–96, especially pp. 83–96, for the ancient evidence. See also W. Burkert, "Hellenistica Pseudopythagorica," *Philologus*, 105 (1961), 226–46, on p. 236 for third-century BC and later pseudo-Pythagorean literature identified as stemming from 'underground Platonism'.
20. Berthelot, *op. cit.* (1), 2.1.5; 2.1.11; 2.1.13.
21. *Ibid.* 2.1.12 contains the only mention of *ios* in *Phusika kai Mustika*. Both *ios* and *iosis* are referred to in many other texts in Berthelot's *Collection*.
22. Recorded as Pythagorean in the feminine form *ia* by Ioannes Laurentius Lydus, *De mensibus*, 4.1.
23. See note 19.
24. To Democritus: Columella, *De re rustica*, 11.3.64, and Tatian, *Ad Graecos*, 17. To Bolos the Democritean: Stephen of Byzantium, *Ethnica* (ed. Westermann, 1839), 68, entry for *Apsunthion*, and Scholia on Nicander, *Theriaca*, 764. To Bolos of Mendes, the Pythagorean: *Suidas*, ed. A. Adler (Leipzig: Teubner, 1928), B481.
25. The title of the short mystical chemical text by Ostanos the philosopher (Berthelot, *op. cit.* (1), texts, 4.2) claims it was given to Petesios, the Egyptian form of the name Isidore (see Berthelot, *op. cit.* (1), translations, p. 27, n. 1.) Isidore was the son of Basilides the gnostic, and could have forged this text. Discussed by C. A. Wilson, "Philosophers, Iosis and Water of Life," *Procs. Leeds Phil. & Lit. Soc., Lit. & Hist. sect.*, 19, pt. 5 (1984), 101–219, on pp. 159–61.
26. P. Kingsley, "Empedocles and his interpreters: the four-element doxography" *Phronesis*, 39 (1994), 235–54, on pp. 235–6.
27. Dibikos, illustration in 'The goldmaking of Cleopatra', Berthelot, *op. cit.* (1), intro., p. 132, fig. 11; the stillhead is called *phiale*. Tribikos, illustration, *ibid.*, intro., p. 139, fig. 15; description, texts, 3.50.1, where the stillhead is named 'the bronze'. Tube-still, illustration, *ibid.*, intro., p. 140, fig. 16; description, texts, 3.47.2 and 3.50.2.
28. *Ibid.*, texts, 3.8.
29. D. B. Harden, "Ancient glass, 2: Roman," *Archaeol. j.*, 126 (1969), 44–77, pp. 46–8 for dating and suggestion that glassblowing was developed in Syria earlier than in Egypt.
30. G.-D. Lu, J. and D. Needham, "The coming of ardent water," *Ambix*, 19 (1972), 69–112, on pp.

- 72–3 and 108 for E. von Lippmann with bibliography. R. J. Forbes, *Short History of the Art of Distillation* (Leiden: Brill, 1948), pp. 87–8.
31. H. Diels, "Die Entdeckung des Alkohols," *Abh. Preuss. Akad. Wiss., phil.-hist. Kl.*, **3** (1913), 1–35, on pp. 21–5, 35. The author of *Refutationes omnium haeresium* was formerly believed to be St. Hippolytus.
 32. H. Degering, "Ein Alkoholrezepte aus dem 8. Jahrhundert," *Sitzungsber. preuss. Akad. Wiss., phil.-hist. Kl.*, (1917), 503–15, on p. 506 (Weissenau recipe). I. Puccinotti, *Storia della Medicina*, 3 vols. (Livorno: Wagner, 1850–66), vol. 2, document 6, p. lxiv. For fuller discussion of ritual gnostic use of the firebearing distillate of wine in the Roman and early medieval periods, and for links with the chemical art, see Wilson, *op. cit.* (25), pp. 152–73.
 33. Tertullian, *De praescriptione haeresium*, c.40. Irenaeus, *Adversus haereses*, 1.21.4.
 34. Tertullian, *De baptismo* = *Homily on Baptism*, ed. E. Evans (London: S.P.C.K., 1964), c.8.
 35. Irenaeus, *op. cit.* (33), 1.21.5. 1.21.3, and 1.13.1.
 36. ps.-Cyprian, *De rebaptismo*, c.16.
 37. A recipe 'cited by Anaxilaus from Democritus' is in the Stockholm papyrus; see Halleux, *op. cit.* (2), p. 110. For the feasibility of distilling wine at that period, see A. L. Butler and J. Needham, "An experimental comparison of the East Asian, Hellenistic and Indian (Gandharan) stills . . .," *Ambix*, **27** (1980), 69–76, on pp. 71–2. The stillhead used was of the *mastarion* type, with a single outlet tube, and the strongest spirits (60% ethanol) came over at the beginning of the operation.
 38. Augustine, *De haeresibus*, c.57 in J. E. Migne, *Patrologiae cursus completus, series latina*, 221 vols. (Paris: 1844–55), vol. 42, col. 40–1.
 39. ps.-Hippolytus, *Refutationes omnium haeresium*, 5.21. Berthelot, *op. cit.* (1), texts, 1.13.1–5. Discussed by Wilson, *op. cit.* (25), pp. 164, 166.
 40. *The Books of Jeu*, ed. C. Schmidt, tr. V. McDermot (Leiden: Brill, 1978).
 41. *Ibid.*, p. 108, c.45. The translator explains in a note that 'vinewood' is the literal translation of the Coptic *peloole*.
 42. M. Savonarola, *Libellus . . . de aqua ardente*, in Joannes de Rupescissa, *De consideratione quintae essentiae* (Basel, 1561), pp. 250–1, 253.
 43. Mystis was the eponymous inventor of the Dionysus mysteries, according to one myth. The mountain dancing was a particular feature of Dionysus worship in Northern Greece, Macedonia and Thrace in the classical period, connected with the biennial re-appearance of trieteric Dionysus.
 44. J. U. Powell, *Collectanea Alexandrina* (Oxford: Clarendon Press, 1925), p. 32. The manuscripts all give *phialen* (accusative case) which Powell emended to *phiales*.
 45. The usual meaning of *phiale* was drinking cup, a vessel unsuitable to be placed on a fire; and Bacchus' limbs were already in a cauldron, a vessel intended for use on a fire. Modern editors have emended the text in various ways, but without producing a satisfactory meaning. My suggestion here requires the restoration of *phialen* (emended by Powell and others, see note 44). More detailed discussion in C. A. Wilson, "Dionysian ritual objects in Euphron and Nonnus," *Papers, Leeds Internat. Latin Seminar*, **7** (1993), 213–19, on p. 218.
 46. Discussed more fully in C. A. Wilson, "Wine rituals, maenads and Dionysian fire," *Papers, Leeds Internat. Latin Seminar*, **10**, (1998), forthcoming.
 47. F. M. Cornford, *The Origin of Attic Comedy* (London: Arnold, 1914), pp. 88–9. A. B. Cook, *Zeus*, 3 vols. (Cambridge: Cambridge University Press, 1914), vol. 1, p. 627. They connected the rite with the mystic Orphic phrase: 'A kid I have fallen into the milk', since the possibility of ritual wine-distilling had not been put forward at that time.
 48. M. L. West, *Studies in Aeschylus* (Stuttgart: Teubner, 1990), p. 49 on the possibility that Aeschylus took part in the Eion campaign. Athenian maenads did not practise mountain dancing; and the Athenian festivals of Dionysus differed from those of Northern Greece, and did not include the 'return' of trieteric Dionysus in every second year.
 49. 'The bronze' was one of the names for a stillhead. 'The iron' could have been the short sword carried by Macedonian maenads to enable them to sacrifice a goat, hare or other mountain animal to Dionysus at the beginning of their secret rituals held in a mountain glen or cave. References in C. A. Wilson, *op. cit.* (46).
 50. While the mountain dancing of the maenads of early historic times would have brought them into an altered state of consciousness, it is most unlikely that they became drunk on spirits of wine. Raw, immature spirits are unpleasantly fiery, and any maenad who risked drinking the liquid would have been terrified by the burning sensation in her throat and the possibility that further drinking might cause her internal organs to burn up.

51. Theophrastus, *De lapidibus* (On stones), c.60; c.58.
52. Dioscorides, *Materia medica*, 5.95.
53. Recorded in a wordlist of secret terms used by the experimenters: Berthelot, *op. cit.* (1), texts, 1.2: *hudos skuthikon/eau scythique*. The name must predate the Scythians' disappearance from history in the second century AD, and could go back to the time when mercury was first extracted from the 'hard and stony' Caucasian cinnabar at the Scythian end of the Black Sea.
54. Aristotle, *De anima* (On the soul), 406b.
55. *Ibid.*, 405a1 and 17f.
56. Halleux, *op. cit.* (2), Leiden papyrus X, no. 55 for gilding with gold leaf, nos. 73 and 79 for gilding with gold-coloured agents, and no. 26 for silver-coating copper with tin.
57. Vitruvius, *De architectura*, 7.8.4.
58. Alexander of Aphrodisias, *Commentaire sur les m  t  ores*, tr. G. de Moerbeke, ed. A. J. Smet (Louvain: Leuvense Universitaire Uitgaven, 1968), p. 136.
59. See section above on 'Wine-distilling in the Dionysus cult'.
60. Berthelot, *op. cit.* (1), texts, 3.8.
61. *Ibid.*, texts, 3.47.6–7.
62. *Ibid.*, texts, 3.47.7 explains that at the end of the distillation the plants have lost their colour which is their *pneuma* (spirit).
63. R. P. Multhauf, *The Origins of Chemistry* (London: Oldbourne, 1966), p. 108 for the stages whereby orpiment was transformed into a silver 'tincture' for copper. But the concept that there had to be a further transformation to violet colour (*ibid.*, pp. 106–8) is incorrect. It is drawn from A. J. Hopkins, *Alchemy, Child of Greek Philosophy* (New York: Columbia University Press, 1934) and other modern interpreters who have believed that *iosis* means 'violet-flowering'. But the noun *iosis* is derived from *ios*, and could not have been formed from the Greek *ion* (violet).
64. See note 55.
65. 'On the sympathies and antipathies of stones', according to his entry in the *Suidas* (see note 24). Halleux, *op. cit.* (2), p. 63 believed that the title there is incomplete, and had originally included the words 'plants' and 'animals'. Various fragments from the book cited by later classical authors concern the properties of plants or animals.
66. Not later than the mid-second century BC when the phrase 'one nature conquers another nature' was re-used in an astrological book. See note 6.
67. Berthelot, *op. cit.* (1), intro., pp. 132–3. It became one of the catchphrases attached to the chemical art.
68. See section above on 'Plato and the four elements.'
69. Wilson, *op. cit.* (25), pp. 175–9 for discussion of the evidence, including that from later recipes, and for all references.

CORRECTION

15th January, 1998

Dear Dr. Roberts,

Being better acquainted with ancient lore than new computers, I sent in three versions of my review of D. G. White, *The Alchemical Body* published in *Ambix XLIV*, November 1997. The version used left out a line, which is entirely my own fault for which I apologize. The words on page 152 between "on" and "back" should read: "Siddha theory and practice. The author also tells of ritual songs reaching".

MARIANNE WINDER