

DEMOCRITUS AND THE BEGINNINGS OF GREEK ALCHEMY

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AMONG the names of the Greek philosophers of the “divine” or “sacred art”, known in antiquity for their importance and universal authority as being “ecumenical” (οἰκουμενικός), is that of Democritus.¹ Also attributed to Democritus is the famous *Physika et Mystika* (hereafter *Ph. et M.*), and that its author is to be identified with the philosopher of Abdera was claimed by Synesius in his commentary or scholia on the work.² Despite these and other ancient associations of Democritus of Abdera with the beginnings of Greek alchemy, modern scholars are almost unanimous in denying their credibility. Only Berthelot seems to have been willing to allow that it was “par une sorte d’affinité naturelle que les alchimistes aient rapporté leurs origines à Démocrite”.³ It has, in fact, become common to refer to “pseudo-Democritus”, and to identify him with Bolus of Mendes.⁴ Direct authorship of the *Ph. et M.* by Bolus seems never to have been claimed, but scholars such as Berthelot, Diels, von Lippmann, Festugière, Wellmann, and others, have seen Bolus as a principal link or source for the alchemical or metallurgical endeavors attributed to Democritus in antiquity.⁵ The purpose of this study is two-fold: first, to examine again Bolus’ alleged authorship of the pseudo-democritean works concerned with metallurgy, and a particular metallurgical problem, viz, the making of gold;⁶ second, to ascertain how the name of Democritus became connected with the beginnings of Greek alchemy, and especially to determine what philosophical beliefs or views of the genuine Democritus may have contributed to this connection. “Forgeries” are, in any case, often pieces of quasi-historical reconstruction and show, for example, what people wanted to be regarded as original.

Until the publication of P. M. Fraser’s *Ptolemaic Alexandria* in 1972, there has been little in English on Bolus of Mendes, and some of what has been written by French and German scholars is conjectural.⁷ Fraser’s discussion is by far the most cautious, but he does not deal extensively with Bolus and the alchemical literature, and there is need for a reasonably comprehensive treatment of Bolus as the alleged pseudo-Democritus and source for Greek alchemy.

I. BOLUS AND ALCHEMY

Much of what is known about Bolus and his work is found in two brief entries in the *Suda-Lives*. nos. 481–82 under B:

Bolus Democritus (or Democritean?), philosopher, *Scientific Observation and Medical Art*; it contained natural cures by the remedies of nature.

Bolus, a Mendesian, Pythagorean, *On Things from the Reading of Histories Worthy of Our Attention, On Wonders, Natural Drugs*; his also are the *On Sympathies and Antipathies, On* (?). . . *Stones* (in alphabetical order), *On Signs from the Sun and Moon and Ursa Major and Light and the Rainbow*.⁸

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In addition to these entries, most probably taken from two different sources though referring to the same person, there is an important remark by the first cent. A.D. agricultural writer Columella: *sed Aegyptiae gentis auctor memorabilis Bolus Mendesius, cuius commenta quae appellantur graece Χειρόκητα sub nomine Democriti falso produntur* (*De re rus.* VII 5, 17 = D.-K. B300, 3). The Χειρόκητα is not in the Suda entries, but Wellman regarded it as the same as *On Wonders*, that is, treating of remarkable remedies.⁹ Given, however, that χειρόκητα means something like “artificial” or “manufactured things”,¹⁰ and that Columella mentions herbal remedies in connection with Bolus (see *De re rus.* XI 3, 53), Fraser suggests that *Natural Drugs* (Φυσικά δυνάμερά) in the Suda-list is only a partial title: its full title may have been *Natural and Artificial Drugs* (Χυσιῶν καὶ Χειρόκητων δυνάμερά).¹¹

Two additional specific references to Bolus in antiquity are Steph. Byz. s. v. Ἀψυνθος and Schol. Nicandr. *Ther.* 764 which mentions *On Sympathies and Antipathies*, also in the Suda-list.¹² That Bolus composed works other than those found in the Suda entries above, is not attested by ancient authors. Despite this fact, Wellmann, in particular, ascribed additional works to Bolus: *On the Jews*, *Jocular Recipes* (Πάγνια) *On Agriculture* (Γεωργικά), and a work the title of which is nowhere attested in antiquity, *On Gilding and Silvering* (Βαφικά).¹³ Wellmann’s reasons for these attributions will be examined presently.

None of the previous evidence provides clear dates for Bolus’ life, though scholars generally put it between 250 and 115 B.C. on the basis of Bolus’ use of the ninth book of Theophrastus’ *History of Plants*, and the use of Bolus’ own *On Wonders* in Apollonius’ *Wonder-Book* which refers to no known source earlier than the second century B.C. Fraser guesses on the basis of this evidence that Bolus was active in the final reign of Euergetes II (145-116 B.C.).¹⁴

Some notion of Bolus’ intellectual activity can be formed from the two direct references by Columella (at *De re rus.* VII 5, 17 and XI 3, 53) and probably from the titles of the works assigned to him in antiquity. He certainly seems to be among those who tried to discern the hidden properties (ἰδιότητες) and natures or powers (φύσεις) of the various phenomena of organic and inorganic nature, and the “hostile” or “friendly” relations existing between them. Probably his doctrine of sympathies and antipathies was based on a principle of universal sympathy found also, for example, in the works of Theophrastus and the Stoics.¹⁵ Considerable confusion, however, about his endeavors has been created by the Suda entries: in one he is called Democritus (or a Democritean?); in the other, he is a Pythagorean. The latter designation probably means little as has been shown by Kroll and others.¹⁶ The first entry poses more serious problems, and it was largely on the basis of this entry that Wellmann regarded Bolus as the author of several works ascribed to Democritus in antiquity.¹⁷ Given the fact that the MSS. of the Suda have Δημοκρίτος, it is possible that some of Bolus’ writings appeared under Democritus’ name. But from this possibility it neither follows that Bolus was a forger, nor that the reference at Colum. *De re rus.* VII 5, 17 must be so interpreted.¹⁸ It is true, of course, that Columella says that the Χειρόκητα circulated under the false name (*falso nomine*) of Democritus, but this could be understood in at least two ways. First, that Columella was unfamiliar with a tradition known to the Suda in which some of Bolus’ works circulated under Democritus’ name (hence Bolus-Democritus). Second, Columella’s remark could be an incorrect supposition based on Bolus having adapted Democritus’ work, keeping the same title.¹⁹ In fact, Pliny who himself used Columella as a source claimed at *N. H.* XXIV, 160: *Democriti certe chirometa esse constat*, which suggests he was correcting those (Columella?) who believed that Democritus had not

composed a *χειρόκμητα*. In any case, as Kroll has convincingly argued, Bolus could hardly have tried to circulate his own writings as those of Democritus since he referred to sources later than the philosopher, notably Theophrastus, as is clear in Steph. Byz. s. v. ἸΨυνθος: “a city of Thrace . . . there is also a kind of plant about which Bolus the Democritean (sic) says that Theophrastus in the ninth book *On Plants* (reports that) sheep in Pontus feeding on wormwood (ἰΨύνθιον) do not have bile”.²⁰

Moreover, the assumption of Wellman and others that some works transmitted under Democritus’ name are really to be attributed to Bolus will not withstand close scrutiny given other evidence. For example, as Kroll noted, an *On Agriculture* (Περὶ γεωργίας) is listed in Thrasyllus’ catalogue of Democritus’ writings (Diog. Laert. IX 48), and at *De re rus.* XI 3, 2 Columella cites from Democritus’ *Georgicon* the latter’s belief that building strong defenses (*munimenta*) about gardens is not a sensible way of making gardens safe from human and bovine intruders.²¹ In itself such a belief is one that could easily have been held by Democritus of Abdera, and there is no reason for assigning it to Bolus or pseudo-Democritus.

The *Παίγνια* and *Βαφικά* pose special problems, and are immediately relevant to the study of Democritus and the beginnings of Greek alchemy. Suffice it to say, there are no convincing reasons to attribute the *Παίγνια* to Bolus, and a *Βαφικά* by him most likely never existed. The *Παίγνια* bears, of course, Democritus’ name, and since for Wellmann Bolus’ correct name was Bolus-Democritus (“ein Doppelname”), the work must be by Bolus. Wellmann’s main reason, however, for thinking the *Παίγνια* was by Bolus, were the similarities between several of its recipes or prescriptions and the views attributed to Democritus in Pliny’s *Naturalis Historia* and in the *Geoponika*.²² Since these views are, according to Wellmann, really those of Bolus-Democritus, the *Παίγνια* is also by Bolus. Similar faulty reasoning is used to support the existence of a *βαφικά* by Bolus. For Wellmann this work formed a direct link between Bolus and the alchemists, though he did not believe the work was to be identified with the *Ph. et M.* But “on the analogy of the chemical treatise of Hermes Trismegistos, one could think of the title *Φυσικαὶ βαφαί* or *Βίβλοι φυσικῶν βαφῶν* or finally *βαφικά*”.²³ This is clearly conjecture on Wellmann’s part. What, however, led Wellmann to think that such a book existed in the first place? His claim was based essentially on passages in four ancient texts:

(1) Seneca *Ep. mor.* 90, 33 (= D. K. B 300, 14): but Posidonius again remarks: ‘Democritus is said to have discovered the arch, whose effect was that the curving line of stones, which gradually lean toward each other, is bound together by the keystone’. I am inclined to pronounce this statement false. For there must have been, before Democritus, bridges and gateways in which the curvature did not begin until the top. It seems to have quite slipped your memory that this same Democritus discovered how ivory could be softened, how, by boiling a pebble could be transformed into an emerald, — the same process used even today for colouring stones which are found to be amenable to this treatment.²⁴

(2) Pliny *N. H.* 37, 197: and furthermore there are treatises by authorities (*commentarii auctorum*), whom I at least shall not deign to mention by name, describing how by means of dyestuffs emeralds and other transparent coloured gems are made from rock-crystal, or a sardonyx from a sard, and similarly all other gemstones from one stone or another.²⁵

(3) Pap. Holm. a 12: another (procedure) Anaxilaus also attributes to Democritus is the following: having ground very finely common salt with fine alum (στυπτηρία) together with vinegar, and having formed ‘rolls’ (κολλούρια), he dried these three

days in a bath; and then having ground them, he melted down copper also three times, and cooled it by quenching it in sea water. What will result, experience (πειρα) will show.²⁶

(4) Democritus' Παύγια (D.-K. B300, 25): to make copper (things) appear gold: having mixed native (unburnt? ἄπυρον) sulphur with chalk, wipe it off (on the objects).

The evidence here presented shows, of course, that Anaxilaus probably wrote a work in which Democritus was mentioned (see 3 above). Certainly Pliny made use of a work by Anaxilaus in which animals, plants, trees, metals, and gems were treated.²⁷ But there is no reason to assume that Anaxilaus in the Stockholm papyrus is referring to Bolus and not to Democritus of Abdera, or to the work of some forger. Moreover, the passage does not say that Democritus himself performed the experiment, but only that Anaxilaus maintained that he did.²⁸ Thus it seems that Anaxilaus believed that Democritus was involved in the imitation of silver (the procedure in 3 above is listed under the "making of silver"). The other texts cited above are similarly inconclusive at best in providing evidence for the alleged βαφικά of Bolus. It is odd, for example, that Pliny does not mention Democritus at all at *N. H.* 37, 197 contrary to his usual practice of naming the author he believed to be the Abderite. The passage of Seneca might well reflect an interest of the historical Democritus in the technology of softening ivory and producing synthetic gems.²⁹ In brief, the passages cited by Wellmann do not prove either the existence of a work by Bolus on metallurgical subjects, or that he is really the Democritus mentioned.

To conclude this part of the study, the following observations are in order. First, there is no convincing evidence that Bolus of Mendes is the pseudo-Democritus whose name is connected with the beginnings of Greek alchemy. Second, there is no evidence that Bolus composed a βαφικά, or that he was interested in metallurgical or alchemical matters. Almost no fragments of his writings can be identified with certainty except those in Columella, Stephanus Byzantinus, and the scholia to Nicander's *Theriaka*. Wellmann's own learned reconstruction of Bolus' alleged lost treatise on gilding and silvering rests, in the last analysis, on assumptions which cannot be verified, and may well be false.

II. DEMOCRITUS AND THE EARLY ALCHEMICAL LITERATURE

If Bolus was not responsible for the pseudo-democritean works on metallurgy and alchemy, who then was? The question cannot be answered. Preservation and transmission of Democritus' works, like those of other ancient authors, was neglected in antiquity. Despite the fact that several thinkers were considered his "students", e.g. Nessas and Metrodorus, both from Chios, Anaxarchus and Bion, both from Abdera, Diotimus of Tyre, the existence of a philosophical school at Abdera which could have established a canon for Democritus' writings, seems doubtful. Already in the fourth century B.C. uncertainty existed whether Democritus or Leucippus composed the *Great World Order*.³⁰ In the third century B.C., Callimachus, famous librarian at Alexandria compiled *A List of Rare Words and Constructions in Democritus*, possibly concerned with the problem of authenticity.³¹ About 200 B.C. Hegesianax wrote *On Democritus' Style*. In the *Attic Nights* of Aulus Gellius (ca. 150 A.D.), Pliny the Elder is taken to task for attributing wrongly to Democritus a treatise *On the Power and Nature of the Chameleon* (X 11, 1 ff.).³² Further evidence of ancient attention to the Democritean corpus is found about the 3rd century A.D. in Diogenes Laertius' *Lives*. After reproducing Thrasyllus' catalogue probably of the first century A.D. (IX 46-49), Diogenes

remarks that some treatises attributed to the Abderite are either “compilations” from his writings or are admittedly not his own (. . . τὰ μὲν ἐκ τῶν αὐτοῦ διεσκεύασται, τὰ δ’ ὁμολογουμένως ἐστὶν ἀλλότρια). Diogenes, however, does not name these “spurious” works, and there is no guarantee that his (or Thrasyllus’) catalogue is accurate or complete. For example, the authenticity of *On Those in Hades* was suspected by E. Rohde, and on *On Agriculture* was deemed apocryphal by E. Oder.³³

The classifications in Thrasyllus’ catalogue are, of course, significant because they reveal Democritus as a polymath; the titles of his works are grouped under the following headings:³⁴ ethics, physics, unclassified (ἄσύντακτα), mathematics, poetry and grammar (μουσικά), and “technical” subjects. Many of the works listed as “unclassified” deal with the “causes” (αἰτίαι) of phenomena, and they show Democritus’ keen interest in research on particular subjects, and especially the principles or causes of things (αἰτιολογία).³⁵ There are, for example, treatises on the causes of sounds, fire, seeds, and on the stone (Περὶ τῆς λίθου), probably the magnet.³⁶ Given then, the historical Democritus’ interest in such different subjects, his considerable literary productivity (some seventy works are listed by Diogenes), and the poor preservation and transmission of his writings, it is not surprising that the way was paved for others to publish works under Democritus’ name. Certainly by the first century A.D. he had become something of a legendary figure, and received notice by such disparate authors as Pliny and Petronius.³⁷ And if the evidence of Aulus Gellius can be trusted, the works falsely attributed to Democritus were by more than one person (*multa autem videntur ab hominibus istis male sollertibus huiuscemodi commenta in Democriti nomen data. . .*, X 12, 8).

In view of the previous evidence, decisions about which works can be ascribed to Democritus of Abdera are not easily made. That Democritus was interested in metallurgical phenomena is not in itself implausible. He wrote, for example, on magnetism. But the main evidence for Democritus’ interest in metals and their properties is provided by Theophrastus in his *De sensibus*.³⁸ In a critique of Democritus’ views on the senses and the objects of sensation, Theophrastus ascribes a theory to the Abderite on the composition of iron and lead. The former consists of more void than lead which has an even and uniform composition throughout. Thus lead is heavier though softer than iron (*De sens.* 62). Later in his discussion of colour, Theophrastus gives evidence that Democritus wrote extensively on colours, and the composition of objects having colour (*De sens.* 73–82). Iron, for example, becomes redder when placed in fire (75); sulphur is mentioned probably at the conclusion of an account of yellow (77).³⁹ Some of Theophrastus’ report suggests also that Democritus was interested in the phenomena of tinting or dyeing (at 73 Theophrastus cites Democritus’ reference to the structure of the murex-shell, and the purple sometimes used for dyeing in antiquity was produced by the glands of the murex).⁴⁰ Further preoccupation with colour on Democritus’ part is suggested by Galen (*De elem. sec. Hipp.* I 2 = D.-K. A49) where after citing Democritus’ view that colour exists by “convention” (νόμῳ) several examples of color are given as not existing by “nature” (φύσει). In sum, there seems to be incontestable evidence that Democritus of Abdera had interest in metals and colours.⁴¹

It is now appropriate to turn to pseudonymous works to see if they contain anything reminiscent of the Abderite’s beliefs. In doing so, it is illustrative to call attention to A. J. Hopkin’s study, *Alchemy, Child of Greek Philosophy* (1934), in which the influences of Plato and Aristotle on alchemy are considered, but without mention of the historical Democritus.⁴² Although he discusses pseudo-Democritus, Hopkins is not alone in omitting treatment of the

influences of Democritus and atomic theory on the alchemical literature. It is also important to bear in mind that throughout its history, alchemy was an attempt to transmute metals, especially to produce precious metals from base ones, i.e. to make gold. From the perspective of a practical craft or technology, alchemy can be considered a branch of metallurgy, despite the fact that from its earliest appearance, religious or supernatural elements were usually connected with it, e.g. the origins of "chemy" with angelic and human intercourse, or with the god Hermes-Toth.⁴³

Some of the texts considered alchemical are not clearly so.⁴⁴ One of the earliest is the London papyrus 121 from about the third century A.D. (= D.-K. B300, 19) which is entitled "Jocular Recipes (or Prescriptions) of Democritus",⁴⁵ and the first of its twelve recipes on how, for example, to eat garlic without smelling, how to drink much without intoxication, or how to copulate often, is a prescription on how to make copper things appear gold by powdering them with sulphur and chalk. Diels believed the recipe showed the beginning of the "Goldmacherkunst".⁴⁶ Some of the recipes ante-date Pliny the Elder, and παίγνια (which commonly means "toy" or "plaything") is already used almost as a literary term by Democritus of Abdera's contemporary, Gorgias (*Hel.* 21).⁴⁷ The prescriptions are usually thought to be by someone other than Democritus (Bolos?), and Democritus' reputation as the "laughing philosopher", itself based on some of his own moral sayings, may well have enabled the "Jocular Recipes" to circulate under his name.⁴⁸ In and of themselves, other than their humorous and folk remedy nature, the prescriptions represent nothing which could not have been written by Democritus himself.⁴⁹ But equally important, the prescription for "making gold" is not alchemical. It is itself something of a joke, like the rest of the recipes.

More serious is the formula attributed to Democritus by Anaxilaus in the Stockholm papyrus (*Pap. Holm.* a 12). This, like the London papyrus, is probably from the third century A.D. though again, its dating has nothing to do with the antiquity of contents since Anaxilaus lived in the first century A.D. But the formula (cited earlier in this study) concerns making copper silver-like in appearance. Many recipes preserved in other texts, e.g. in Leyden papyrus X and in the *Ph. et M.* also deal with the imitation of silver (and probably not its forgery as Diels and others believe).⁵⁰ But the formula ascribed to Democritus by Anaxilaus has nothing to do with alchemy understood as the actual transmutation of metal, in this case, copper into silver.

The metallurgical procedures or recipes found in the Stockholm and Leyden papyri are similar to those in the *Ph. et M.* attributed to Democritus, and it is now time to consider this work. It has, of course, been examined in some detail by Berthelot, Hammer Jensen, Kopp, and Festugière,⁵¹ and the following discussion will focus not on the technical procedures described in the work, e.g. the manufacture of alloys or the superficial treatment or coloring of metals,⁵² but on its authorship, composition, and philosophical assumptions.

Some preliminary observations on the *Ph. et M.* are in order. First, the title itself does not appear to be original, and commentators such as Zosimus refer to it as "the prescriptions" or "recipes" (αἱ τὰξεις).⁵³ Second, the work in its present form has the appearance of being a compilation, and seems to fall into at least seven parts with little or no apparent relationship to one another:⁵⁴ (1) two recipes for dyeing in purple and a catalogue of stuffs useable for purple colouring (41, 1-42, 2); (2) a narrative of how a student conjures up his dead instructor from Hades to learn his teachings (42, 3-43, 3); (3) ten recipes in the imperative singular for making gold (43, 4-46, 13); (4) a polemic against the young (νεοί) who do not

accept the master's teaching (46, 14–48, 15); (5) three recipes again in the imperative singular for making gold, the last of which is attributed to Pammenes who taught it to Egyptian priests⁵⁵ (this section seems to mark the end of a treatise on making gold (48, 16–49, 19)); (6) theoretical remarks addressed to colleagues in the imperative plural (49, 19); (7) nine recipes for making *asemon*, a lustrous, silver-like alloy⁵⁶ (49, 20–53, 28), and a brief conclusion (53, 29) on making gold and silver. Lagercrantz, somewhat like Berthelot before him,⁵⁷ saw the work was falling essentially into three main parts: the first consists of recipes for dyeing in purple, and is purely technical without alchemical significance (for Berthelot this was the oldest part of the work, and was to be connected with Democritus or his “school”); the second part deals with the conjuring up of a dead teacher (for Berthelot a “magical” section which antedates Pliny the Elder’s work); the third part is alchemical and deals with the making of gold and silver as a “healing of the soul”, i.e. a cure for the disease of poverty (for Berthelot this is the most recent part of the work, but anterior to the fourth century A.D.). That this third part is not later than the fourth century seems clear from Synesius’ commentary on it.⁵⁸ Further indication of dating for this part is provided by reference to κλαυδιανόν (44, 7) an alloy resembling gold, and containing copper, lead, and tin or brass; its name is derived from the emperor Claudius (10 B.C.–A.D. 54). The term λακκά, a plant whose root was used in red dye, occurs in the first part (42, 2) and is borrowed from India. It appears only in another late text of the seventh century A.D. though it may well have been familiar since the first century A.D. when regular commercial relations were established between India and Alexandria.⁵⁹ Additional complication in dating the work as a whole is given by the conjuring up of the dead teacher. As Festugière noticed, this curious narrative is a collection of Hellenistic themes, e.g. the anguished search for truth, the necessity of a revelation from a divine or inspired master, the discovery of a temple column containing a secret.⁶⁰ It has also been noted that the address to “fellow prophets” (46, 14–47, 15), an apparent conflict between the young and the old about the nature of matter (ύλη), and the making of precious metals as a “healing of the soul” and deliverance from all labour (see Synesius’ remark on poverty as the incurable disease, 59, 6 f.) are factors indicating that this section of the work dates from a later period of Greek alchemy, ca. the fourth century A.D., and not from its very beginnings.⁶¹

An important question concerns the identity of the student and defunct teacher who are prominent in part of the work. Their names are not mentioned in the text, and no location is given for the mysterious temple though the anonymous narrator later says, “and I came carrying the *physika* (natural questions, or treatises on natural questions?) in Egypt” (43, 4). Synesius identifies the work’s author as Democritus of Abdera who came to Egypt, and was initiated into the mysteries by Ostanēs in a temple in Memphis (57, 1).⁶² Synesius then mentions four books on gilding and tinting (βίβλοι τέσσαρες βαφικαί): on gold, silver, stones (gems), and purple (57, 1) even though nothing is said of these four books in the commentary following, and the four books do not correspond to the present text of the *Ph. et M.* since the section on purple comes first, and the section on stones or gems is non-existent. An almost identical report is given by Georgius Syncellus (ca. 800 A.D.) who adds that among the priests and philosophers present at Democritus’ initiation, was Maria who together with Democritus, was praised by Ostanēs for concealing their craft (τέχνη) in clever riddles (σοφοῖς αἰνίγμασι).⁶³ But Synesius’ remarks do not quite apply to the *Ph. et M.*, for the narrator who is identical with the author of the work and presumably Democritus, has heard the story of the initiation from the student. Moreover, “I came

carrying the *physika* in Egypt” does not agree with the report at 57, 1 that it was Ostanēs who came to Egypt, and there initiated Democritus. If one assumes, however, that it is Ostanēs, and not Democritus, who is the student of the defunct teacher who still remains unknown, some of the confusion is clarified.⁶⁴ The tradition, of course, that Democritus was instructed in the magical arts by Ostanēs is an old one going back at least to Hermippus of Smyrna who composed *On the Magi*, and some of whose views are preserved in Bk. XXX of Pliny’s *Naturalis Historia*.⁶⁵

The previous observations on the *Ph. et M.* illustrate some of the problems connected with understanding this disorganized treatise or compilation attributed to Democritus of Abdera by Synesius. There is, of course, the possibility that the text now extant is not the one Synesius knew. Certainly, as noted before, the book on stones or gems mentioned by him no longer exists, and the book on purple precedes those on gold and silver. A key question concerns, of course, the reasons Synesius might have had for believing that his curious work was by Democritus. Berthelot, without defending Democritus of Abdera’s authorship, did in his discussion of the conjuration scene, refer to Democritus’ lost work *On Those in Hades*, and remarked “peut-être aussi faut-il y chercher quelque ressouvenir des idées du vrai Démocrite sur les fantômes et sur les songes, auxquels il supposait une existence réelle”.⁶⁶ But such evidence is hardly convincing enough to have established Democritus’ authorship either in Synesius’ mind or in that of a modern scholar. The more important issue is: are there any beliefs in the *Ph. et M.* which show a possible influence of Democritus and atomism on the work?

A major philosophical concept of the treatise is found in the enigmatic formula or slogan ἡ φύσις τῇ φύσει τέρεται, καὶ ἡ φύσις τὴν φύσιν νικᾷ καὶ ἡ φύσις τὴν φύσιν κρατεῖ, which is referred to as the “writing” (γραφὴ) of the dead teacher, a writing discovered when a temple column mysteriously broke asunder (43, 3). Synesius specifically ascribes the formula to Ostanēs (57, 1), and it remained a slogan of later alchemy, embracing the principle of the transmutation of metals. Bidez-Cumont and others regard the formula as Hellenistic in origin, and connect it with Bolus of Mendes.⁶⁷ That the formula seems to be Hellenistic is suggested by a partial paraphrase in Firmicus Maternus reporting the views of Nechepso:

Nechepso, the most just ruler of Egypt and an exceedingly good astronomer, gathered by means of the decans themselves, all vices and virtues showing what disease each decan caused, because one nature is conquered by another (*natura alia natura vincitur*) and one god often conquers another. And from contrary natures and contrary powers he found cures for all sicknesses by the teaching of divine reason.⁶⁸

Nechepso is, of course, with Petosiris the titular author of an important astrological work probably of the second century B.C., but granting that the formula of the *Ph. et M.* is partially paraphrased by Firmicus, there is no conclusive evidence for assigning the formula to Bolus. Bidez-Cumont did so believing that the formula reflects the “medico-magical system” of sympathies and antipathies, and thus the conflict and harmony of particular natures or powers (φύσεις) among themselves.⁶⁹ This is certainly a reasonable understanding of the formula, and Festugière saw it simply as the law of sympathies and antipathies applied to the realm of metals.⁷⁰ One of the phrases of the compound statement occurs, for example, at the conclusion of each of the ten recipes for making gold (43, 4–46, 13), and at the end of each of the other recipes for making gold (48, 16–18), and those for making silver

(49, 20–53, 28). In the polemic against the young, they are accused of not knowing “the antipathies of natures or powers (τὰ τῶν φύσεων ἀντιπαθῆ), how one kind (εἶδος) ‘destroys’ (ἀνατρέπει) ten others; for a single drop of olive oil is able to remove much purple, and a little sulphur is able to burn many kinds” (47, 15 l. 24 ff.).

Yet the formula of the *Ph. et M.* is not wholly foreign to the thought of Democritus of Abdera, and can be given an atomistic interpretation. First, it is important to note with what frequency the term φύσις appears in what seem to be genuine fragments of his works, e.g. B33, B176, B183, or B278, understood sometimes as a natural disposition (in B33) and sometimes as the very constitution or nature of a thing (in B278). Second, if Simplicius, the commentator on Aristotle’s *Physics*, can be trusted, the Democriteans called the atomic particles “physis” (B168 = D.-K. A58), a report very similar to that of Aristotle himself at *De caelo*, 275b 3: “they (the atoms) are differentiated by their shapes, but their nature (φύσιν), they say, is one, just as if each were a separate bit of gold”.⁷¹ The atoms differ, of course, from a substance like gold in being qualityless, or certainly without sensible qualities.⁷² If these reports are correct, the formula in *Ph. et M.* allows of an atomistic interpretation since it is well known that for Democritus the atoms are in constant motion, and their coming together sometimes forms compounds while their separation often results in the destruction of compounds.⁷³ Aristotle once compares atoms to motes seen in sunbeams (*De An.* 404a 3), and Lucretius developed the image at length, for in the sun’s rays entering a dark room “you will see many minute bodies mingling in many ways throughout empty space in the very light of the rays, and as if in eternal combat struggling, warring, battling in companies and never giving pause, harried by constant gathering and partings, so you may surmise from this what it is like when the principles of things are forever tossed about in the great void” (*De re. nat.* 11, 114–22). That the image developed by Lucretius is in keeping with the formula of the *Ph. et M.* is contingent, in part, on how one understands the term φύσις. Is it to be understood as nature in general, or does it refer to a particular nature or power? Diels understood it as “eine Natur freut sich der andern.—Eine Natur vergewaltigt die andre.—Eine besiegt die andre”.⁷⁴ and this makes sense given the contexts in which the formula is repeated in *Ph. et M.* There it refers to the particular qualities or properties of metals; as these form alloys or compounds, a particular property, e.g. a gold-like appearance comes into being. Now if one understands the formula atomistically, it can be paraphrased as follows: some atoms delight in one another and so form compounds: some atoms prevail over others, and conquer them thus bringing about either the dissolution of previous compounds or the creation of new ones. Moreover, in the *Ph. et M.* the student of the unknown teacher complains that he knew nothing of how “substances and natures (or powers) unite and react together” (συνουσιωθῶσι καὶ συνεισκριθῶσιν αἱ οὐτίσι καὶ φύσει 43, 3 l. 11). Now in the doxographical tradition “substances” (οὐσίαι) is, like φύσις noted above, one of the terms used for Democritus’ atoms, and σύγκρισις is used for the combination or union of atoms, e.g. Simpl. *De caelo* 294, 33 = D.-K. A37; cf. Simpl. *Phys.* 28, 15 = D.-K. A 38). Lastly, as has often been noted, one of the main principles of Greek physics, beginning with the Presocratics, can be recognized in the *Ph. et M.* and other Greek alchemical writings, viz. the notion of some kind of material substratum underlying all change; change itself is merely a transition from one quality to another while the substratum remains the same.⁷⁴ For the Presocratics this substratum or primary “stuff” was usually identified with one or more of the four elements: earth, air, fire, and water. But in the case of Democritus and the atomists, the substratum consisted of indivisible particles which, unlike

the elements, were devoid of any qualities other than size and shape. Plato and Aristotle with their doctrines of the receptacle or space (χώρα) and prime matter (πρώτη ύλη) respectively, also dealt with the problem of the substratum, but their views were anticipated by the atomists with whom the notion of a qualityless "stuff" underlying all change, emerges as a clear philosophical principle.⁷⁶ It is, therefore, not surprising that Plato and Aristotle, together with Democritus, were considered by the alchemists among the founders of their art.⁷⁷ To be sure, the substratum or basic substance of the alchemists' procedures was often identified with lead, one of their main concerns being its transmutation into gold or silver. How, in particular, could lead or any base metal, while remaining the same metal or substance, receive another appearance or colour? The alchemists reasoned basically as follows: when subjected to heat or fire, lead passes into a fluid state, and this constitutes something like prime matter where "all things are accomplished by means of dissolution" (*Ph. et M.* 47, 14). It is now formless matter having itself no determinate qualities, but able to receive new qualities or appearances. Indeed, in his commentary, Synesius, like the author of the *Ph. et M.*, sometimes uses the terminology of Aristotle, e.g. at 63, 9, and Synesius may have Plato's *Timaeus* in mind when he compares mercury to a wax which receives various colours (62, 8). As Berthelot noted, mercury acts like Plato's receptacle or space in that it forms that permanent background or being in which qualities, like colour, appear (see *Tim.* 50 A-51B);⁷⁸ and a much vexed problem has been the extent to which Democritus' own beliefs, e.g. in qualityless atoms having shapes, have influenced this and other doctrines in the *Timaeus*.⁷⁹

In the final analysis, it must be emphasized that apart from the notion of a stuff or matter itself without quality, and the uses of οὐσίαι and φύσεις which can be given atomistic interpretations, there seems to be nothing else linking the *Ph. et M.* with the atomic theory of Democritus. Similarly, in the other writings of the Greek alchemists, there are few specific references to atomism. Only in two works does the actual term ἄτομα appear, and in one of these the reading is uncertain.⁸⁰ Yet as has often been noted, it was primarily because Democritus enjoyed the reputation of being interested in all kinds of practical and technical skills that his name became linked with the early alchemical treatises.

CONCLUSION

The previous discussion of the *Ph. et M.* and other works of early Greek alchemy, is not to be viewed as an attempt to claim these for Democritus of Abdera. Nonetheless, the belief of Synesius that the author of *Ph. et M.* was Democritus, should not be wholly dismissed. There are, as was argued, some notions in the work, itself probably a compilation, which allow of an interpretation in keeping with the Abderite's atomic theory. There is, of course, great likelihood that Democritus was interested in metallurgy and in colours, for besides the evidence in Theophrastus' *De sensibus* discussed above, a work on colours (Περὶ χρωμάτων) is listed in Thrasyllus' catalogue of Democritus' writings at Diog. Laert. IX, 46. Certainly some of the early "alchemical" works, e.g. the Stockholm papyrus, with their emphasis on technical procedures and lack of the mystical, religious elements found in later alchemical treatises, are not out of keeping with the Abderite's interest in natural phenomena. The name of Democritus, like that of Pythagoras and other illustrious early thinkers, could be and obviously was exploited by those who wanted a favorable reception for their own views. That the *Ph. et M.*, or the *Letter of Democritus to Leucippus* which contains nothing very Democritean,⁸¹ were falsely ascribed to Democritus is without doubt. Yet these forgeries

could not have survived scrutiny if Democritus' own writings had been carefully preserved, or if knowledge of his beliefs had been maintained and transmitted. Bolus of Mendes may have considered himself a Democritean or even have had the double name, Bolus-Democritus, and his own work probably contributed to a belief in hidden or occult powers and in the principle of sympathy and antipathy, but there is no evidence either that he forged works in Democritus' name or that he was interested in metallurgy and the processes of silvering and gilding, much less alchemy. To be sure, Egypt is the most likely place for the beginnings of Greek alchemy,⁸² but because of Bolus' own Egyptian roots, it does not follow that he was one of the founders of Greek alchemy. Democritus' own atomic theory with its belief in qualityless atoms may well have contributed to some philosophical assumptions of alchemy, and to consider Democritus as one of the Greek alchemists is not as nonsensical as it may seem to those imbued with the view that Democritus was a rationalist par excellence.⁸³

NOTES

1. The text referred to is in Marcellin Berthelot, *Collection des anciens alchimistes grecs*, 3 vols., Vol. III, Pt. 1: *Texte grec* (Paris, 1888; repr. London: Holland Pr., 1963; hereafter cited as *Collection*), pp. 25–26. Berthelot's collection has often been criticized, e.g. for its lack of order and careful editing. An extensive critique is by Edmund O. von Lippmann, *Entstehung und Ausbreitung der Alchemie* (Berlin: J. Springer, 1919), pp. 647–658. See also A. Rehm, "Zur Überlieferung der griechischen Alchemisten," *Byzantische Zeitschrift*, 1939, 39: 394–434, on pp. 397–398. The appearance in 1981 of the first of twelve anticipated volumes containing the complete corpus of the Greek alchemical texts is most welcome. For discussion of the historical background to this project, and a brief assessment of Berthelot's work, see H. D. Saffrey's introduction to Robert Halleux, *Les alchimistes grecs*, Vol. 1 (Paris: Société d'éditions "Les belles lettres", 1981), pp. vii–xv. On alchemy as the "sacred art", see E. Riess, "Alchimie", Vol. 1, *Real-Encyclopädie d. klassischen Altertumswissenschaft*, ed. G. Wissowa (Stuttgart, 1894), cols. 1338–1355, in cols. 1339–1340. The encyclopedia is cited hereafter as *RE*. There are several ancient lists or catalogues of famous individuals claimed to the practitioners of the sacred art. See, for example, M. Berthelot, *Les origines de l'alchimie* (Paris, 1885; hereafter cited as *Orgines*), pp. 127–132. See also F. Sherwood Taylor, "A Survey of Greek Alchemy", *Journal of Hellenic Studies*, 1930, 50, 109–139, on pp. 113–123 where the important names connected with alchemy are systematically given.
2. Synesius' commentary is in Berthelot, *Collection*, Vol. III, Pt. 2, pp. 56–69. It is actually a series of answers to questions posed by Dioscorus, a priest of Serapis in Alexandria. The identity of Synesius is unknown, but he is probably not to be identified with the famous bishop of Cyrene. See, for example, E. Riess, *RE* 1, col. 1345, von Lippmann, *Entstehung*, (*op. cit.*, note 1) pp. 96–98, R. Halleux, "Les textes alchimiques", *Typologie des sources du moyen âge occidental*, 32 (Turnhout: Brepols, 1979), p. 62, and I. Hammer Jensen, "Die älteste Alchymie", *Kgl. danske Videnskabernes Selskab, Historisk-filologiske Meddelelser*, IV, 2 (Copenhagen, 1921), pp. 3–159 who on pp. 134–136 suggests that the author was a Neoplatonist.
3. Berthelot, *Orgines*, p. 263. The *Ph. et M.* continued to be attributed to Democritus until the seventeenth century, and as late as 1674 Olaus Borrichius argued that Democritus composed chemical treatises. For a survey of early modern scholarship on Democritus and alchemy or chemistry, especially on the *Ph. et M.*, see H. Kopp, *Beiträge zur Geschichte der Chemie*, Pt. 1 (Braunschweig, 1869), pp. 110–136.
4. On Bolus of Mendes, see J. J. Waszink, "Bolos", Vol. 2, *Reallexicon für Antike und Christentum*, ed. T. Klauser (Stuttgart: Hiersemann, 1954), cols. 502–508, and the bibliography in col. 508. See also P. M. Fraser, *Ptolemaic Alexandria*, 3 vols., Vol. 1: *Text* (Oxford Univ. Pr., 1972), pp. 440–444, and Vol. 2: *Notes*, pp. 636–646. References to Bolus in other works will appear in subsequent notes. On Mendes, a town and district of the eastern Nile delta, see H. Kees, *RE*, 15, 1932: cols. 780–784.
5. Berthelot discusses Bolus briefly in *Orgines*, pp. 156–158; H. Diels, *Antike Technik* (Leipzig and Berlin: B. G. Teubner, 1924), pp. 126–128; von Lippmann, *Entstehung*, pp. 328–330; R. P. Festugière, *La révélation d'Hermès Trismégiste*, 2 vols., Vol. 1: *L'astrologie et les sciences occultes* (Paris: Librairie Lecoffre, 1944), pp. 224–238; M. Wellmann, "Bolos", *RE*, 3, 1899: cols. 676–677, and "Die Φουσικά des Bolos Demokritos und der Magier

- Anaxilaos aus Larissa I", *Abhandlungen der preussischen Akademie der Wissenschaften* (Berlin, 1928), 7: 3–80. Wellmann's views much influenced Diels in his edition of the Presocratics where some notes on Democritus are largely either quotations from Wellmann or observations made by him. See H. Diels, *Die Fragmente der Vorsokratiker*, 3 vols., ed. W. Kranz, Vol. II (Berlin: Weidmann, 8th ed. 1956), B300, pp. 210–221. This work is cited hereafter as D.-K. "A" refers to the "Leben und Lehre" section: "B" to "Fragmente". Diels' edition of Democritus in D.-K. is translated into Italian with useful additional notes by V. Alfieri, *Gli atomisti: frammenti e testimonianze* (Bari: Laterza and Figli, 1936), pp. 41–320. See also the discussions of Bolus in J. Bidez and F. Cumont, *Les mages hellénisés*, 2 vols., Vol. 1: *Introduction* (Paris: Société d'éditions "Les belles lettres", 1938), pp. 198–204, and Halleux, "Les textes alchimiques" (*op. cit.* note 2), p. 63 and *Les alchimistes grecs*, I, pp. 62 ff. Halleux is largely dependent on the work of Wellmann, and does not cite Fraser's discussion of Bolus.
6. See, for example, the remarks of Taylor, "Survey", (*op. cit.* note 1) p. 109 or of H. H. Dubs, "The Origin of Alchemy", *Ambix*, 1961, 9: 23–36, on pp. 23–24, and Halleux, "Les textes alchimiques" (*op. cit.*, note 2) pp. 43–49 who gives a very good summary of the definition, object, and limits of alchemy.
 7. Fraser's work cited in note 4 above is the only fairly extensive discussion of Bolus in English. In addition to the works cited in note 5 above, see also M. Wellmann, "Die Georgika des Demokritos", *Abhandlungen der preussischen Akademie der Wissenschaften* (Berlin, 1921), 4: 3–58, and his "Der Physiologus. Eine religionsgeschichtlich-naturwissenschaftliche Untersuchung", *Philologus*, Supplbd. 22, 1, 1930: 1–116, esp. pp. 94–112. See also T. Weidlich, *Die Sympathie in der antiken Literatur* (Stuttgart, 1894), pp. 13–35.
 8. *Suidae Lexicon*, ed. Ada Adler, 5 vols., Vol. 1 (Stuttgart: B. G. Teubner, 1929, repr. 1971). The entries on Bolus = D.-K. B300, 1. All translations are mine unless otherwise indicated. Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, p. 63 translates the work listed in 481 as "*Histoire et Art de la Médecine*" on the basis of the title Περὶ τῶν ἐκ τῆς ἀναγνώσεως τῶν ἱστοριῶν in the second entry. This is a possible meaning, but one is also able to think of ἱστορία in the senses of scientific observation, inquiry, or even a body of recorded medical cases. These senses of the term perhaps fit medicine more than the general "history". Unfortunately there is no fuller context to establish its meaning. "On . . ." (Περὶ) in the second entry is Küster's emendation. The text is corrupt, and various unconvincing attempts have been made to restore it, on which see Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 641, n. 536.
 9. See Wellmann, "Die Georgika," (*op. cit.* note 7) p. 8. See also Fraser's remark, *Ptolemaic Alexandria* (*op. cit.* note 4), II, pp. 640–641, note 535.
 10. See χειρόκμητος in *A Greek-English Lexicon*, comp. by H. G. Liddell and R. Scott, and ed. H. S. Jones (Oxford: Oxford Univ. Pr., 9th ed. 1940; repr. 1961). Hereafter *LSJ*. See also Halleux, *Les alchimistes grecs* (*op. cit.* note 1), p. 66 who notes that the term "semble se référer aux travaux faits à la main, c'est-à-dire plus spécifiquement aux applications médicales, magiques, techniques".
 11. Fraser, *Ptolemaic Alexandria*, (*op. cit.* note 4) II, p. 641, note 36. That the work dealt with herbal remedies was realized by Weidlich on the basis of Pliny the Elder's reports; see Weidlich, *Sympathie* (*op. cit.* note 7), p. 28. Taylor, "Survey" (*op. cit.* note 1), pp. 114–115 claims unconvincingly that χειρόκμητα in the sense of "artificial substances" is applicable to the *Ph. et M.*
 12. Stephanus Byzantinus, *Ethnicorum*, vol. 1, ed. by August Meineke (Berlin: G. Reimer, 1849). The text is quoted by Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 638, n. 526. My translation of it appears later on p. 4 of this study. The text of the Scholia to Nicander's *Theriaca* is found in D.-K. B300, 4 (also quoted by Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 644, n. 544): "Bolus the Democritean in *On Sympathies and Antipathies* says the Persians having a poisonous tree in their country, planted it in Egypt in the expectation many would die from it, but since this land is good, the tree changed into its opposite nature and bore the sweetest fruit".
 13. See Wellmann, "Die Φυσικά", pp. 9–10, and D.-K., II, p. 150. *On the Jews* is assigned in the Suda to a Δαμόκριτος ἱστορικός, and dealt with "horror" stories about the veneration of an asses' head and ritual murder. That the βαφικά was a product of Wellmann's learned imagination was claimed, in effect, by W. Kroll, "Bolos und Demokritos", *Hermes*, 1934, 69: 228–232 on p. 230: "ganz in der Luft schweben, um dieses Beispiel herauszugreifen, die von Wellmann dem Bolos zugeschriebenen βαφικά". See also Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 642, note 538. Despite Kroll's observation, and his own note that "ce titre n'est nulle part indiqué dans es fragments", Festugière writes about Bolus' βαφικά as established fact, *La révélation*, I, pp. 223–226. Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, pp. 68–69 who also observes that a βαφικά is nowhere attested for Bolus, believes it "plus raisonnable de penser que la chimie était une part de χειρόκμητα . . ." This is certainly reasonable since the alchemical books of Zosimus were called χειρόκμητα. But Zosimus is several centuries after Bolus, and the little evidence there is in Columella and Pliny about the χειρόκμητα of Bolus suggests it dealt with herbal remedies, and not gilding and silvering.

14. Fraser *Ptolemaic Alexandria* (*op. cit.* note 4), I, p. 440. See also Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, pp. 66–67. For the fullest discussion of the evidence for dating Bolus, see Wellmann, “Die Georgika” (*op. cit.* note 7), pp. 5–16.
15. On the doctrine of sympathy and antipathy, see especially Weidlich, *Sympathie* (*op. cit.* note 7), pp. 3–6, and J. Röhr, “Der okkulte Kraftbegriff im Altertum”, *Philologus*, Supplbd. 17, I, 1923: 1–133, esp. pp. 34–76.
16. Kroll, “Bolos” (*op. cit.* note 13), p. 231. Also as Weidlich noted, “pythagorisch aber habe damals alles Geheimnisvolle, Wunderbare, Zauberhafte geheissen”, *Sympathie* (*op. cit.* note 7), p. 17. See also Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, p. 64. Certainly the designation did not mean that Bolus was a Pythagorean in terms of doctrine or way of life. There is also the tradition that Democritus himself was a student of Pythagoras. See W. Schmid, *Geschichte der griechischen Literatur*. I. Müllers *Handbuch der Altertumswiss.*, Vol. VII: 5 (Munich: Biederstein, 1948), p. 239, note 8.
17. For Wellmann “Bolos Democritus” was a double name. His view, however, was not accepted by Kroll, “Bolos” (*op. cit.* note 13), pp. 229–230 or Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 637, n. 524.
18. Kroll’s observation, (*ibid.*), p. 230 is decisive against forgery on Bolus’ part: “und wollte Bolos auf den Namen des grossen Abderiten fälschen, so war es völlig verkehrt, wenn seinen eigenen Namen in irgendeiner Form beibehielt und auf seine Schriften setzte”.
19. This second possibility is suggested by Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 640, note 532.
20. See note 12 of this study and “Bolos” in D.-K., II, p. 251 where almost the same report is in Apollonius’ *Wonder-Book*. Apollonius also drew extensively from Theophrastus who, in turn, drew from Democritus in his botanical writings. See Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 644, n. 547.
21. Kroll, “Bolos” (*op. cit.* note 13), p. 230.
22. Several recipes in the Παύγνια are discussed by Wellmann in “Die Georgika” (*op. cit.* note 7) pp. 29–32, and in “Die Φυσικά” (*op. cit.* note 13), pp. 67–68. For the text, see D.-K. B300, 19, pp. 220–221 or K. Preisendanz, *Papyri Graecae Magicae*, 2 vols., Vol. II (Leipzig: B. G. Teubner, 1931), vii. 169–186, pp. 7–8. Παύγνια were also composed by Anaxilaus of Larissa on which see Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, p. 69.
23. Wellmann, “Die φυσικά” (*op. cit.* note 13), p. 68: “wie dieser Titel dem Werke des Alchemisten und Mystikers Demokrit, der in die nachchristliche Zeit gehört, verbleiben muss, so darf man, wie mir scheint, bei Bolus nach Analogie der chemischen Schrift des Hermes Trismegistos an den Titel φυσικὰ βαφαί oder βίβλοι φυσικῶν βαφῶν oder endlich βαφικά denken”.
24. *Seneca ad Lucilium Epistulae Morales*, trans. R. Gummere, 3 vols., Vol. II, Loeb Classical Library (Cambridge, Mass.: Harvard Univ. Pr., 1920; repr. 1962), p. 421. On interpretation of the text, see Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 639, note 528. See also Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, pp. 66–67 who considers it one of the “principal” fragments with a “trait à la chimie”.
25. *Pliny Natural History*, trans. D. E. Eichholz, 10 vols., Vol. X, Loeb Classical Library (Cambridge, Mass.: Harvard Univ. Pr., 1962; repr. 1971), pp. 324–327.
26. For the Greek text, see either *Papyrus Graecus Holmiensis, Recepte für Silber, Steine und Purpur*, ed. O. Lagercrantz (Uppsala: Almqvist and Wiksells, 1913), p. 3, or Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, p. 110. Halleux’s excellent edition of the *Pap. Holm.* supersedes that of Lagercrantz. See Lagercrantz’s comments on pp. 149–150 and those of Halleux on p. 62 and p. 184. It should be added that στυπτηρία was commonly used by the alchemists, but it seems not always identical with modern alum, and may have been used as a term for arsenic. See Taylor, “Survey” (*op. cit.* note 1), p. 123 and Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, p. 31 and his very useful “Lexique”, p. 230.
27. The work’s title is not known. On Anaxilaus, see Wellmann, “Die φυσικά” (*op. cit.* note 13), esp. pp. 52–62, or his “Anaxilaos”, *RE*, I, 1894: col. 2084.
28. As noted by Lagercrantz, *Papyrus* (*op. cit.* note 26), p. 108.
29. It seems generally accepted by Diels, *Antike Technik* (*op. cit.* note 5) p. 129 and Wellmann, “Die φυσικά”, (*op. cit.* note 13), p. 29 that Posidonius described Democritus’ alchemical practices, i.e. those of Bolus, but as Fraser, *Ptolemaic Alexandria* (*op. cit.* note 4), II, p. 639, n. 528 observed, Posidonius perhaps attributed to Democritus only the invention of the arch. Seneca may have the remainder of his information from another source. The production of synthetic gems was widespread in antiquity, and has nothing especially to do with alchemy. See I. Hammer Jensen, “Deux Papyrus à contenu d’ordre chimique”, *Oversigt kgl. danske Videnskabernes Selskabs Forhandlinger* (Copenhagen: Host and Son 1916–17), pp. 279–302, esp. pp. 297–301, and the very useful survey of Halleux, *Les alchimistes grecs* (*op. cit.* note 1), I, pp. 47–52. See also the various recipes for the imitation of precious stones in the *Pap. Holm.*, *ibid.*, p. 113 ff. It should be added that Seneca seems to have known the work of Democritus fairly well. At *Quaest. nat.* V, 12 he gives Democritus’ atomistic explanation of wind; at IV, B, 9 in

- a passage R. Halleux, "Le problème des métaux dans la science antique", *Bibliothèque de la Faculté de Philosophie et Lettres de l'Université de Liège*, 209 (Paris: Société d'édition "Les belles lettres", 1974), p. 76 notes is not in D.-K., Seneca describes an "experiment" of Democritus used to explain why the air near the earth is warm. On the text, see Halleux's excellent discussion, *ibid.*, pp. 76–78. In view of these passages, it seems unlikely that Seneca would have confused Democritus with Bolus in the passage of *Ep. mor.*
30. For a detailed summary of the history of the transmission of Democritus' works, see Schmid, *Geschichte* (*op. cit.* note 16), pp. 243–253, esp. pp. 243–244. On the "school" of Democritus, see Alfred Stückelberger, "Vestigia Democritea", *Schweizerische Beiträge zur Altertumswissenschaft*, 17 (Basel: Reinhardt, 1984) pp. 9–29.
 31. It was claimed by E. Oder that Callimachus "unmasked" Bolus' pseudonymous works in this treatise. But Fraser correctly notes that nothing of the work survives nor is the title certain; *Ptolemaic Alexandria* (*op. cit.* note 1), II, p. 639, note 529 and pp. 658–659, note 68.
 32. Naturally claimed by Wellman for Bolus. See "Die φυσικά" (*op. cit.* note 13), p. 12 and pp. 27–28. See also Weidlich, *Sympathie* (*op. cit.* note 7), p. 25 and I. Hammer Jensen, "Pseudo-Demokrit", *RE*, Suppbld. 4, 1924: cols. 219–223, in col. 221.
 33. See Wellman, "Die Georgika" (*op. cit.* note), pp. 12 and p. 4 respectively, and Hammer Jensen, *RE*, Suppbld. 4, 1924: cols. 221–222.
 34. The classifications are probably Alexandrian and antedate Thrasyllus' work in the first cent. A.D. See Schmid, *Geschichte* (*op. cit.* note 16), p. 246.
 35. Schmid discusses Democritus' interest in "causes", *ibid.*, pp. 255–263. See also Alfieri, *Atomisti* (*op. cit.* note 5), pp. 71–72. On D.-K., II, p. 91, it is remarked that the unclassified works were probably included later in the catalogue, and are suspect. Yet there is, if genuine, B118 attributed to Democritus: "I would rather find one causal explanation (αἰτιολογίαν) than be king of the Persians".
 36. So D.-K., II, p. 91. For Democritus on magnetism, see Guthrie, *History*, II, m.p. 426. See also the various entries on λίθος in *LSJ s.v.*
 37. The reference to Democritus in Petronius is in Eumolpus' remarks at *Satyricon* 88 where Democritus is said to have spent his time in experiments to discover the properties of minerals and plants.
 38. The text is in D.-K. A135. See also the text and commentary of G. M. Stratton, *Theophrastus and the Greek Physiological Psychology before Aristotle* (London: G. Allen and Unwin, 1917, repr. W. C. Brown). See also Halleux, "Le problème des métaux", (*op. cit.* note 29) pp. 74–79 who notes on p. 74 that "la théorie atomique ne fait pas aux métaux une place privilégiée". This is correct, and yet Halleux remarks that "l'originalité de Démocrite est d'avoir approfondi la notion de structure, corollaire de sa philosophie corpusculaire, pour élucider des problèmes relatifs à certains métaux: rapport entre poids spécifique et dureté, conductibilité, thermique, attraction magnétique". To the evidence of Theophrastus should be added that of Seneca, *Quaest. nat.* IV B, 9 who describes Democritus' "experiment" involving the placement of bronze and glass vases in the sun. The bronze vase heats more quickly than the glass vase and retains its heat longer. The reason for this phenomenon is that harder and more compact objects have smaller openings. See Halleux, *ibid.*, pp. 76–78 on this calorimetric experiment.
 39. On the problem with the text, *ibid.*, pp. 199–200.
 40. A number of the recipes in the Leiden and Stockholm papyri deal with dyeing in purple. See Halleux, *Les alchimistes grecs*, (*op. cit.* note 1) I, pp. 43–46.
 41. A work *On Colors* is listed in Thrasyllus' catalogue a D. L. 9, 49. See also D.-K. A123–126.
 42. Arthur J. Hopkins, *Alchemy, Child of Greek Philosophy* (New York: Columbia Univ. Pr. 1934). See especially pp. 12–37 where Hopkins discusses Greek philosophical influences on alchemy. He discusses only Plato and Aristotle without mention of the Presocratics who, of course, influenced Platonic and Aristotelian thought.
 43. See, for example, Riess, "Alchimie", cols. 1339–1342, and cols. 1346–1349 or W. Gundel, "Alchimie", *Reallexicon für Antike und Christentum*, Vol. II, ed. T. Klauser (Stuttgart: Hiersemann, 1950), cols. 239–259, esp. cols. 249–257.
 44. This has been noted by Hammer Jensen, "Die älteste Alchymie", (*Op cit.*, note 2) pp. 82–83. See also *RE* cols. 1341–1342. Scholarly opinion is, of course, divided on this matter. Scholars who think of them as alchemical are Lagercrantz, von Lippmann, Diels, and Lindsay. For a judicious discussion of the division of opinion see, Halleux, *Les alchimistes grecs*, (*op. cit.* note 1) I, pp. 24–30 where he focuses on the Leyden and Stockholm papyri, and the question whether they represent "technique ou alchimie". Halleux notes that "il est extrêmement difficile de distinguer une recette technique d'une recette alchimique" (p. 29). Yet he believes the works are "une compilation à caractère alchimique et non technique même si certains procédés sont industriels" (in a letter to me dated Oct. 9, 1986).

45. Translated "passatempi" by Alfieri, *Atomisti* (*op. cit.* note 5), p. 303. On the Παύγνια, see Wellmann, "Die Georgika", pp. 29–32, and D.-K. II, p. 220. The recipes are sometimes considered examples of "white magic" (the *magia naturalis* of the medieval world).
46. D.-K. II, p. 220. But wrongly so, according to Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) p. 81.
47. See v. Blumenthal, *RE*, 18: 1, 1942: cols. 2396–2398.
48. The view of Democritus as the "laughing philosopher" is briefly discussed by Schmid, *Geschichte* (*op. cit.* note 10) p. 238 note 3 and p. 248.
49. Democritus' interest in popular beliefs, for example, the existence of *daemones* is treated by H. Diels, "Ueber Demokrists Dämonenglauben", *Hermes*, 1894, 7: 154–157 and by D. McGibbon, "The Religious Thought of Democritus", *Hermes*, 1965, 93, 385–397.
50. See, for example, Diels, *Antike Technik* (*op. cit.* note 5), pp. 148–149 or Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) pp. 82–83. She maintains more clearly than Diels that many of these recipes are based on the methods of craftsmen who worked empirically on imitating silver. The alchemists relied not so much on experience as on theory and a belief in divine aid in the attempt to transform base metals into precious ones. See also Halleux, *Les alchimistes grecs*, (*op. cit.* note 1) I, pp. 24–30 and pp. 35–42 where he gives a good summary of "les recettes d'argent et d'or". For a lucid discussion of the technical procedures in the *Ph. et M.* on the imitation of silver and gold, see Taylor, "Survey", (*op. cit.* note 1) pp. 124–130. On the relation of the recipes of the Leiden and Stockholm papyri to those in *Ph. et M.*, see Halleux, *Les alchimistes grecs*, (*op. cit.* note 1) I, 72–75, and "Les textes alchimiques", (*op. cit.* note 2) 63. Halleux's text and treatment of the *Ph. et M.* will appear in *Les alchimistes grecs II*, scheduled to appear at the end of 1987.
51. For discussion, see Berthelot, *Orgines*, pp. 154–162, Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) pp. 84–98, Kopp, *Beiträge*, pp. 110–143 who includes Pizementi's 1573 Latin translation, and Festugière, *La révélation* (*op. cit.* note 5) pp. 223–238. For the Greek text of the *Ph. et M.*, see Berthelot, *Collection*, Vol. III, Pt. 1: *Texte grec*, pp. 41–53.
52. For the technical aspects, see esp. the notes to Berthelot's French translation, *ibid.*, Vol. II, pp. 43–57, and Taylor, "Survey", (*op. cit.* note 1) pp. 124–130.
53. See Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 12) p. 84 and note 1 for references. In the text of the work, there is at 43, 3 the statement, "and I came in Egypt bearing the φυσικὰ". There is also language suggestive of the "mysteries", e.g. "initiated" (τελειωθέντων) at 42, 3.
54. On the divisions of the work, see Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) p. 84, Festugière, *La révélation* (*op. cit.* note 5), p. 224, and Lagercrantz, *Papyrus graecus*, (*op. cit.* note 26) pp. 108–111. There is no fundamental disagreement on the work's divisions which have no clear relationship to one another.
55. On Pammenes, see Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) p. 89. Berthelot would wrongly identify this figure with Phimenes of Leyden Papyrus X. See Lagercrantz, *Papyrus graecus*, (*op. cit.* note 26) p. 110.
56. Much has been written on *asemon* and the other σώματα or metals of the alchemists, on which see Taylor, "Survey", (*op. cit.* note 1) pp. 122–124 for a brief, useful summary. On *asemon* in particular see Halleux, *Les alchimistes grecs*, (*op. cit.* note 1) I, pp. 35–38 with his bibliography.
57. Berthelot, *Orgines*, p. 152 and Lagercrantz, *Papyrus graecus*, (*op. cit.* note 26) p. 108. Halleux apparently argues in his forthcoming *Les alchimistes grecs II* (see note 50) that the *Ph. et M.* is not a heterogeneous work of diverse dates (contrary to Berthelot). Halleux in a letter to me dated Oct. 9, 1986 writes: "j'ai repéré les citations dans le reste du corpus. Elles montrent que l'oeuvre est homogène, mais mutilée du début et de la fin. L'ensemble date du début de notre ère et il n'y a pas d'interpolations".
58. On the dating of Synesius' work, see Lagercrantz, *Papyrus graecus*, (*op. cit.* note 26) p. 90.
59. On *claudianum* and *lacca*, see Festugière, *La révélation*, (*op. cit.* note 5) p. 225.
60. *Ibid.* pp. 229–230.
61. See Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) pp. 90–91.
62. The connection of Democritus with Ostanos and his journeys to Egypt and the near East is an old one. On Ostanos and Democritus, see Bidez-Cumont, *Les mages*, (*op. cit.* note 5) I, pp. 170–171. The tradition may go back at least to Hermippus of Smyrna's *On the Magi*. The travels of Democritus have confirmation in fragments of his writings which may, however, be spurious, namely, B246 and B299 on which see W. K. C. Guthrie, *A History of Greek Philosophy*, 5 vols., Vol. II (Cambridge: Cambridge Univ. Pr., 1965), pp. 386–387.
63. See the Greek text cited by Lagercrantz, *Papyrus graecus*, (*op. cit.* note 26) p. 91, note 1 and Bidez-Cumont, *Les mages*, (*op. cit.* note 5) II, 311 = D.-K. B300, 16. On Maria, see von Lippmann, *Entstehung* (*op. cit.* note 1) p. 46.

- and the summary of the school by Taylor, "Survey", (*op. cit.* note 1) p. 114. The school typified by Maria and Comarius seems to have used very different procedures from those of Democritus' followers.
64. See Hammer Jensen, "Die älteste Alchymie", (*op. cit.* note 2) p. 86.
 65. See note 612 above and Bidez-Cumont, *Les mages*, (*op. cit.* note 5) II, p. 267. The immediate source of Pliny is presumably Apion who used Hermippus.
 66. Berthelot, *Origines*, pp. 151–152. On the authenticity and likely content of *On Those in Hades*, see Guthrie, *History*, (*op. cit.* note 62) II, pp. 436–438.
 67. See Bidez-Cumont, *Les mages*, (*op. cit.* note 5) I, pp. 243–246 or Fraser, *Ptolemaic Alexandria*, (*op. cit.* note 4) I, p. 433 who with justifiable caution remarks that the Hellenistic origin of the saying is "seemingly demonstrated by the appearance of this quotation from 'Ostanes' in the astrological work of Nechepso and Petosiris".
 68. Iulii Firmici Materni *Matheseos Libri VIII*, ed. W. Kroll and F. Skutsch (Leipzig: B. G. Teubner, 1907), pp. 264–265. See also Fraser, *Ptolemaic Alexandria*, (*op. cit.* note 4) II, 645 note 549.
 69. Bidez-Cumont, *Les mages*, (*op. cit.* note 5), I, pp. 244–245.
 70. Festugière, *La révélation*, (*op. cit.* note 5) p. 232.
 71. See J. Barnes, *The Presocratic Philosophers* (London: Routledge & Kegan Paul, rev. ed. 1982), p. 344 who accepts the report in Simplicius contrary to J. McDiarmid, "Phantoms in Democritean Terminology: περιπάλαξις and περιπαλάσσεσθαι", *Hermes*, 1958, 86: 291–298 who holds that Simplicius' report comes from Aristotle, *Phys.* 265b 25. See p. 293, note 1.
 72. For a good summary of the nature of atoms, see Guthrie, *History*, (*op. cit.* note 62) II, pp. 392–396.
 73. For a discussion of the formation of compound bodies in atomic theory, see C. Bailey, *The Greek Atomists and Epicurus* (New York: Russell & Russell, 1964, repr. of 1928 ed.), pp. 339–358.
 74. Diels, *Antike Technik* (*op. cit.* note 5), p. 131. See also Festugière, *La révélation* (*op. cit.* note 5), p. 231 who would translate "*une nature est charmée . . .*" rather than "*la nature est charmée . . .*".
 75. See Festugière, *La révélation*, (*op. cit.* note 5) pp. 234–236 who affirms that the doctrine of the unity of prime matter "*paraît constante des présocratiques au Stagirite*", and sees this doctrine as underlying Greek alchemy.
 76. In his discussion of the receptacle or "nurse of becoming" at 50A–C, Plato compares it to a mass of plastic material, citing gold as an example of how figures of all sorts can be moulded from it. The receptacle is later seemingly identified with "space" named for the first time at 52B. On the relevance of this passage to alchemy, see Hopkins (*op. cit.* note 42), *Alchemy*, pp. 14–18 and pp. 93–94.
 77. See, for example, Berthelot, *Origines*, pp. 142–144.
 78. See Berthelot, *Collection*, II, Pt. 2, pp. 66–67 and *Origines*, pp. 265–271.
 79. For studies dealing with Democritus' influence on the *Timaeus*, see Schmid, *Geschichte*, (*op. cit.* note 16) p. 332 note 3.
 80. Berthelot, *Origines* p. 263 note 2 found only two places, one in Stephanus and one in Olympiodours, where the term occurs. But in the Olympiodorus passage, τὸ ἄμα perhaps make better sense than ἄτομα. See also Stückelberger, *Vestigia Democritea*, p. 159 on these two passages.
 81. The *Letter* is added to the *Ph. et M.*, but its origin and date are even less certain. See Bidez-Cumont, *Les mages*, (*op. cit.* note 5) I, p. 201 and pp. 210–211.
 82. This view has prevailed among scholars of ancient alchemy. The belief, however, that alchemy first arose in Egypt has been questioned by Dubs, "The Origin of Alchemy", (*op. cit.* note 6) who puts its beginnings in China.
 83. The view is a common one both in antiquity and in the modern world. For example, Berthelot writes, *Origines* p. 147: "c'était un rationaliste et un esprit puissant". Similar views are expressed on p. 153 where he refers to Lucian's view of Democritus " . . . Démocrite, doué d'une incrédulité inflexible vis-à-vis des miracles, d'après Lucien, un philosophe naturaliste et libre penseur par excellence . . .". Similarly Stückelberger, *Vestigia Democritea*, p. 158 claims that the "mystical strain" of the *Ph. et M.* is "dem Rationalismus Demokrits völlig fremd".