

Greek Alchemists at Work: 'Alchemical Laboratory' in the Greco-Roman Egypt

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Abstract

The paper focuses on the alchemical laboratory of ancient Greco-Egyptian alchemists, by taking into account especially the earliest alchemical texts (both in the Greek and in the Syriac tradition), ascribed to Pseudo-Democritus, Maria the Jewish and Zosimus. The first part analyzes the possible relationships between the workshops of Egyptian craftsmen (first of all, dyers, metals workers and glass workers) and the activity of the alchemists. The second part gives a general overview on the alchemical instruments described in the *Corpus alchemicum*.

Keywords

alchemy, alembic, ancient craftsmanship, Egypt, furnaces, *kerotakis*, laboratory, still, workshops

1. The Working Space: Workshop and Laboratory

Place where scientific research and development is conducted and analyses performed, in contrast with the field or factory. Most laboratories are characterized by controlled uniformity of conditions (constant temperature, humidity, cleanliness). Modern laboratories use a vast number of instruments and procedures to study, systematize, or quantify the objects of their attention [...].

* I would like to sincerely thank the Von Humboldt Universität and, in particular, Prof. Philip Van der Eijk for the support they are giving to my research on ancient alchemy and medicine. In addition, I am grateful to Dr. Georgia Petridou and Dr. Chiara Thumiger for their very helpful suggestions and remarks.

Thus reads the *Encyclopedia Britannica*,¹ as it gives a general definition of ‘laboratory’ which can be applied to different disciplines and surely – as we shall see below – to chemistry as well. Surely enough a similar formulation is not neutral from an epistemological point of view and must be handled by historians of science with caution in order to avoid anachronism: the meaning of the word ‘laboratory’ changed during the centuries² and such definition represents the most recent step in a long historical process,³ which should not be overlooked. However, with this *caveat* in mind, we can think of the *EB*’s entry as a guide that will assist us, as we draw attention to some problems arising from an historical investigation on the instruments used during the early phases of alchemy in the Greco-Roman Egypt (1st–4th c. CE).⁴

First of all, the laboratory occupies a physical space, in which the expert in the science, which this structure is devoted to, finds all the best conditions, in term of resources and tools, for conducting his experiments. However, only from the nineteenth century on did the laboratory become the privileged and, so to speak, the standard place to carry out a pure scientific investigation based on the experimental method. Its long evolution is usually traced back to the alchemical workspaces, which became more common in the sixteenth century and proliferated in the following century.⁵

¹ “Laboratory,” *Encyclopædia Britannica Online*. Encyclopædia Britannica, 2011. Web. 17 Jun. 2011 (<http://www.britannica.com/EBchecked/topic/326771/laboratory>).

² See Steven Shapin, “The House of Experiment in Seventeenth-Century England,” *Isis*, 1988, 79: 373–404, p. 377; Ursula Klein, “Some Revisions of the Standard View of Early Modern Experimentation,” *Isis*, 2008, 99: 769–782, pp. 770s.; Graeme Gooday, “Placing or Replacing the Laboratory in the History of Science,” *Isis*, 2008, 99: 783–795, with particular emphasis on the last two centuries.

³ The historiography of science at the moment lacks a comprehensive study on the origins and evolution of the laboratory, as has been recently pointed out by Robert E. Kohler, “Focus: Laboratory History,” *Isis*, 2008, 99: 761–768. For a useful overview on Lab History, see Marco Beretta, *Storia materiale della scienza. Dal libro ai laboratori* (Milano: Mondadori, 2002), pp. 286–311.

⁴ The following abbreviations are used in the article: CAAG = Marcelin Berthelot, Charles Émile Ruelle, *Collection des anciens alchimistes grecs*, 3 vols., (Paris: Georges Steinheil, 1887–1888); CMA II = Marcelin Berthelot, Rubens Duval, *L’alchimie au Moyen-Âge*, 3 vols., Vol. 2: *L’alchimie syriaque*, (Paris: Imprimerie Nationale, 1893); LSJ⁹ = Henry George Liddell, Robert Scott, Henry Stuart Jones, *A Greek-English Lexicon* (Oxford: Clarendon Press, 1996⁹); PGM = Karl Preisendanz, *Papyri Graecae Magicae*, 2 vols. (Leipzig und Berlin: Teubner, 1928–1931). The Greek authors are cited according to the LSJ⁹; the papyri are cited according to the *Checklist of editions of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets* (http://scriptorium.lib.duke.edu/papyrus/texts/clist_papyri.html#s).

⁵ See Beretta, *Storia materiale* (cit. note 3), pp. 288–291; Tara Nummendal, *Alchemy and Authority in the Holy Roman Empire* (Chicago: University of Chicago Press, 2007), pp. 119–146. The work of the seventeenth century alchemist George Starkey has been deeply

Pamela H. Smith⁶ pointed out how “by the mid-sixteenth century the laboratory was referred to formally as *officina* and *laboratorium*, and numerous images⁷ that illustrated actual and ideal laboratories were published both in technical treatises [...] and in works of spiritual alchemy.” The medieval word *laboratorium*, not attested in classical Latin,⁸ appears to receive a fresh use to indicate a specific space where alchemists or iatrochemists were at work. For instance, at the beginning of the seventeenth century the alchemist Andreas Libavius gave a detailed description of a ‘chemical house’ or ‘laboratory’ in the annotated second edition of his book *Alchymia*, illustrating it with some interesting pictures (see Fig. 1).

In the first book of his commentary, Libavius introduced a long chapter under the title of *De aedificio et laboratorio Chymico* (8th chapter). Here he described the house of the chemist, which was required to contain an appropriate space in which to place all the necessary instruments for chemical experiments. The beginning of the chapter reads (p. 92):⁹

investigated, on the basis of his laboratory notebooks, by William R. Newman and Lawrence M. Principe, *Alchemy Tried in Fire: Starkey, Boyle, and the Fate of Helmontian Chymistry* (Chicago: University of Chicago Press, 2002) and *George Starkey, Alchemical Laboratory Notebooks and Correspondence* (Chicago: University of Chicago Press, 2004).

⁶ Pamela H. Smith, “Laboratories,” in *The Cambridge History of Science*, 7 vols., Vol. 3: *Early Modern Science*, edited by Katharine Park, Lorraine Daston (Cambridge: Cambridge University Press, 2006), pp. 290–305 (quotation at p. 299).

⁷ For a critical approach on similar representations, see Christopher R. Hill, “The Iconography of the Laboratory,” *Ambix*, 1975, 22: 102–110.

⁸ See Owen Hannaway, “Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe,” *Isis*, 1986, 77: 584–610, pp. 584s. A simple research in the DLD (“Database of Latin Dictionaries,” <http://clt.brepols.net/dld/Default.aspx>) shows that the entry *laboratorium* is present only in few Medieval Latin dictionaries. See, in particular, Albert Blaise, *Lexicon latinitatis mediæ ævi* (Turnhout: Brepols, 1975), which simply reports s.v. *laboratorium* (*laborarium*): “Lieu où l’on travaille, laboratoire;” Charles du Fresne Du Cange, *Glossarium mediæ et infimæ latinitatis* (Niort: L. Favre, 1883–1887), which reads s.v. *laboratorium*: “Ut *Laborarium*. Buschius de Reformatione Monast. apud Leibnizium tom. 2. Scriptor. Brunsvic. pag. 868: *Quomodo in claustris et dormitorio, in ambitu et Laboratorio se habere deberent, declaravi*. Gall. *Laboratoire*;” Du Cange explains in the same page (t. 5, col. 5a), s.v. *laborarium*: “Locus laborantium. Ugutioni: *operatorium, officina, ἐργαστήριον*;” the *Dictionnaire latin-français de Firmin Le Ver*, edited by Brian Merrilees and William Edwards (Turnhout: Brepols 1994), has s.v. *laboro*, 7. *Laboratorium*: “Locus laborantium, *ouvroir*;” in a similar way, the *Dictionarius familiaris et compendiosus* by Guillaume le Talleur, edited by Brian Merrilees and William Edwards (Turnhout: Brepols, 2002), reads s.v. *laboro*, 7. *Laboratorium*: “*Ouvreur. i. locus in quo laboratur*.”

⁹ The *Commentarium alchymiae Andreae Libavii Med. D. Pars prima, sex libris declarata* follows the second edition of the work *Alchymia* (Frankfurt: J. Saurius, 1606); after a general introduction (pp. 1–70), we have the first part of the commentary entitled *Commentarium in librum primum Alchymiae partis 1 lib. 1*. The eight chapter runs from p. 92 to 99. The quoted English translation is by Hannaway, *Laboratory Design* (cit. note 8), p. 599.

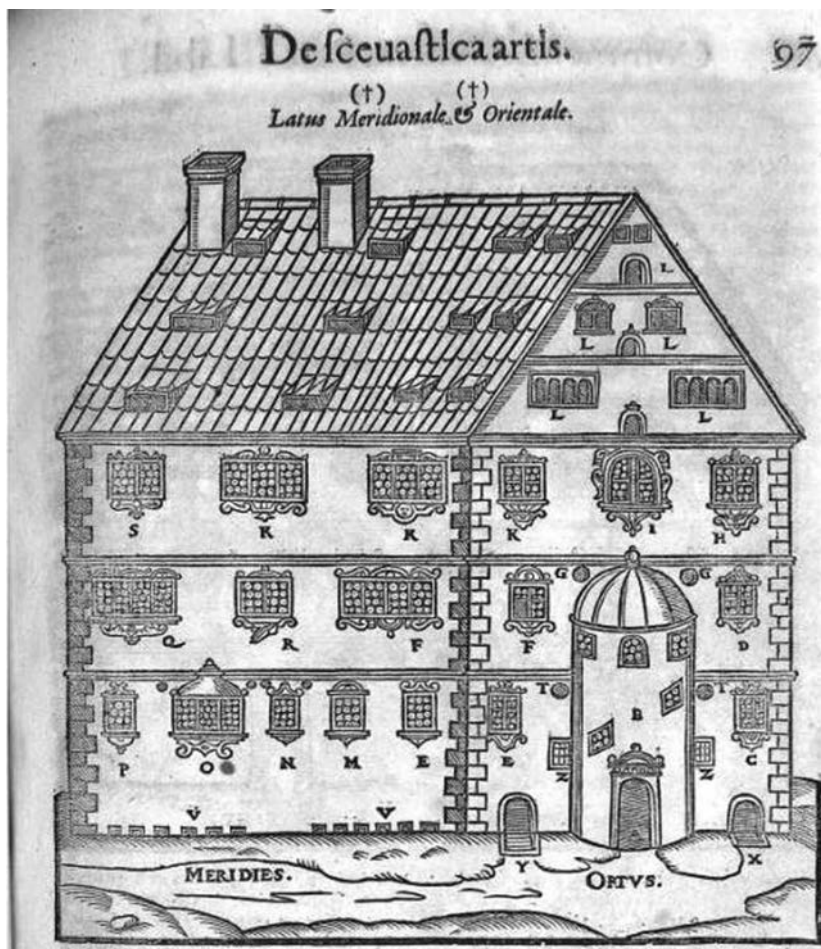


Figure 1. Chemical house from Libavius' commentary on *Alchymia* (1606).

We do not want the chemist to neglect the exercises of piety or exempt himself from other duties of an upright life, simply pining away amidst his dark furnaces. Rather we want him to cultivate *humanitas* in a civil society and to bring luster to his profession by an upright household [...]. Thus we are not going to devise from him just a *chymeion* or laboratory (*Itaque non χυμείον seu laboratorium ei affingimus*) to use as a private study and hideaway in order that his practice will be more distinguished than anyone else's; but rather, what we shall provide for him is a dwelling suitable for decorous participation in society and living the life of a free man, together with all the appurtenances necessary for such an existence.

In Libavius' polemical account against the laboratory of Tycho Brahe,¹⁰ which was located in the basement of his castle-observatory and situated in the isolated island of Hven, the use of the Greek word *χυμείον* as a synonym for *laboratorium* (denoting the place where the alchemist was supposed to conduct his activity) is remarkable. This form clearly reminds of the Greek *χυμεία* or *χημεία*, the term by which both Greco-Egyptian and Byzantine alchemists sometimes called their 'art'/τέχνη. Libavius surely knew these words, which had already been recognized by humanists¹¹ as the origin of the medieval forms *alchemia*, *alchymia*, or *alchimia*. These represented the first attempts to transliterate the Arabic *al-kīmiya*.¹² However, although the form *χυμείον* is surely linked to the newly discovered Greek term *χυμεία*, it represents most probably a sort of artificially created word, since such form is never attested either in the Greek alchemical texts or in Byzantine literature. The introduction of such a neologism is particularly interesting, since Libavius seems to try in this way to fill a gap in the ancient Greek language, which did not have any specific word to indicate an alchemical workshop or 'laboratory'.

The new word makes sense from a purely linguistic point of view; in fact, in ancient Greek sources the workshops of several craftsmen were sometimes indicated by different nouns ending in -εῖον, which could derive both from the names of the treated substances and from those of the craftsmen's activities; some cases are listed in Table 1:

On the other hand, a more common word that was employed to indicate different kinds of workshops is ἐργαστήριον (or its diminutive ἐργαστηρίδιον), which has the same etymology as the Latin *laboratorium*: both, in fact, are linked to the notion of 'work' (ἔργον, *labor*) and may be referred to the activities of several craftsmen. Ἐργαστήριον may indicate (LSJ⁹ 682), for instance, a butcher's shop (Ar. *Eq.* 744; D.H. XI 37,5), a perfumer's shop

¹⁰ See Hannaway, *Laboratory Design* (cit. note 8), pp. 599s. and Nummendal, *Alchemy and Authority* (cit. note 5), p. 120.

¹¹ See Alan J. Rocke, "Agriculture, Paracelsus and *Chymia*," *Ambix*, 1985, 32: 38–45. Humanists appear to have discovered the Greek word *χημεία* by reading and interpreting especially two entries of the Byzantine Lexicon *Suda* (δ 250 Adler, s.v. δέρας and χ 280 Adler, s.v. χημεία): see Sylvain Matton, "L'influence de l'humanisme sur la tradition alchimique," *Micrologus*, 1995, 3: 279–345, pp. 312–316.

¹² Libavius, in fact, considered the term *chemia* – to be related, in his opinion, to the preparation of chemical substances – as the second part of the word *alchemia*: see William R. Newmann, Lawrence M. Principe, "Alchemy vs. Chemistry: the Etymological Origins of a Historiographic Mistake," *Early Science and Medicine*, 1998, 3: 32–65, p. 44.

Table 1. Workshops' names

Greek name	Activity or substance	Translation
ἀργυροκοπεῖον	from ἀργυρόκοπος, 'coiner or silversmith'	'silversmith's workshop, mint' (LSJ ⁹ 236) ¹³
βαφεῖον	from βαφεύς, 'dyer' and βαφή, 'dye'	'dyer's house or workshop' (LSJ ⁹ 311) ¹⁴
βυσσοφαντεῖον	from βύσσος, 'flax' ¹⁵	'workshop for weaving linen' (LSJ ⁹ 334) ¹⁶
δορυξεῖον	from δορυξός, 'spears maker'	'workshop where spear-shafts are made' (LSJ ⁹ 446) ¹⁷
κεραμεῖον	from κεραμεύς, 'potter' and κέραμος, 'potter's clay'	'potter's workshop' (LSJ ⁹ 940) ¹⁸

¹³ Harp. 56,5 Dindorf (see also Ps.-Zonar. α 306,15 Tittmann; Phot. α 2790 Theodoritis; *Suid.* α 3796 Adler) ἀργυροκοπεῖον Ἀντιφών ἐν τῷ πρὸς Νικοκλέα ὅπου κόπτεται τὸ νόμισμα. ὁ νῦν σημαντήριόν τινες καλοῦσιν, "*argyrokopeion*: Antiphon (fr. 36 Thalheim-Blass) in his speech against Nicocles; where coinages are struck; now someone call it *sēmantērion*." The meaning of 'silversmiths' workshop' is attested, for instance, in Plb. XXVI 1,2 (see note 24) and in various *Orations* by Libanius (XXV 22,2; XXVI 8,36; XXXI 12,2). See also *P.Mich.* XVIII 773, where a silversmith complained that a silver lump and a necklace had been taken away from his workshop (see ll. 7–9 εὐρών με ὁ Πτολεμαῖος ἐν τῷ ἀργυροπίῳ ἐν Κροκοδίλων πόλει κατέστησέ με ἐπὶ τὴν τράπεζαν καὶ παρέδωκεν Μενελάῳ, "Ptolemaios found me in the silversmith's shop in Krokodilopolis, took me to the bank, and handed me over to Menelaos").

¹⁴ Strabo in his *Geography* emphasized the importance of the purple in the Phoenician city of Tyros (XVI 2,23): ἡτύχησε δὲ καὶ ὑπ' Ἀλεξάνδρου πολιορκία ληφθεῖσα· ἀλλὰ τῶν τοιούτων συμφορῶν κατέστη κρείττων καὶ ἀνέλαβεν αὐτὴν τῇ τε ναυτιλίᾳ [...] καὶ τοῖς πορφυρεῖσις. [...] καὶ δυσδιάγωνον μὲν ποιεῖ τὴν πόλιν ἢ πολυπληθία βαφείων, πλουσίαν δὲ διὰ τὴν τοιαύτην ἀνδρείαν, "(*scil.* Tyros) could not resist to the Alexander's siege. But it rose above such misfortunes and recovered itself by means of the art of navigation [...] and of its dye-houses. [...] Even if the great number of dye-workshops makes the city unpleasant to live in, they guarantee the wealth of the city because of such ability (in dyeing)." On the basis of the Greco-Egyptian papyri, we can infer that the βαφεῖον was sometimes located in the house of the dyer (in the ground floor, *P.Oslo* III 138, 4th c. CE, from Oxyrhynchos); in the same building the dyes were sold as well (*P.Mich.* VIII 500, 2nd c. CE).

¹⁵ The word *βυσσοφαντής (from βύσσος and ὑφαίνω, 'to weave') is never attested.

¹⁶ Attested by an Egyptian papyrus from Krokodilopolis, *SB* XVIII 13312 (see note 20).

¹⁷ See Hsch. δ 2236 Latte δορυξεῖον ὅπου τὰ δόρατα ξύεται, "*doryxeion*: where the spears are made."

¹⁸ Aesch. III 119; Hsch. κ 2263 Latte κεραμεῖα ἔνθα τὰ ὀστράκινα σκεύη πιπράσκειται, "*kerameia*: where the earthen vessels are sold."

Table 1. (Cont.)

Greek name	Activity or substance	Translation
λινυφαντεῖον	from *λινουφαντής (written λινοφαντής in the papyri), ¹⁹ 'linen weaver'	'workshop for weaving flax' (LSJ ⁹ 1052) ²⁰
λινύφειον (or λινούφιον)	from λινούφης or λινόυφος (written λινυφής/λίνυφος as well), 'linen weaver'	<i>idem</i>
πορφυρεῖον	from πορφύρα, 'purple' ²¹	'dye-house for purple' (LSJ ⁹ 1145) ²²
ύελουργεῖον	from ύελουργός (or ύαλ-), 'glass-worker'	'glass-house' (LSJ ⁹ 1840) ²³
χρυσοχοεῖον	from χρυσόχοος, 'goldsmith'	'the shop or the workshop of the χρυσόχοος' (LSJ ⁹ 2011) ²⁴

(D. XXV 52,6; Hyp. *Ath.* 6) and a barber's shop (Plu. *De soll. animal.* 973B 10). Furthermore, it is sometimes referred to the sculptor's workshop (Aesop. XXVII 1.1; Str. V 15,1; S.E. *M.* IX 197,4 and X 208,3) or to a general shop, which

¹⁹ See UPZ I 18 (2nd c. BCE).

²⁰ See BGU I 122 (147 CE): ἐπ'ἀμφόδου λινυνφ[εῖων] (see also BGU I 110 and 324; VII 1642; XIV 2456; XV 2471 etc.); SB XVIII 13312 (224–218 BCE), ll. 3–4: ὑπάρχοντος ἡμῖν λινυφαντεῖου [καὶ βυσσοφαντεῖου ἐν τῇ προ]γεγραμμένῃ πόλει, ἃ πεπόνηκεν, ἃ βουλόμεθα καθελόντες ἰδρύσασθαι νέα λινυφαντεῖα δύο κτλ.; *P. Tebt.* I 15 (118 BCE), l. 237 τὸν αὐτὸν δὲ τρόπον μηδὲ λινυφαντεῖα μηδὲ τῶν λινύφων καὶ βυσσοουργῶν καὶ ἐριουφαντ[ῶν] κτλ. (the same decree of Euergetes II has been partially copied also in *PSI* XIV 1401).

²¹ The word πορφυρεῖς usually does not indicate the 'dyer', but the 'fisher for purple fish' (LSJ⁹ 1451).

²² Str. XVI 2,23 (see note 14).

²³ See Dsc. V 161 ἀσβόλη, ἣ οἱ ζωγράφοι χρῶνται, λαμβάνεται μὲν ἐκ τῶν ύελουργείων, "The soot that painters use is taken from glass-making factories" [transl. by Lily Y. Beck, *Pedanius Dioscorides of Anazarbus, De materia medica* (Hildesheim, Zürich, New-York: Olms - Weidmann: 2005), p. 400].

²⁴ The word is already attested by Demosthenes in the 21st speech *Against Midias* (sect. 22,1s.): Παμμένης Παμμένους Ἐρχιεὺς ἔχω χρυσοχοεῖον ἐν τῇ ἀγορᾷ, ἐν ᾧ καταγίγνομαι καὶ ἐργάζομαι τὴν χρυσοχοϊκὴν τέχνην, "I, Pammenes, son of Pammenes, of Erchia, have a workshop in the agora, where I live and practice the goldsmith's art;" see also Plb. XXVI 1,2 μάλιστα δὲ πρὸς τοῖς ἀργυροκοπέοις εὕρισκετο καὶ χρυσοχοεῖοις, εὐρησιλογῶν καὶ φιλοτεχνῶν πρὸς τοὺς τορευτὰς καὶ τοὺς ἄλλους τεχνίτας, "He was found especially in the silversmiths' and goldsmiths' workshops, where he invented ingenious arguments and discussed both with those who work on relief and with the other experts;" SB XIV 11974 (187 CE); *P.Lund.* V 14 (3rd c. CE).

is often not specified by our sources: for instance, Strabo (XVII 1.15) mentions some ἐργαστήρια in Alexandria, in which papyrus leaves were used (and maybe sold) like vessels for drinking. Finally, a consistent part of the occurrences in the literary sources deals with metallurgical activities, which were related both to the fabrication of weapons and to the work of mine products: Galen (*De simpl. med. temp.* XII 230,1–5 K.) quotes a town called Ἐργαστήρια between Pergamon and Cyzicus where μολύβδαινα was extracted; Plutarch mentions the spear- and sword-makers' ἐργαστήρια (*Pel.* 12,1) and recalls the shops of luxury metallic items, such as gilded armours and silvered shields (*Phil.* 9.9).²⁵ Lastly, the *Allegoriae homericae* employ the same word in association with the holy workshop of Hephaestus, where the God was believed to manipulate the sacred φύσις.²⁶

A more complete picture is given by the papyri, where both ἐργαστηρίδιον and ἐργαστήριον are often connected with several craftsmen, some of whom have been already listed in the previous table: in fact, several places which were specialized in the production of different handcrafts are mentioned by papyrological documents, as one may infer from the examples in the following table:

Table 2. Specific ἐργαστήρια

brewery	<i>P.Col.</i> III 34 (254 BCE), <i>recto</i> , ll. 7s.: εἰς τ[ὸ ἐργαστήριον τοῦ] ζυτοπ[οιοῦ]; <i>P.Cair. Zen.</i> II 59199 (254 BCE)
carpenter's workshop	<i>BGU</i> IV 1151 (13 BCE), f. 2 ^v , l. 40: ἐργαστη(ρίων) ξυλοπωλ(ίων); <i>BGU</i> IV 1053 (13 BCE), f. 1, l. 49: ἐργαστηρίου ξυλοποιού
coppersmith's workshop	<i>P.Oxy.</i> VI 989 (3 th /4 th c. CE); ²⁷ <i>P.Berl. Bork.</i> (4 th c. CE), f. 4, l. 133: [ἐργαστή]ριον Πβήχιος χαλκορύπου
dyer's workshop	<i>P.Oxy.</i> XIV 1648 (2 nd c. CE), f. 3, l. 61: βαφικά ἐργαστήρια; <i>CPR</i> XIV 10 (6 th c. CE), ἐργαστηρ(ίου) βαφ(ευτικού). See table 1, s.v. βαφεῖον

²⁵ See, for instance, also Aesop. LIX 1,1 (εἰς χαλκῆως ἐργαστήριον = LIX 3,1) and XCV 1,1 (εἰς χαλκούργου ἐργαστήριον); D. XXVII 9,5 (workshops where spear-makers were at work; see XXVII 31,3–5 as well); D.H. IX 60,5 (τὰ τ' ἐργαστήρια <πλήρη ὀρών> ἅπαντα πολεμικῶν ὄπλων) etc.

²⁶ Heraclit. *All.* 51,5 Τὸ μὲν οὖν ἐν οὐρανῷ σεμνὸν ἐργαστήριον Ἡφαίστου τὴν ἱερὰν φύσιν οὕτως ἐδημιούργησεν, "So the holy workshop of Hephaestus in the heaven worked in this way the sacred nature."

²⁷ The papyrus mentions the workshops of different χαλκεῖς, 'coppersmiths' or simply 'blacksmiths, workers in metal' (LSJ⁹ 1973).

Table 2. (Cont.)

goldsmith's workshop	<i>BGU</i> IV 1127 (18 BCE), ll. 9s.: ἐργαστηρίδιον χρυσοχοῦν; <i>P.Sijp.</i> 16 (155 CE). ²⁸ See table 1, s.v. χρυσοχοεῖον
greengrocer's shop	<i>P.Oxy.</i> XII 1461 (222 CE), ll. 5s.: ἐργαστήριον λαχανοπωλ(ικόν)
pickle-seller's shop	<i>P.Ross. Georg.</i> III 38 (6 th c. CE), l. 11: ἐργαστήριον σαλγαμαρικόν
potter's workshop	<i>P.Flor.</i> I 50 (269 CE), f. 3, l. 68: κεραμικόν ἐργαστήριον. See table 1, s.v. κεραμεῖον
weaver's workshop	<i>P.Mich.</i> XI 620 (239/40 CE), f. 1 ^r , l. 10: ἐργαστήριον γερδια[χόν]; <i>P.Neph.</i> 48 (4 th c. CE), l. 11: μικρόν λινυφικόν ἐργαστήριον. ²⁹ See table 1, s.vv. λινυφαντεῖον and λινύφειον.
workshop where to full wool	<i>P.Bon.</i> (135 CE), for instance 24a8s.: ἐργαστήριον ἐρ[ιορ]αβδισ[τικ]όν

Finally, the Greek magical papyri hand down different spells or rituals to guarantee profitable activity to unspecified workshops,³⁰ which evoke in some way the astrological treatises in which the authors indicate the right astral junction for opening an ἐργαστήριον. For instance, Hephaestion of Thebes (4th/5th c. CE) specifies:

When to open workshops. It is better to open workshops, to collect livelihood and what concerns the weights and the measures, when the moon is in Libra, in the second place when it is in Cancer, in the third place in Aries etc. (*Apotelesmatica*, p. 89, ll. 4–9 Pingree).³¹

²⁸ In the papyrus the workshop of the goldsmith Νεῖλος is mentioned.

²⁹ In this case the workshop belonged to a linen weaver.

³⁰ See *PGM* IV 2359–72; VIII 54–64: “Take a piece of olive wood and make a small dog-faced baboon sitting down, wearing the winged helmet of Hermes and a box of its back, and inscribe the name of Hermes on the papyrus and put it in the box. Write in myrrh ink, praying for what you do or what you wish, and after putting a lid on, burn incense and place it where you wish in the middle of the workshop. And the name to be written is: PHTHORON PHTHIONĒ [...] give to the workshop business, favor, prosperity, elegance, both to NN himself and to his workshop, immediately, immediately; quickly, quickly” [Transl. by Hans Bieter Dietz, *The Greek Magical Papyri in Translation, Including the Demotic Spells* (Chicago & London: Chicago University Press, 1986), p. 146].

³¹ The Greek text reads: Πότε ἐργαστήρια ἀνοίγειν. Ἐργαστήρια δὲ ἀνοίγειν καὶ βίον συλλέγειν καὶ ὅσα σταθμοῖς καὶ μέτροις χρῆται ἄμεινον ἐν Ζυγῷ οὐσης τῆς Σελήνης, κατὰ τὴν τάξιν δευτέραν ἐν Καρκίνῳ, κατὰ τὴν τρίτην ἐν Κρίῳ κτλ.

In one case only do the magical papyri describe the production of an ink that was made inside an ἐργαστήριον, which perhaps was expected to be protected by means of the following ritual:

*Himerios*³² recipes. *Drawing made with Typhonian ink*: a fiery red poppy, juice from an artichoke, seed of the Egyptian acacia, red Typhon's ocher, asbestos, quicklime, wormwood with a single stem, gum, rainwater. *To do well at the workshop*: On the egg of a male bird write and then bury the egg near the threshold where you live. 'CHPHYRIS egg, which is CHORBAI SANACHARSŌ AMOUN etc.' (PGM XII 96–101).³³

The bulk of data that have been listed so far seems to suggest a complex picture of the activities of the ancient craftsmen, who clearly did their own work in particular workshops equipped with a specific set of instruments. However, the general word ἐργαστήριον did not have any connection to a specific 'art', but it could indicate at the same time a workshop where different kinds of items were produced and the shop where to sell such hand-crafts. The chemical or alchemical nuance, which became specific to the Latin word *laboratorium* from the fifteenth-sixteenth century on, is entirely missing during the first centuries CE, when Greek alchemy moved its first steps. Furthermore, none of the names of workshops quoted above is ever mentioned either by the *Corpus alchemicum graecum* handed down by the Byzantine tradition or by the so-called (al)chemical papyri of Leyden and Stockholm:³⁴ both never offer any instance even for the more general ἐργαστήριον to indicate the place where alchemists were at work.

Such lack is remarkable, especially if we consider some similarities between the activities which were supposed to be carried out in the workshops we mentioned and the different arts which the earliest extant alchemical works appear to have been interested to. In particular, the four books ascribed to Pseudo-Democritus were dealing with different kinds of dyeing techniques which were related to different methods for dyeing wool

³² Perhaps to be identified with the 4th century philosopher: see Betz, *Greek Magical Papyri* (cit. note 30), p. 156, n. 24.

³³ Transl. by Betz, *Greek Magical papyri* (cit. note 30), p. 156. The Greek text reads: Τ]ὰ παρὰ Ἡμερίου· Τυφωνίου μέλανος γραφή· ἀνε[μώ]νης, φλογίτιδος, χυλοῦ κινάρας, σπέρματος ἀκάν[θη]ς Αἰγυπτίας, μίλ[τ]ου Τυφῶνος, ἀσβέστου, κονίας, ἀρτεμ[ισ]ίας μονοκλῶνου, κόμewς, ὀμβρίου. Ἐργαστήριον εὖ πράσσειν· ἐπὶ ᾧ οὐ ὄρνιθος ἀρσενικοῦ ἐπίγραφει καὶ κατόρυξον πρὸς οὐδὸν, δ[που] εἴ, τὸ ὥν· χφυρις, ὥν, ὃ εστιν χορβαί σαναχαρσω Ἀμοῦν κτλ.

³⁴ Just in one case (Com. Alch. CAAG II 290,93 Ἰδοῦ ἐξ ἐνὸς μαργαρίτου καὶ ἐνὸς ἄλλου, ἔχεις, ὦ Κλεοπάτρα, πᾶν βαφεῖον) one may find the term βαφεῖον, which, however, does not have the usual meaning of 'dyer's workshop'. Berthelot translated (CAAG III 279): "Voici que d'une seule perle et d'une autre (encore), tu tires, ô Cléopâtre, toute la teinture."

purple, manipulating metals and counterfeiting precious stones³⁵. Similar topics are also covered by the papyri of Leyden and Stockholm and are very likely to have been important subjects of discussion for different alchemical authors, who are usually dated back to the 1st–2nd century CE. Maria the Jewish and Pseudo-Democritus are quoted by an anonymous recipe-book in connection to a process of mordanting wool;³⁶ another recipe in the same collection specifies that Maria and Ostanès employed different dyes to make emeralds (or a green precious stone), sapphires (or a blue precious stone) and rubies (or a red precious stone).³⁷ A work attributed to the alchemist Pebichius, which is survived only in Syriac translation,³⁸ describes an alchemical book by Ostanès as dealing with every field of knowledge, and in particular with the making of gold, the precious stones, purples and the divine dyes of glass.

In addition, Zosimus attacks the alchemists who believed in astrological influence operating on the dyeing processes and dismissed the study of the books of ancient authors, who explained the correct procedures to follow in order to reach good results.³⁹ Despite the general context of similar claims, it is possible at least to highlight a similarity with the astrological and magical texts, which specifies the more propitious time for opening a workshop and the rituals to perform in order to have a good business.⁴⁰

³⁵ The most complete and ancient source on the Pseudo-Democritus books is Synesius, CAAG II 57.11–13: 'Εκ τούτου λαβὼν ἀφορμὰς, συνεγράψατο βιβλους τέσσαρας βαφικὰς, περὶ χρυσοῦ καὶ ἀργύρου καὶ λίθων καὶ πορφύρας, "(scil. Democritus) got from him (i.e. the Persian magus Ostanès) the bases (of the alchemical processes) and wrote four books on dyeing, on gold and silver and precious stones and purple" (see also Syncell. p. 297, ll. 24–28 Mosshammer). Just an epitomized version of these books, including a small section on purple and two larger sections on the making of gold and silver, has been preserved by Byzantine manuscripts under the title of "Natural and secret questions" (*Φυσικὰ καὶ μυστικά*, which combine the part on purple and the part on the making of gold; see CAAG II 41–49) and "On the making of silver" (*Περὶ ἀσήμου ποιήσεως*, see CAAG II 49–53).

³⁶ CAAG II 354–355.

³⁷ CAAG II 351–352.

³⁸ The Syriac text (preserved by the Cambridge manuscript Mm. 6.29, f. 13) is still unpublished; a partial French translation is available in CMA II 310.

³⁹ Zos. Alch. I 12–13 and 160–70 Mertens. The issue of the *καριναὶ βαφαί* (or *καταβαφαί*), namely the dyeing processes which were supposed to be dependent on the astrological influences, is discussed by Zosimus, especially in the second section of his book *Πρώτων βιβλίων τῆς τελευταίας ἀποχῆς* [CAAG II 239–246 = André-Jean Festugière, *La révélation d'Hermès Trismégiste*, 3 vols., Vol. 1: *L'astrologie et les sciences occultes* (Paris: Les Belles Lettres, 1944), app. 2, pp. 363–368, with French translation and commentary at pp. 275–282].

⁴⁰ See, for instance, Michèle Mertens, *Zosime de Panopolis, Mémoires authentiques. Les alchimistes grecs* IV/1 (Paris: Les Belles Lettres, 1995), p. 62, n. 9.

Nonetheless, similar overlaps between alchemy and craftsmanship are far from evident, especially if we focus on the possible relationships, or even identifications, between the alchemists and the experts in some of the above mentioned arts. Alchemical texts often mention the τεχνίται,⁴¹ with particular attention to the βαφείς,⁴² the χρυσόχοι⁴³ and the χαλκείς⁴⁴ or χαλκουργοί,⁴⁵ and refer to different tools or ingredients⁴⁶ which were considered as peculiar to particular arts: especially the recipes, which describe a wide range of manipulations related to dyeing processes and to

⁴¹ The Leiden and Stockholm papyri recipes often claim that the results of the processes for imitating silver are so good than they can deceive even the τεχνίται ('experts'): see *P.Leid.X.* 8, 6s. ἔσται πρῶτον ἄσημον, ὥστε καὶ τοὺς τεχνίτας λαθεῖν (= *P.Leid.X.* 8g, 7s.), "It will be as good of the first quality, which will deceive even the artisans" (transl. by Earle Radcliffe Caley, "The Leyden Papyrus X. An English Translation with Brief Notes," *Journal of Chemical Education*, 1926, 3: 1149–66, p. 1152); *P.Holm.* 3, 4s. καὶ γίνεται ἄργυρος ὁ πρῶτος, ὡς καὶ τοὺς τεχνίτας λανθάνειν (= *P.Holm.* 48,4), "It becomes silver of the first quality, which deceives even the artisans." Pseudo-Democritus in the sixth recipe of the section "On the making of silver" (CAAG II 52,9–19) – where he describes how to prepare a dyeing solution in which to deep a metallic leaf – specifies (l. 11): κατεργάζου λοιπὸν ὡς τεχνίτης, "Carry out the rest like a craftsman." A recipe for counterfeiting pearls (CAAG II 369,18–27), based on the cooking of a white pastry put inside of an onion, reads (ll. 22–24): Τὸν βόλβον βάλλον εἰς φούρνον ἕως ὅπτηθῇ τὸ στέατον· καὶ ἄρας, καὶ ψύξας, εὐρήσεις λευκανθέντα. Λοιπὸν σὺ καθάρων στίλβον ὡς ἐπινοεῖς, ὡς τεχνίτης τὰ οἰκεῖα ποιῶν, "Put the onion in the oven until the pastry is cooked; take it out, dry it and you will find it to become white. Then make it glitter by cleaning it as you know, in the same way the craftsman does his own work."

⁴² See, for instance, *P.Holm.* 106,4ss. Λαβὼν τὸν ἄφρον τῆς ἰσάτεως παρὰ τῶν βαφέων [...] διάτριψον ἐπὶ τῆς θύιας [...]. Εἴτα λαβὼν τὸ ἄνθος τὸ ἀπὸ τῶν βαφέων, "Take scum of woad from the dyer [...] and triturate it in the mortar [...]. Then take the brilliant color prepared by the dyer etc." (transl. by Earle Radcliffe Caley, "The Stockholm Papyrus. An English Translation with Brief Notes," *Journal of Chemical Education*, 1927, 4: 979–1002, p. 993); Zos. Alch. CAAG II 154,18s. ὕδωρ θεῖον αἰνίσσονται· ἀλλὰ καὶ ὁ κρόκος καθ' ἑαυτὸν ἀδύναμει, εἰ μὴ διὰ τοῦ σκεύους τοῦ θεοῦ ὕδατος· καὶ οἱ βαφεῖς οὕτω χρῶνται, "They speak darkly about the divine water; but the saffron does not work by itself, without the instrument (?) of the divine water; and dyers employ it in this way." See also *P.Oxy.* III 467 = Robert Halleux, *Papyrus de Leyde, papyrus de Stockholm, recettes, Les alchimistes grecs I* (Paris: Les Belles Lettres, 1981), p. 156, l. 6s.: στυπτηρίαν ἣν οἱ βαφεῖς χρῶνται).

⁴³ Moyses Alch. CAAG II 309,17 ἀμμωνιακοῦ Κανώπης ἣν χρῶνται οἱ χρυσοχοὶ μέρος α', "one part of the Ammon salt from Canope (?) which is used by goldsmiths."

⁴⁴ *P.Holm.* 9,2 Ἀγόρασον ἄνθρακας, οἷς οἱ χαλκείς χρῶνται, "Buy charcoal which the smiths use" (transl. by Caley, "The Stockholm Papyrus" (cit. note 42), p. 982).

⁴⁵ Moyses Alch. CAAG II 304,8–10 καθμίαν λευκὴν [...] ἣν χρῶνται οἱ χαλκουργοί, "white cadmia [...] which the smiths use."

⁴⁶ See, for instance, *P.Leid.X.* 32,1–2 and 42,2 (κόλλα χρυσοχοῦχα, 'solder for goldsmiths'); *P.Leid.X.* 19,5–9 and *P.Holm.* 1,3 (ἄξος βαφικόν, 'dyer's vinegar'); *P.Holm.* 89,3 (στυπτηρία βαφικὴ, 'dyer's alumn').

the making both of metallic alloys and of fake precious stones, refer to the use of different specific devices:

1. *P.Leid.X.* 68,2s. describes the preparation of a gilded ink based on a certain amount of gold which had been melted in a goldsmiths' melting-pot (χῶνον χρυσοχοϊκόν).
2. A recipe included into a collection ascribed to Moses (*CAAG* II 305,7-14) explains how to make a gilded alloy by mixing liquid substances and minerals: all the ingredients are mingled and melted in a goldsmiths' furnace (κάμινος χρυσοχοϊκή).
3. Two further recipes of the same collection instruct to use a furnace for making glass (κάμινος ὑελουργική) in order both to process the θείον (litt. 'sulphur'), which was supposed to become black (*CAAG* II 307,20-26), and to make the μαγνησία white (*CAAG* II 308,6-10). In addition, two recipes that have been preserved by the London Syriac manuscripts⁴⁷ prescribe to process the *misy* [*CMA* II 57,2-6 (Syriac text) and 102,1-7 (French translation)] and the copper [*CMA* II 58, 14-21 (Syriac text) and 104,7-18 (French translation)] in a similar furnace [ܩܡܝܢܐ ܕܕܝܪܐܝܐ, *qamyna* (= κάμινος) *dzgwggya*, 'glass-blower's furnace'].⁴⁸
4. A recipe handed down in the London Syriac manuscripts [*CMA* II 51,16-18 (Syriac text) and 92,23-93,2 (French translation)] explains how to produce a red substance called minium (ܡܝܢܝܐ, *syryqwn*) by mixing white lead with vinegar and cooking it in a potter's furnace (ܩܡܝܢܐ ܕܬܝܢܐ, *'twn qwqya*).⁴⁹
5. *P.Holm.* 2,5 (recipe on the making of silver), *P.Holm.* 16,3 (recipe on the purification of crystal) and another anonymous recipe on the purification of crystal (*CAAG* II 361,23) prescribe to employ the furnace used for warming baths (βαλανεῖον)⁵⁰ in order to accomplish the described operations.

⁴⁷ Namely the manuscripts Egerton 709 (16th c.) and Oriental 1593 (15th-16th c.), which are kept at the British Museum Library: see their description by Rubens Duval in *CMA* II, pp. XLVI-XLVIII.

⁴⁸ See also *CMA* II 256, 24 (10th book of Zosimus) and 261, 12 (12th book of Zosimus).

⁴⁹ This passage is handed down by the Cambridge Syriac manuscript Mm. 6.29 (f. 73^v) among the recipes that belong to the 10th book of Zosimus (see *CMA* II 256, 1-5).

⁵⁰ See Halleux, *Papyrus de Leyde* (cit. note 42), p. 34; in two cases the alchemical recipes (*P.Holm.* 16 and *CAAG* II 361,25) state to employ the χαλκείον/χαλκεῖον ('cauldron, boiler') of these furnaces.

If such passages, on the one hand, show the attention the alchemical authors devoted to craftsmanship, on the other they seem to point out a distinction between the alchemists themselves and the craftsmen of different arts. Halleux,⁵¹ commenting on these references in the Leiden and Stockholm papyri, wrote: “D’autre part, l’auteur prescrit d’utiliser un creuset d’orfèvre, de la paille d’orfèvre, du vinaigre et de l’alun de teinturier et d’aller chercher la mousse de guède chez les teinturiers. Cela signifie qu’il n’est ni orfèvre, ni forgeron, ni teinturier.” On the basis of the previous data, it seems possible to infer that alchemical practice involved a complex and wide set of tools and instruments which were peculiar to different ancient τεχναί. Zosimus, for instance, at the end of his treatise *Πρώτον βιβλίον τῆς τελευταίας ἀποχῆς*, says explicitly:⁵²

These dyes have the property of getting rotten both in a big and in small quantity; that means that they may be obtained by the glass-makers furnaces, by small or big melting-pots, and by any kind of instruments, by means of the fire and according to its intensity. The experience will prove it, when jointed to a completely purified soul (CAAG II 246,17–21).⁵³

The focus on dyeing techniques – which in Zosimus’ opinion could be realized following different ways both by means of raw and cooked substances and by means of liquid and solid ingredients –⁵⁴ brings to mind the four βαφικαὶ βίβλοι ascribed to Democritus and the wide range of different arts which the first alchemists seems to have been concerned with.⁵⁵ If we restrict our analysis to the four fields – namely the purple dyeing, the making of gold and silver by treating base metals or producing particular alloys, and the counterfeiting of precious stones – which feature in the Leiden and Stockholm papyri, Pseudo-Democritus and other ancient alchemists, such as Ostanes and Maria, it seems clear that each of these τέχναι was based on the use of specific tools and ingredients and was related to the activity of specialized craftsmen.⁵⁶ The dyeing of clothes was peculiar to the βαφεῖς

⁵¹ Halleux, *Papyrus de Leyde* (cit. note 42), p. 28.

⁵² See *supra*, note 39.

⁵³ The Greek text reads: “Ἐχουσιν οὖν φύσιν αὐταὶ αἱ βαφαὶ καὶ πολλὰ σήπτεσθαι, καὶ ὀλίγα, τοῦτέστιν γίνεσθαι καὶ ἐν καμνίνοις ὑελοψιχοῖς, καὶ ἐν χωνείαις μεγάλαις καὶ μικραῖς, καὶ ἐν διαφόροις ὀργάνων <διὰ> φώτων, καὶ ἐν ποσότητι αὐτῶν καὶ ἡ πείρα ἀναδείξει, μετὰ καὶ τῶν ψυχικῶν πάντων κατορθωμάτων. Festugière, *La révélation d’Hermès* (cit. note 39), did not reedit this part, but he gave just a French translation of this passage (p. 282).

⁵⁴ See CAAG II 246,1–16 with the commentary by Festugière, *La révélation d’Hermès* (cit. note 39), p. 281.

⁵⁵ See *supra*, pp. 280–281.

⁵⁶ A general inquiry on the Egyptian craftsmen during the Roman period is carried out by Peter van Minnen, “Urban Craftsmen in Roman Egypt,” *Münstersche Beiträge zur antiken*

and the working of metals to different craftsmen, such as the χρυσόχοοι (experts at working gold), the ἀργυροκόποι (experts at working silver), the χαλκείς/χαλκουργοί/χαλκοτύποι (experts at working bronze),⁵⁷ the σιδηρουργοί (experts at working iron). Finally, a particular expertise was surely necessary for producing fake precious stones, which were based on the dyeing of white quartz by means of different minerals substances.⁵⁸ Such procedures, which are clearly linked to the traditional Egyptian skill of producing glazed quartz and manipulating vitreous substances⁵⁹, must be probably related to the activity of glass-workers,⁶⁰ whose furnaces are many times quoted also in the alchemical texts. These activities were well established in Egypt since the ancient times and were often related to the temple activities. The archeological inquiries have discovered different evidences that show the continuity of such craftsmanship until the Hellenistic and Roman period, where it is possible to sketch a more detailed picture on the basis of the larger bulk of preserved documents. For instance, Flinders Petrie discovered the rest of a dyer's workshop in Athribis (see Fig. 2), which very likely dates back to the Roman period and has been described by the scholar as follows:

[...] There are three vats in the bench of the north, and beyond the cistern the blench passes into a vat room, with sixteen vats in the raised bench around the sides. These vats are lined with cement and deeply stained. Most of them are black blue with indigo, and some are red.⁶¹

Handelsgeschichte, 1987, 6: 31–87. The Byzantine period is analyzed by Itskhok Fishelevich Fikhman, *Египет на рубеже двух эпох. Ремесленники и ремесленный труд в IV – середине VII в.* (Moskva, 1965); German summary in I.F. Fikhman, “Grundfragen der handwerklichen Produktion in Ägypten vom 4. bis zur Mitte des 7. Jahrhunderts u.Z.,” *Jahrbuch für Wirtschaftsgeschichte*, 1969, 4: 149–159.

⁵⁷ See, in particular, Fabienne Burkhalter, “La production des objets en métal (or, argent, bronze) en Égypte Hellénistique et Romaine à travers les sources papyrologiques,” in *Commerce et artisanat dans l’Alexandrie hellénistique et romaine (Actes du colloque d’Athènes, 11–12 décembre 1988)*, edited by Jean-Yves Empereur (Athènes: EFA, 1998), pp. 125–133.

⁵⁸ See Halleux, *Papyrus de Leyde* (cit. note 42), p. 28.

⁵⁹ See Eve Dray, Oliver H. Myers, “Glazed Quartz beads of the Romano-Arab Period,” *Journal of Egyptian Archaeology*, 1946, 32: 65–68; Alfred Lucas, John R. Harris, *Ancient Egyptian Materials and Industries*, 4th ed., (London: E. Arnold, 1962), pp. 41–45 and 167s.; Paul T. Nicholson, Edgar Peltenburg, “Egyptian faience,” in *Ancient Egyptian Materials and Technology*, edited by Paul T. Nicholson and Ian Shaw (Cambridge: Cambridge University Press, 2000), pp. 177–194.

⁶⁰ See Marco Beretta, *The Alchemy of Glass. Counterfeit, Imitation and Transmutation in Ancient Glassmaking* (Sagamore Beach: Watson Publishing International, 2009).

⁶¹ William M. Flinders Petrie, *Athribis* (London: BSAE, 1908), p. 11 and pl. XXXIV.

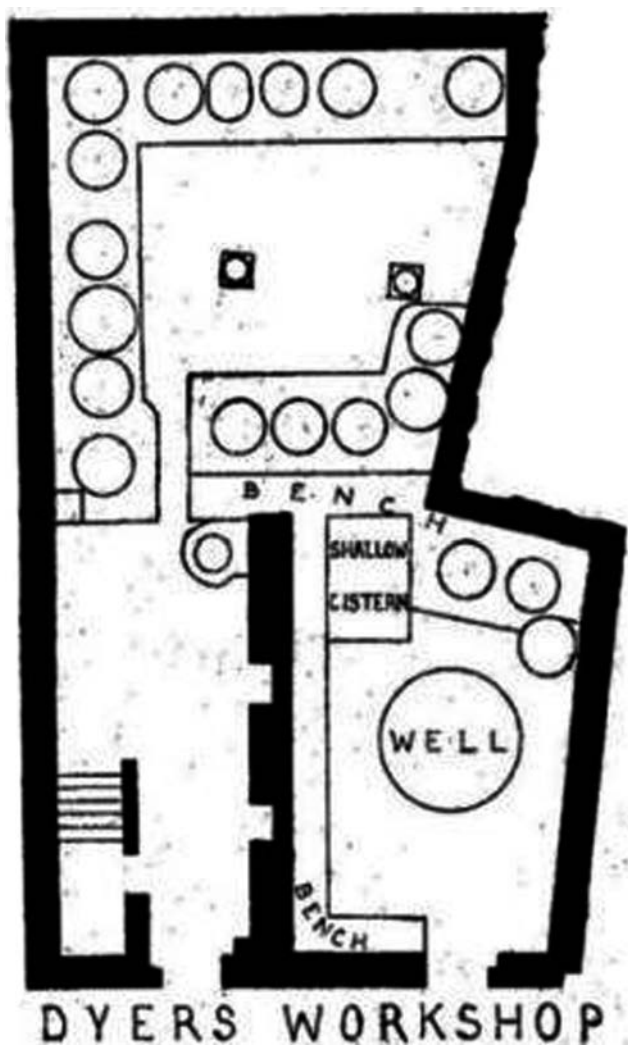


Figure 2. Dyer's workshop from Athribis (Petrie's sketch).

In addition, a papyrus from Oxyrinchus (*P.Oxy* XIV 1648; 2nd c. CE) lists some tools (namely two vessels, a χαλκεῖον μολυβοῦν and a πίθον ὀστράκινον) which belonged to another dyer's workshop that the owner wanted to sell. In the third column of the recto, in fact, the sale contract of this βαφεῖον has been transcribed as follows:

Sarapias and Aunchis, both daughters of Harthonis son of Paapis, and their mother Terathonis daughter of Zoilus son of Sarapion son of Petosorapis have sold the produce and roof and dyeing-workshops constructed jointly, which belong to them in the aforesaid dyeing-place, and the leaden pot and the earthenware cask which they possess there, and further the vacant spaces which they possess on the west of the workshop (*P.Oxy* XIV 1648, col. iii, ll. 56-64).⁶²

The big amount of vats described by Petrie and the vessels quoted by the *Oxyrhynchus papyrus* allow us to have a more clear idea about the tools which were peculiar to the workshop of a dyer, whose activity is well represented also in some Pompeii's frescos.⁶³

Different working spaces, which were equipped with specific tools and instruments, were surely proper also to the other τέχναι we have already mentioned in connection with the earliest alchemical works. Many glass-making workshops have been discovered in Egypt by archeologists: new excavations at Tell el-Amarna – which had been partially investigated by Petrie⁶⁴ – have located furnaces (dating back to the 18th Dynasty) which were surely used to make frit and probably glass as well;⁶⁵ several Roman primary glass workshops have been found in the Wadi Natrum region

⁶² Transl. by Bernard P. Grenfell, *The Oxyrhynchus Papyri* (London: Egypt Exploration Society, 1920), vol. 14, p. 86; the Greek text reads: Σαραπιάς καὶ Αὐγχίς ἀμφοτέραι Ἀρθώνιος Παάπιος καὶ ἡ τούτων μήτηρ Τεραθώνις Ζωίλου Σαραπ(ίωνος) τοῦ Πετωουσοράπιος πεπράκ(ασι) τὰ ὑπάρχ(οντα) αὐταῖς φορτία καὶ δόκωσιν καὶ τὰ συνφοδομημ(ένα) βαφικά ἐργαστήρια ἐν τῷ ἀποδεδ(ειγμένῳ) βαφείῳ καὶ ὃ ἔχουσιν ἐν τούτῳ χαλκεῖον μολυβοῦν καὶ πίθον ὀστράκ(ινον), ἔτι δὲ καὶ οὓς ἔχουσι ἀπὸ λιβδό(ς) τοῦ ἐργαστηρίου ψιλ(οὺς) τόπ(ους).

⁶³ See George A. Faber, "The Roman Dyers," *Ciba Vision (Dyeing and Tanning in Classical Antiquity)*, 1938, 9: 291-295; Robert J. Forbes, *Studies in Ancient Technology*, 2nd ed., 7 vols., Vol. 4: 126-137 (Leiden: E.J. Brill, 1964). On the basis of the archeological evidences found in Pompeii, Heather Hopkins ("Reconstructing the Dyeing Industry in Pompeii through Experimental Archaeology: the Challenges and Rewards of a New Approach") tried to reproduce the Roman dyeing processes by reconstructing the ancient tools and furnaces: the paper, which has been presented at the *First European Textilforum, Openlucht Museum, Eindhoven* (2009), is available at the webpage <http://www.textilforum.org/forum09/h-hopkins2009.pdf>.

⁶⁴ See, for instance, Paul T. Nicholson, "Petrie and the Production of Vitreous Materials," in *L'apport de l'Égypte à l'histoire des techniques. Méthodes, chronologie et comparaisons*, edited by Bernard Mathieu, Dimitri Meeks, Myriam Wissa (Le Caire: IFAO, 2006), pp. 207-216.

⁶⁵ Paul T. Nicholson, Caroline M. Jackson, "Tell el-Amarna and the Glassmakers' Workshop of the Second Millenium BC," in *La route du verre. Ateliers primaires et secondaires du second millénaire av. J.C. au Moyen Âge*, edited by Marie-Domenique Nenna (Lyon: Maison de l'Orient Méditerranéen-Jean Pouilloux, 2000), pp. 11-22.

(between Cairo and Alexandria)⁶⁶ and around the Lake Maryut,⁶⁷ two areas rich of *nitron*, where the making of glass was carried out by means of basin furnaces. In addition, various textual evidences confirm the presence of secondary *ateliers* in numerous Egyptian cities (Alexandria, Thebes, Hermopolis, Oxyrinchus) from the Hellenistic period to the Late Antiquity.⁶⁸ Lastly, workshops for the working of metals are well represented in different hieroglyphic reliefs, the most ancient of which date back to the Old Kingdom. Important examples have been found, for instance, in the Tomb of Mereruka (Saqqara)⁶⁹ and in the tomb of Rekh-Mi-Re (Thebes).⁷⁰

The relationship between similar *ateliers* and the practice of the ancient alchemists, such as Pseudo-Democritus, Ostanos or Maria, is controversial: the presence of dissimilar workshops in Egypt, which most probably fitted the specific needs of different craftsmen, contrasts with the tendency of the earliest alchemical texts to deal with a complex set of dyeing techniques. It is difficult to imagine just one working space where the ‘alchemist’ tried to put in practice all the processes as described, for instance, by the Leiden and Stockholm papyri or by what is still extant from the four Pseudo-Democritean books. Similar practices required different instruments which were at the disposal of the Greco-Egyptian craftsmen, who were usually organized in separated guilds or professional associations:⁷¹ the figure, then,

⁶⁶ Marie-Dominique Nenna, Maurice Picon, Michèle Vichy, “Ateliers primaires et secondaires en Égypte à l’époque gréco-romaine,” in Nenna, *La route de verre* (cit. note 65), pp. 97–102; Marie-Dominique Nenna, “Les artisanats du verre et de la faïence: tradition et renouvellement dans l’Égypte gréco-romaine,” in Mathieu, Meeks, Wissa, *L’apport de l’Égypte à l’histoire des techniques* (cit. note 64), pp. 188–190; Marie-Domenique Nenna, Maurice Picon, Michèle Vichy, Valérie Thirion-Merle, “Ateliers primaires du Wadi Natrum: nouvelles découvertes,” *Annales de l’Association internationale pour l’histoire du verre*, 2005, 16: 56–63.

⁶⁷ Nenna, Picon, Vichy, “Ateliers primaires et secondaires en Égypte” (cit. note 66), pp. 102–104.

⁶⁸ Beretta, *Alchemy of Glass* (cit. note 60), pp. 40–46; Nenna, Picon, Vichy, “Ateliers primaires et secondaires en Égypte” (cit. note 66), pp. 104–112.

⁶⁹ Bernd Scheel, *Egyptian Metalworking and Tools* (Oxford: Shire Publications, 1989), pp. 21–33; Prentice Duell, *The mastaba of Mereruka* (Chicago: University of Chicago Press, 1938).

⁷⁰ Norman De Garis Davies, *The Tomb of Rekh-mi-re at Thebes* (New York: Metropolitan Museum of Art, 1943).

⁷¹ See Minnen, “Urban Craftsmen in Roman Egypt” (cit. note 56), pp. 48–72; for the Byzantine Egypt, see Itskhok Fischelevich Fikhman, “Sur quelques aspects socio-économiques de l’activité des corporations professionnelles de l’Égypte byzantine,” *Zeitschrift für Papyrologie und Epigraphik*, 1994, 103: 19–40. On the organization of such guilds, see Arthur Edward R. Boak, “The organization of Gilds in Greco-Roman Egypt,” *Transactions and*

of the ‘alchemist’, who was supposed to be interested to a wide bulk of τέχνηαι, does not correspond completely to the figure of the simple craftsman, who was in all likelihood specialized in a single art only. On the other hand, Halleux recently highlighted “le contexte à la fois technique et intellectuel” of the recipes collected by the Leiden and Stockholm papyri:⁷² the papyri do not have any sign that may suggest their use inside a workshop and the compiler of such collections appears to have been more interested to copy a book to be kept in a library instead of a recipe-book that was useful for the practice.⁷³ In addition, a more evident interest towards a classification of different dyeing ingredients and techniques is attested by the Pseudo-Democritus’ work: for instance, with regard to the purple dyes, he made a list of substances which have been organized on the basis both of their effects and of their use by ancient experts.⁷⁴ Furthermore, different passages focus on the dyeing power of the nature (φύσις), which seems to reveal itself in all the technical fields the four books dealt with.⁷⁵

A similar intellectual attitude may have been one of the basis that pushed ancient ‘alchemists’ to study and at least partially systematize a technical tradition which had its roots in the work and activities of the Greco-Egyptian τεχνίτες. However, the above mentioned references, in the *Corpus alchemicum*, to specific instruments which were proper to the different craftsmen allow us to believe that alchemists as well made use of similar devices in their practice, maybe by sharing specific tools and even the working spaces with the experts in different fields. Zosimus, sketching a brief history of alchemy in Egypt,⁷⁶ compared the τεχνίται who either

Proceedings of the American Philological Association, 1937, 68: 212–220. Some considerations on the possible relationships between the professional associations and the earliest alchemists have been developed by Jack Lindsay, *The origins of Alchemy in Graeco-Roman Egypt*, (London: Muller, 1970), chap. 10.

⁷² See Halleux, *Papyrus de Leyde* (cit. note 42), p. 30.

⁷³ See Halleux, *Papyrus de Leyde* (cit. note 42), p. 27.

⁷⁴ CAAG II 42,9–20. Pseudo-Democritus wrote similar catalogues also in relation to the ingredients used for the making of gold and silver, as one may infer by comparing some passages of Synesius’ commentary (CAAG II 56–69) with three excerpts that have been included in a recipe-book handed down under the name of Moses (see, in particular, CAAG II 306,15–307,16; Matteo Martelli, “Divine Water in the Alchemical Writings of Pseudo-Democritus”, *Ambix*, 2009, 56: 5–22, pp. 16–18). I will conduct a more detailed analysis of these parts in my forthcoming new critical edition of the Pseudo-Democritus’ alchemical books, which will be published in the collection “Textes at Travaux de Chrysopoeia.”

⁷⁵ See, in particular, CAAG II 46,21–48,3 and 49,10–22.

⁷⁶ In the first part of the *Πρώτων βιβλίον τῆς τελευταίας ἀποχῆς*: see Festugière, *La révélation d’Hermès* (cit. note 39), pp. 363s. (Greek Text) and pp. 275–277 (French translation).

extracted mineral ores or struck coins under the strict control of Egyptian kings with the first alchemists – with particular attention to Democritus – who were not allowed to reveal their secrets, since they “were friend of Egyptian kings and boasted to be among the ‘prophets’ of the first order” (φίλοι ὄντες τῶν βασιλέων Αἰγύπτου καὶ τὰ πρωτεία ἐν προφητικῇ αὐχοῦντες). Even if their mutual relationship and interactions are difficult to specify, it is possible to suppose that the alchemists and the ‘experts’ who worked for Egyptian kings shared in some way a common knowledge and practice. For instance, on the basis of the Byzantine chronicler John of Antioch (7th c. CE)⁷⁷ we know that alchemists were able to produce some kind of wealth – probably connected to the striking of fake coins – since the chronicler tells how the emperor Diocletian (284–305) ordered to burn all the books on the alchemy of gold and silver (περὶ χημείας χρυσοῦ καὶ ἀργύρου) by means of which Egyptian people raised the funds necessary for sustaining their insurrections against Roman control.⁷⁸ Such practical aims (which were probably related to the production of different luxury items as well)⁷⁹ appear to link in some way the craftsmen activities and the alchemical practices: if one imagines an ancient ‘alchemist’ trying to put into practice some of the procedures described in the alchemical recipes, one then cannot rule out that this alchemist had at his disposal the same tools and workshops, which were used by the Greco-Egyptian craftsmen, and which are often quoted by the *Corpus alchemicum* itself.

2. Alchemical Instruments and Procedures

If we go back to the starting definition of ‘laboratory’, the presence of a vast number of instruments “to study, systematize, or quantify the objects” of an inquiry is taken to be a specific feature of the modern space devoted to scientific investigations. Especially with regard to the field of chemistry several studies have focused on the distilling and sublimating devices,⁸⁰

⁷⁷ Fr. 248 Roberto.

⁷⁸ For a general comment on this notice, which is usually considered plausible by scholars, see Halleux, *Papyrus de Leyde* (cit. note 42), pp. 23s. On the possible relationships between alchemy and the striking of coins, see, in particular, Paul T. Keyser, “Greco-Roman Alchemy and Coins of Imitation Silver,” *American Journal of Numismatics*, 1995/96, s.s. 7/8: 209–233.

⁷⁹ See Halleux, *Papyrus de Leyde* (cit. note 42), p. 26.

⁸⁰ See, in particular, Jules Dujardin, *Recherches rétrospectives sur l'art de la distillation. Historique de l'Alcool, de l'Alambic et de l'Alcoométrie*, (Paris: chez l'auteur, 1900), pp. 20–28;

whose first examples have been often traced back to Greco-Egyptian alchemy.⁸¹ Such equipment, in fact, was both described by ancient alchemical authors and illustrated in several pictures that are handed down in Byzantine and Syriac manuscripts. It has been highlighted how these instruments were likely developed from the common tools of more popular and widespread arts, such as cuisine and perfumery.⁸² Greco-Egyptian alchemy, on the other hand, has been usually regarded as one of the first and fundamental steps in the progressive specialization of such technology. One wonders whether the alchemists' attention to a set of specific devices progressively peculiar to alchemical literature may be evidence for the formation of a specific space to accommodate such equipment and to carry out the technical processes as described in the recipe-books or even in more complex treatises.

Especially the works of the earliest authors deserve a particular attention, because they appear to deal with the description and the classification of different instruments. First of all, several alchemical works mention that Maria the Jewish wrote about several kinds of devices. Zosimus – our first source on Maria's treatises, which have been not included into the alchemical anthologies handed down by the Byzantine tradition – explicitly states:

The construction of several instruments has been described by Maria, not only the instruments for the sulphur waters, but also different types of *kerotakis* and furnaces (VII 10-12 Mertens).⁸³

Unfortunately, it is difficult to identify the works in which Maria dealt with these instruments, which seem to be related to various alchemical operations; as Mertens⁸⁴ pointed out, the Jewish alchemist is likely to have

Robert J. Forbes, *A Short History of the Art of Distillation, from the Beginnings up to the Death of Cellier Blumenthal*, (Leiden: Brill, 1948), pp. 13-28; F. Sherwood Taylor, "The evolution of the Still," *Annals of Science*, 1945, 5: 185-202; Mertens, *Zosime de Panopolis* (cit. note 40), pp. cxvi-cxxx; Robert G. W. Anderson, "The Archaeology of Chemistry," in *Instruments and Experimentation in the History of Chemistry*, edited by Frederic L. Holmes, Trevor H. Levere, (Cambridge, London: The MIT Press, 2000), pp. 5-35.

⁸¹ See, for instance, Forbes, *A Short history of the Art of Distillation* (cit. note 80), p. 6: "We must adopt the general opinion that distillation was first discovered by the Alexandrian Chemists in the first century AD until we have further proof."

⁸² Mertens, *Zosime de Panopolis* (cit. note 40), p. cxiii.

⁸³ The Greek text reads: Πολλὰ μὲν οὖν ὀργάνων κατασκευαὶ γεγραμμέναι εἰσὶν τῇ Μαρίας, οὐ μόνον ὑδάτων θείου, ἀλλὰ καὶ κηροτακίδων εἴδη πολλὰ καὶ καμίνων.

⁸⁴ Mertens, *Zosime de Panopolis* (cit. note 40), p. 189, n. 11.

described three kinds of devices: various types of stills, the so called *kerotakis* and, most probably, different furnaces.

With regard to the first group of instruments, the ὄργανα ὑδάτων θείου, ‘the instruments for the sulphur waters’, are very likely to be identified with different kinds of stills. A Zosimus’ passage reads again:

And there is also another way to supply sulphur water (or divine water), but not by a *tribikos*: there must be just one pipe that is inserted into the bottom of a copper vessel, of a length of a cubit and half; in the same way there must be just one receiver and at the bottom a vessel with unburnt sulphur, to which the copper vessel is fitted; then encase it in animal fat or wax or clay or as you want and heat (the sulphur) and let it rise up (III 21–26 Mertens).⁸⁵

This text follows a previous passage (III 1–20 Mertens) where Zosimus explained how to assemble a similar device, which was equipped with three receivers (called τριβικός). Since this first instrument is explicitly ascribed to Maria, scholars usually agree to attribute also the second one to the same author. Besides, the same terminology is employed to indicate the different parts, which constituted the distilling device: in both passages, in fact, the bottom vessel containing sulphur is called λοπάς, the still-head of the alembic is called χαλκείον, the pipes are called σωλήνες, and the receivers βίκοι. Such typology is kept also in some images handed down in the Byzantine manuscripts, where the above mentioned device is depicted in different ways (see, for instance, Fig. 3).⁸⁶

The use of such equipment is not made totally clear by the descriptions we can found in the preserved alchemical works. On the one hand, it is a well-known fact that the property of some minerals to quickly volatilize was exploited by the ancients, especially in the extraction of certain chemical substances. Between the 1st century BCE and the 1st century CE some authors focused their attention on a specific method to extract mercury from cinnabar, which exploited the low boiling point of the metal.⁸⁷

⁸⁵ The Greek text reads: “Ἔστι δὲ καὶ ἄλλος τρόπος κομιδῆς ὕδατος θείου, ἀλλ’ οὐχ ὡς τριβικός· ἔστω σωλὴν <εἷς> εἰς πυθμένα χαλκείου ἐντεθειμένος μήκος πήχεως ἐνὸς ἡμίσιους· τῷ αὐτῷ τρόπῳ καὶ βίκος εἷς καὶ ὑποκάτω λοπάς θείου ἀπύρου, εἰς ἣν συναρμόζει τὸ χαλκείον καὶ περιπήλου στέατι ἢ κηρῷ ἢ πηλῷ ἢ ὡς βούλει καὶ καύσας ἀνάσπα.”

⁸⁶ For a complete overview on the images of the alchemical instruments preserved by the most important Byzantine manuscripts (namely *Marcianus gr.* 299, *Parisini gr.* 2325 and 2327, *Laurentianus gr.* 86,10), see CAAG I 127–173 and Mertens, *Zosime de Panopolis* (cit. note 40), pp. 238–261.

⁸⁷ Mercury, in fact, boils at about 629 K (= 357° C).

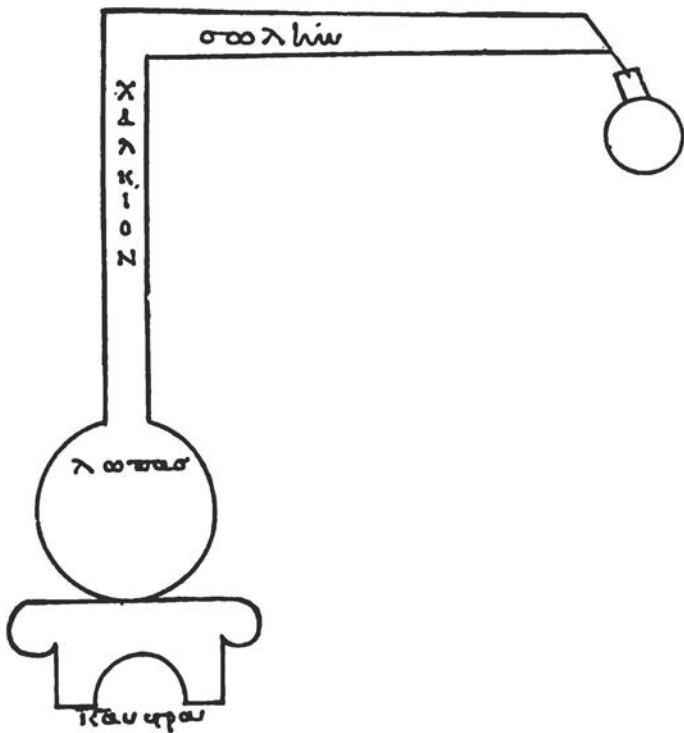


Figure 3. Stylized still, *Marcianus gr.* 299, f. 194 (from CAAG I 140).

Vitruvius (*De Arch.* VII 8,1-4) first pointed out that quicksilver evaporates when cinnabar is brought to high temperature. He explained, in fact, how to dry the excessively moist cinnabar ores by heating them: the quicksilver, which was already exuding from the cinnabar like ‘tears’, evaporated and condensed on the walls of the oven.⁸⁸ Several scholars have recognized in

⁸⁸ *De Arch.* VII 8,1-4: “When these clods (of cinnabar) have been collected, they are so full of moisture that they are thrown into an oven in the laboratory to dry, and the fumes that are sent up from them by the heat of the fire settle down on the floor of the oven, and are found to be quicksilver. When the clods are taken out, the drops which remain are so small that they cannot be gathered up, but they are swept into a vessel of water, and there they run together and combine into one” [transl. by Morris Hicky Morgan, *Vitruvius, The Ten Books on Architecture* (Cambridge: Harvard University Press, 1924), p. 215]. As Earle Radcliffe Caley, “Mercury and its Compounds in Ancient Times,” *Journal of Chemical Education*, 1928, 5: 419–424, p. 420 pointed out, “Vitruvius describes the recovery of mercury from the ore, both in the native state and by a crude method of smelting.” Sometimes, in fact, mercury can be

this passage the description of the chemical reaction:⁸⁹ $\text{HgS} + \text{O}_2 \rightarrow \text{Hg} + \text{SO}_2$. The heated cinnabar, in fact, liberates sulphur and mercury: while sulphur reacts with oxygen, mercury – a less reactive metal that does not oxidize in air – volatilizes very quickly and collects on the oven arch. Nevertheless, a large part of this element was very likely to be wasted: the above described technique was, in fact, more focused on the treatment of cinnabar, so as to make the so called vermilion, rather than of extracting quicksilver.⁹⁰

However, the volatility of the metal was crucial in a more specific method of extraction, which is clearly attested only from the 1st century CE; in fact, both the Greek physician Dioscorides and the Roman naturalist Pliny the Elder explained a sublimating technique which employed a particular apparatus:

Dioscorides: Putting on an earthenware pan (λοπάς) an iron saucer containing cinnabar, they fit on it an *ambix*, luting it round with clay, and then heat it on the coals. For the vapour adhering to the *ambix*, when scraped off and cooled, becomes mercury (*Περὶ ὕλης ἱατρικῆς* V 95).⁹¹

Pliny the Elder: it (*i.e.* cinnabar) is put in an iron shell in flat earthenware pans, and covered with a convex lid smeared on with clay, and then a fire is lit under the pans and kept constantly burning by means of bellows, and so the surface moisture (with the color of silver and fluidity of water) which forms on the lid is wiped off it. This moisture is also easily divided into drops and rains down freely with slippery fluidity (*Naturalis Historia* XXXIII 123).⁹²

found in the mines as a liquid element: Vitruvius mentions a moisture (*umor*) which naturally comes out from its ore. However, cinnabar was smelted in order to make mercury evaporate.

⁸⁹ See, for instance, Robert Halleux, *Le problème des métaux dans la science antique* (Paris: Les Belles Lettres, 1974), p. 186; John F. Healy, *Pliny the Elder on Science and Technology* (Oxford: Oxford University Press, 1999), p. 129.

⁹⁰ Halleux, *Le problème des métaux* (cit. note 89), p. 186: “La procédé, qui a pour but de débarrasser le cinabre du mercure excédentaire, applique une réaction très simple: le cinabre, en présence d’oxygène donne du mercure métallique [...]. Se dernier se sublime, puis se condense sue les parois plus froides ou s’envole en vapeurs délétères.”

⁹¹ Transl. by Taylor, “The evolution of the Still” (cit. note 80), p. 186. The Greek text reads: θέντες γὰρ ἐπὶ λοπάδος κεραμεᾶς κόγχον σιδηροῦν ἔχοντα κιννάβαρι, περικαθάπτουσιν ἄμβικα περιελείψαντες πηλῷ, εἰθ’ ὑποκαίουσιν ἀνθραξιν· ἡ γὰρ προσίζουσα τῷ ἄμβικῳ αἰθάλη ἀποψηχθεῖσα ὑδράργυρος γίνεται.

⁹² Transl. by Harris Rackham, *Pliny, Natural History*, 9 vols., Vol. 9: *Books XXXIII–XXXIV* (Cambridge: Harvard University Press, 1961), p. 93. The Latin text reads: (*minium*) *patinis fictilibus impositum ferrea concha, calice coopertum, argilla superinlita, dein sub patinis accenso follibus continuis igni atque ita calici sudore deterso, qui fit argenti colore et aquae liquore. Idem guttis dividi facilis et lubrico umore compluere.*

Compared to the Vitruvius account, the method described by Dioscorides and Pliny is focused just on the extraction of mercury from cinnabar. The ore was warmed on a high heat – Pliny specifies that bellows were also employed – and mercury rapidly evaporated and condensed on the walls of the upper vessel. In addition, an iron shell was employed because quick-silver does not produce an amalgam in contact with iron, while sulphur reacts with this metal to form iron sulfides.⁹³ It is clear that this technique involved a sublimating apparatus composed by two pieces that slotted into each other (see Fig. 4).

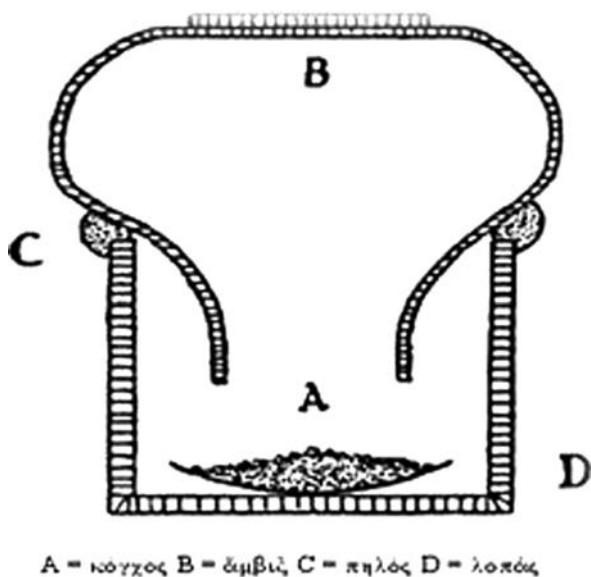


Figure 4. Taylor's reconstruction of the device described by Pliny and Dioscorides (Taylor, "The evolution of the Still" [cit. note 80], p. 187).

The lower vessel (D) was called λοπάς-*patina*; the upper vessel (B), instead, was called ἄμβιξ-*calix*, "a vessel which was widest at the middle and of which the upper portion tapered more or less conically to a narrower

⁹³ Halleux, *Le problème des métaux* (cit. note 89), pp. 186s.

aperture.”⁹⁴ Various scholars⁹⁵ maintain that a similar rudimental apparatus was developed and improved by alchemists (and especially by Maria the Jewish), who separated the lower and the upper container by a pipe, and added another tube with a digestion vessel to the upper one.

Unfortunately, only a few alchemical texts specify that such equipment was used by alchemists to process cinnabar, and the earliest works do not preserve any clear passage, which may explain clearly the sublimating technique for extracting mercury. Nevertheless, the stills described by Maria (in Zos. Alch. III 21–26 Mertens)⁹⁶ seem more suitable to the distillation of liquid substances than to the sublimation of solid ores, like cinnabar. In addition, Stephanus of Alexandria, an alchemist who addressed his lectures to the Byzantine emperor Heraclius (610–641 CE), made a clear distinction between the distilling and the sublimating methods:

There are clearly both a dry vapour and a humid vapour. The humid vapour is extracted by means of the *phanoi* (lit. ‘lamps’)⁹⁷ which have a breast-shaped vessel⁹⁸ [*i.e.* an alembic]. The dry vapour, instead, is extracted by means of a vessel and a copper cover [the same instrument described by Pliny and Dioscorides]: it is similar to the white vapour of cinnabar (II 208,19–24 Ideler, revised on the basis of Taylor’s edition).⁹⁹

⁹⁴ Taylor, “The evolution of the Still” (cit. note 80), p. 188. In the later tradition the Greek name *ambix* was transformed into *al-ambiq* by the addition of the Arabic article *al*: Mertens, *Zosime de Panopolis* (cit. note 40), pp. cxxiis.

⁹⁵ Halleux, *Le problème des métaux* (cit. note 89), pp. 187s.: “C’est l’école alchimique de Marie la Juive qui ajoutera au chapiteau le tuyau de décharge et le récipient, et des alchimistes ultérieurs l’appareillage de refroidissement du tuyau de décharge.” See also Taylor, “The evolution of the Still” (cit. note 80), p. 202; Lindsay, *The origins of Alchemy in Graeco-Roman Egypt* (cit. note 71), chap. 11.

⁹⁶ The passage has been quoted above; see *supra*, p. 292.

⁹⁷ The word φανός seems to have different meanings in the alchemical texts: see Mertens, *Zosime de Panopolis* (cit. note 40), pp. cliii–clxi. On the one hand, it may indicate a glass vessel similar to a kind of phial (see, for instance, Olymp. Alch. CAAG II 75,20); on the other hand, it can refer, especially in Zosimus’ works, to a specific instrument that was used to make the mercury solid (probably a process that combined the liquid metal with sulphur vapours in order to produce a solid substance). In Stephanus’ passage the term probably indicate the lower part of a distilling device.

⁹⁸ A similar expression is attested also in the description of the Pseudo-Democritus’ still, according to Syn. Alch. CAAG II 60,15–61,2 (see *infra*, p. 301).

⁹⁹ F. Sherwood Taylor, “The Alchemical Works of Stephanos of Alexandria. Translation and Commentary, part. II,” *Ambix*, 1938, 2: 38–49, p. 38: Ἀληθής ἐστὶν αἰθάλη τις ὑγρὰ καὶ αἰθάλη ξηρά. Καὶ ἡ μὲν ὑγρὰ αἰθάλη ἀνασπάζεται διὰ τῶν φανῶν τῶν ἐχόντων τοὺς μασθοὺς· ἡ δὲ ξηρὰ αἰθάλη διὰ χύτρας καὶ πώματος χαλκοῦ, ὡς ἀπὸ κινναβάρεως αἰθάλη λευκή.

On the one hand, Stephanus describes the same apparatus that has been already mentioned by Dioscorides and Pliny: the vapour is very likely to be considered ‘dry’ since it was coming out from solid substances (such as cinnabar), which were usually called by alchemists ξηρά (‘dry ingredients’). On the other hand, the alembic is supposed to have been used for treating a ‘humid vapour’, which was produced by distilling a liquid substance. Although Stephanus quotes cinnabar simply in connection with the ‘dry vapour’, it is possible to argue that ancient alembics were employed to distill a solution of this mineral as well. In fact, on the basis of a passage by a later commentator, who is called in the alchemical manuscripts ‘the Anonymous philosopher’ (ὁ φιλόσοφος Ἀνεπίγραφος),¹⁰⁰ Pseudo-Democritus would have already tested a similar method:

This very famous philosopher (*i.e.* Democritus) said: “Who does not know that the vapour of cinnabar is the quicksilver of which it is composed? Therefore, if anyone grinds the cinnabar with *nitron* oil, mixes them together, puts them in the double vases (ἐν ἄγγεσιν διπλοῖς) and lights a persistent fire, he will collect the entire vapour that was staying inactive in the bodies¹⁰¹ (CAAG II 123,3–7).¹⁰²

While Pliny the Elder and Dioscorides described a sublimating technique, where the solid body of the cinnabar was processed on a source of heat, Pseudo-Democritus preferred to grind the ore and mix it with a liquid substance (= *nitron* oil) before distilling it. The explicit mention of the ‘double vases’ seems to refer clearly to a distilling device that is perhaps similar to the alembic described by Maria. Otherwise, as we shall see soon, the same Pseudo-Democritus probably described such instruments in his work. Unfortunately, nobody tried to test this method, in which a solution of sodium carbonate (νίτρον) was used to dissolve the cinnabar. However, we cannot rule out that the development of distilling apparatuses allowed

¹⁰⁰ See Jean Letrouit, “Chronologie des alchimistes grecs,” in *Alchimie: art, histoire et mythes. Actes du I^{er} Colloque international de la Société d’Étude de l’Histoire de l’Alchimie*, edited by D. Kahn, S. Matton (Paris: S.É.H.A., Milan: Arché: 1995), pp. 63s.: Letrouit identifies two distinct authors behind the name ὁ φιλόσοφος Ἀνεπίγραφος, both dating back to the 8th–9th c. CE.

¹⁰¹ The word σώματα is likely to refer to solid substances (or ores) and, in particular, to the cinnabar that was processed.

¹⁰² The Greek text reads: Οὗτος οὖν ὁ ἀγαθώτατος φιλόσοφος· Τίς δὲ οὐκ οἶδεν ὅτι ἡ αἰθάλη τῆς κινναβάρως ὑδράργυρός ἐστι, δ’ ἥς καὶ συντέθεται; Διὸ καὶ εἴ τις ἐλλείψας αὐτὴν τὴν κιννάβαριν νιτρελαίῳ, ἀναφυράσας καὶ περικλείσας ἐν ἄγγεσιν διπλοῖς, ὑποκαύσει φωσὶν ἀλχηκτοῖς, πᾶσαν αἰθάλην λήψεται ἐγκεκαθημένην εἰς τὰ σώματα.

ancient alchemists to try different ways of extracting quicksilver, which were based on the treatment of a liquid solution instead of a solid ore.¹⁰³

Similar liquid solutions must be in some way understood in the light of the above quoted passages by Maria the Jewish, who specified how the distilling devices were especially useful for obtaining ‘divine water’ (see Zos. Alch. III 21–26 and VII 10–12 Mertens).¹⁰⁴ The alchemical expression ὕδωρ θείου or ὕδωρ θεῖον – which seems to have been used by Zosimus with reference to any kind of active liquid substance that was expected to fit the alchemical practice¹⁰⁵ – carries some ambiguity. All the same, various ancient passages describe how to distill a wide range of dissolved substances in order to obtain a supposed reactive solution. First of all, according to Zosimus again, Maria himself wrote on the production of this ὕδωρ:

The divine water (ὕδωρ θεῖον) will be wasted by those who did not understand – as I have written – what is rising up through the vessel (λοπάς) and the tube (σωλήν). It is our custom to call the vapour of native sulphur (θεῖον ἄθικτον) and arsenic minerals (*i.e.* orpiment and sandarac) water (CAAG II 157,4–10).¹⁰⁶

¹⁰³ A similar technique seems to mix the ‘hot method’ of extracting quicksilver, which was based on the volatility of the metal, and the ‘cold method’, according to which cinnabar was pounded with vinegar. This second way is already attested in Theophrastus, *De Lap.* VII 60: ποιείται (scil. ἄργυρον χυτόν) δὲ ὅταν <κιννάβαρι> τριφῇ μετ’ ὄξους ἐν ἀγγεῖω χαλκῷ καὶ δοίδυκι χαλκῷ, “(Quicksilver) is made by pounding cinnabar with vinegar in a copper (or bronze) mortar with a copper (or bronze) pestle (see also Plin. *NH* XXXIII 123)” [transl. by David E. Eichholz, *Theophrastus. De lapidibus, Edited with Introduction, Translation and Commentary*, (Oxford: Clarendon Press, 1965), p. 81]. As recently Laszlo Takacs, “Quicksilver from Cinnabar: The First documented Mechanochemical Reaction?,” *JOM, Journal of the Minerals, Metals and Materials Society*, 2000, 7: 12–13, p. 12, pointed out, Theophrastus and Pliny the Elder described a “mechanochemical reaction” that depends both on the grinding of cinnabar and on the action of copper, a more active metal placed in contact with cinnabar. The vinegar or any other aqueous liquid (water itself, urine, wine, etc.) may be used, because the action of the liquid is purely mechanic: it allows for closer physical contact between the solid ingredients. Kenneth C. Bailey, *The Elder Pliny’s Chapters on Chemical Subjects, part. I*, (London: Edward Arnold & Co, 1929), p. 223, tested this method in laboratory and was able to produce some mercury. However the process is very slow and mercury may sometimes amalgamate with the copper: the reaction may be accelerated by warming the mixture. This technique was inherited by the first alchemists: according to Zosimus (CAAG II 172,13–19) both Chymes and Maria knew a similar process (see also CMA II 47).

¹⁰⁴ These passages have been quoted above; see *supra*, pp. 291–292.

¹⁰⁵ See Cristina Viano, “Gli alchimisti greci e l’acqua divina,” *Rendiconti della Accademia Nazionale delle Scienze detta dei XL. Parte II: Memorie di Scienze fisiche e naturali*, 1997, 21/2: 61–70; Martelli, *Divine water* (cit. note 74), pp. 5–10.

¹⁰⁶ The Greek text edited by Berthelot-Ruelle is not easily understandable; it reads: ὕδωρ θεῖον ληφθήσεται τοῖς μὴ νοοῦσιν, ὡς γέγραπται, ὃ διὰ τῆς λωπάδος καὶ τοῦ σωλήνος εἰς ὕψος ἀναπέμπεται. Ἀλλ’ ἔθος τοῦτο λέγειν ὕδωρ τὴν αἰθάλην θείου ἄθικτου καὶ ἀρσενικῶν κτλ. However, instead of the handed down ληφθήσεται (from λαμβάνω), we have to read λειφθήσεται, as

The explicit reference to the *λοπάς* and to the *σωλήν*, namely two typical parts of the alembic, allow us to suppose that the divine water was obtained also by distilling processes. Despite the polysemy of the word *θεῖον*, which was not very likely to be used in connection just with the sulphur,¹⁰⁷ the mention of the arsenic minerals seems to suggest that different kinds of ores were dissolved into a liquid solution. We are under the impression that ancient alchemists tried to apply the same methods, which were used for extracting quicksilver from cinnabar, to other substances as well: they tried to process different mineral ingredients by combining both dissolving and distilling techniques. In particular, it is possible to recognize a number of passages in the earliest alchemical works which describe similar processes, especially with reference to the orpiment (As_2S_3) and to the realgar (As_2O_3). First of all, a section of a Greek treatise entitled *Isis to her son Horus* explains:

In this way vapour rises up: take some orpiment, boil it in water and put it in a mortar and melt it with an ear of corn and with oil; put it in a casserole and close its mouth with a bowl; light a charcoal fire until the vapour rises up; do the same with realgar (CAAG II 32,23–33,3).¹⁰⁸

The author describes a method that combines a grinding process of the orpiment (or realgar), which is dissolved into a liquid substance, with a distilling one. In Multhau's opinion similar techniques allowed ancient alchemists to obtain pure arsenic by distilling arsenic oxides (As_2O_3) previously melted in oil or in a liquid substance. On this Multhau¹⁰⁹ wrote: "If this material (*i.e.* the oxide produced by roasting realgar or orpiment) is fused in turn with oil or gum, we obtain a black sublimate, the element

Berthelot's translation already suggested (CAAG III 157): "L'eau divine sera perdue pour ceux qui ne comprennent pas ce qui a été écrit, à savoir que le produit (utile) est renvoyé vers le haut par le matras et le tube. Mais on a coutume de désigner par cette eau la vapeur du soufre et des arsenics sulfurés."

¹⁰⁷ F. Sherwood Taylor, "A Survey of Greek Alchemy," *The Journal of Hellenic Studies*, 1930, 50: 109–139, pp. 137s., wrote about the alchemical distilling methods: "The value of the apparatus to the alchemists is not clear. They appear to have distilled sulphur from it and to have obtained liquids [...] and to have used these in the colouring and treatment of metals. No liquid products except melted sulphur can be obtained by distilling sulphur, or any mixture of sulphur and a mineral substance [...]. Perhaps the word 'sulphur' was used in a wider sense, or again sulphur may have been distilled with vegetable oils, so forming sulphur-substituted organic liquids which would have the effect of tinting metals etc."

¹⁰⁸ The Greek text reads: ἡ δὲ αἰθάλη οὕτως αἴρεται· λαβὼν ἄρσενικόν, ἔψει ὕδατι καὶ βαλὼν ἐν τῷ ἰγδίῳ, λείου μετὰ στάχως σὺν ἐλαίῳ ὀλίγῳ, καὶ βαλὼν ἐν λοπάδι καὶ φιάλῃ ἐπάνω πύλῃ ἐπιτίθου ἐπ' ἀνθράκων ἕως οὗ ἔλθῃ ἡ αἰθάλη. ὁμοίως καὶ τὴν σανδαράχην ποιεῖ.

¹⁰⁹ Robert P. Multhau, *The Origins of Chemistry* (London: Oldbourne, 1966), p. 108.

alchemists tried to extend to different ores the same extracting techniques that were used to process the mercury ores (namely the cinnabar).

In addition, the same ὑδράργυρος is sometimes mentioned by ancient alchemists as the liquid substance into which to solve the mineral ingredients that had to be distilled. A specific alembic, which was composed by two main pieces (whose names are in part different from the nomenclature used by Maria) is ascribed by alchemical sources to Pseudo-Democritus. Indeed, Sinesius quotes a long passage by Pseudo-Democritus where the ancient author describes a still which was employed to distill a solution of ὑδράργυρος (litt. ‘mercury’) and different λευκά σώματα (litt. ‘white bodies’):

This is what he said, Dioscorus: mix the bodies [*i.e.* the solid substances] with the mercury, file them finely and add any other mercury: in fact the mercury attracts everything to itself. Let this macerate for three or four days and put it in a vessel, placing it on not hot ashes with high flame, but in ashes at milder temperature [that is the *kerotakis*]. With this emission of heat, a glass instrument that has a breast-shaped protuberance (μαστάριον) is slotted into the vessel (βωτάριον); put it on the top of the vessel and turn it upside down; collect the water going up through the breast and keep it for the fermentation. This water is the divine water (ὑδωρ θεῖον), and this is its extraction (CAAG II 60,15–61,2).¹¹⁴

Pseudo-Democritus, just like Maria, specifies that the name of the extracted substance is ὑδωρ θεῖον, ‘divine water’, which is the result of a distilling process that is carried out by means of a specific instrument composed by different pieces. On the basis of the text above and of two images that are handed down by two Paris manuscripts (*Parisini gr.* 2325, f. 23^v and 2327, f. 33^v), we may propose a hypothetical reconstruction as follows (see Fig. 5):

A-B) First of all, the still was very likely put on a cauldron (A) that contained the ‘mild’ ashes (B). Although Synesius does not speak about it, it is possible to recognize this element in the manuscripts’ illustrations, where

¹¹⁴ The Greek text reads: “Ο λέγει οὖν, Διόσκορε, τοιοῦτόν ἐστι· Βάλε τὰ σώματα μετὰ τῆς ὑδραργύρου, καὶ ῥίνησον εἰς λεπτόν· καὶ ἀναλάμβανε ὑδράργυρον ἑτέραν· πάντα γὰρ ὁ ὑδράργυρος εἰς ἑαυτὴν ἔλκει· καὶ ἕασον πεφθῆναι ἡμέρας τρεῖς ἢ τέσσαρας· καὶ βάλε αὐτὴν εἰς βωτάριον ἐπὶ θερμοσποδιάς μὴ ἐχούσης τὸ πῦρ διάπυρον, ἀλλὰ ἐπὶ θερμοσποδιάν πραεῖαν [ὅ ἐστι κηροτακίς]. Ταύτη οὖν τῇ ἀναδόσει τοῦ πυρός, συναρμόζεται τῷ βωταρίῳ ὑέλινον ὄργανον ἔχον μαστάριον, ἐπὶ τὰ ἄνω προσέχον, καὶ ἐπικέφαλα κείσθω. Καὶ τὸ ἀνερχόμενον ὑδωρ διὰ τοῦ μαζοῦ δέχου καὶ ἔχε καὶ σῆψον. Τοῦτο λέγεται ὑδωρ θεῖον. Αὕτη ἐστὶν ἐκστρόφη. I have considered the expression ὅ ἐστι κηροτακίς as a later note that has been included into the passage at some point of its tradition (see *infra*).

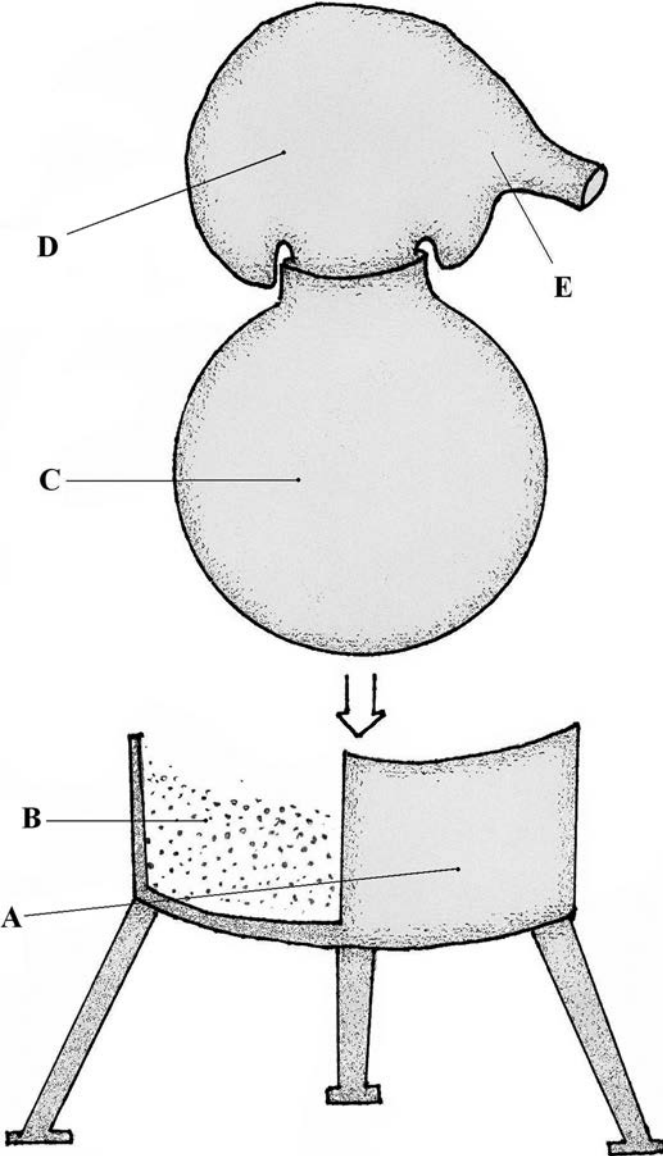


Figure 5. Reconstruction of Pseudo-Democritus' still.

it is called λέβης (see Fig. 6). The βωτάριον (C) is plunged in the ashes in order to heat the whole compound. The milder heat ensures a gradual evaporation.

C) The lower part of the device is called by Pseudo-Democritus βωτάριον, a word that is attested only by the alchemical texts. As Mertens pointed out,¹¹⁵ it is most probably a diminutive of βωτίον, which is explained by Hesych. β 1407,1 L. as follows: βωτίον· σταμνίον. According to Pollux (*Onom.* VI 14,3 Bethe), σταμνίον (diminutive of στάμνος) indicated an ἀγγεῖον οἰνοφόρον ὑάλου ἢ κεράμου πεποιημένον, “a vessel for wine composed by glass or ceramic.” Next to σταμνίον some ancient texts (see Eupol. fr. 217 K-A)

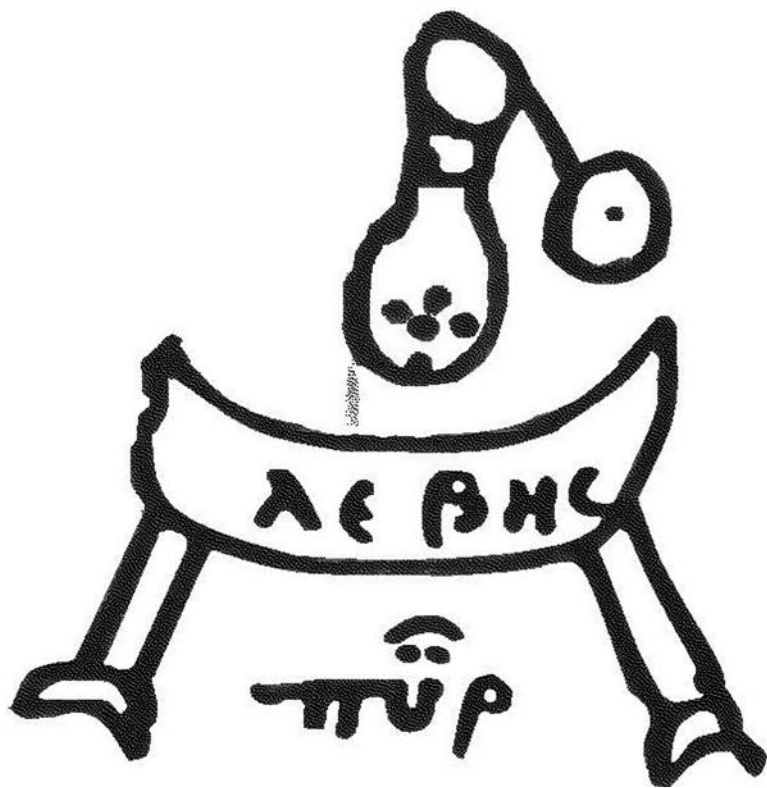


Figure 6. Pseudo-Democritus' still from the codex *Parisinus gr.* 2327, f. 23^v.

¹¹⁵ Mertens, *Zosime de Panopolis* (cit. note 40), p. cxxi, n. 30.

attest the form *σταμνάριον* as well, which allow us to recognize the couple *σταμνίον-σταμνάριον* that could perhaps correspond to *βωπίον-βωτάριον*.

D) The upper part of the alembic (D) corresponds to a glass instrument that has a breast-shaped protuberance (E), into which another vessel (usually called *βίκος, βικίον, φιάλη*)¹¹⁶ was slotted for collecting the distillate. Synesius does not describe this last container, which is nevertheless drawn in the manuscripts' illustrations.

If the descriptions of the alembics ascribed by Zosimus to Maria the Jewish are compared with the passage quoted by Synesius from Pseudo-Democritus, one notices a quite evident difference with regard to the terminology used to indicate the different pieces of similar devices. In particular, Pseudo-Democritus seems to have employed a more specific vocabulary, since the words *βωτάριον* and *μαστάριον* are typical of the alchemical texts or assume a technical meaning in the *Corpus alchemicum*. The first one, as we have already noticed, is a *hapax* attested for the first time in the Pseudo-Democritus' work. The second one, a diminutive of *μαστός* (LSJ⁹ 1083), is usually attested (especially in medical works)¹¹⁷ to indicate female breasts. Most probably because of the similarity between this part of the human body and the shape of the still's upper vessel, the word was included into the alchemical works to indicate a specific device: Zosimus explicitly mentions a breast-shaped instrument (*μαστάριον*; IX 11 Mertens) in a passage dealing with the distillation of eggs;¹¹⁸ in addition, different later alchemical authors often refer to an *ὄργανον μασθωπών* which was likely to be used in distilling processes.¹¹⁹

A progressive specialization of the alchemical vocabulary is recognizable also in the use of the word *κηροτακίς*, term related to a second category of alchemical instruments. A similar device was most probably described by Maria the Jewish (see Zos. Alch. VII 10–12 Mertens)¹²⁰, and it is quoted also in the above mentioned passage by Pseudo-Democritus (see Syn. Alch. CAAG II 60,21)¹²¹. There is a scholarly consensus in tracing back the *κηροτακίς* to the painter's palette (see also CAAG II 250,4s.),¹²² with reference to the

¹¹⁶ Mertens, *Zosime de Panopolis* (cit. note 40), p. cxxii.

¹¹⁷ Anonymi Medici, *De alimentis*, 1,43 and 18,7 Ideler; *De cibis* 5,44 Ermerins; see also Alcyphr. IV 4, 4 (l. 5); IV 13, 13 (l. 4); IV 14, 6 (l. 7).

¹¹⁸ See also Taylor, "The evolution of the Still" (cit. note 80), pp. 197–200.

¹¹⁹ Olymp. Alch. CAAG II 105,6; Com. Alch. CAAG II 291,13; Zos. Alch. (?) CAAG II 251,1; [Zos. Alch.] CAAG II 199,5 etc.

¹²⁰ This passage has been quoted above; see *supra*, p. 291.

¹²¹ See *supra*, p. 301.

¹²² See, for instance, CAAG I 144; Forbes, *A Short History of the Art of Distillation* (cit. note 80), pp. 25s.; Mertens, *Zosime de Panopolis* (cit. note 40), p. cxxx.

melting of the wax colors on a small metallic shovel, which was put down on a vessel containing hot lambs of coal. In the alchemical texts the same metallic leaf was most probably processed in order to change its color: the word *κηροταχίς*, in fact, seems to refer both to the leaf itself¹²³ and to the specific instrument which was used for its treatment.

On the basis of some Zosimus' passages¹²⁴ and of the images preserved by the Byzantine manuscripts,¹²⁵ scholars have tried to reconstruct a specific device composed by different slotted together parts (see Fig. 7):

The instrument could probably have either a cylindrical or a spherical shape (see Fig. 7). A lower vessel contained the source of heat (A), while a volatile substance was put into a second vessel (B) – very often made up by glass – fitted to the first one. On the top of the second vessel alchemists placed the metallic leaf (C), which was covered by a kind of glass cup (D). Usually scholars agree that the metallic leaf was transformed either by the vapour of the volatile substances which were put in the central container,¹²⁶ or by some reactive ingredients which were on the leaf itself.¹²⁷

On the other hand, we must remember that in the above mentioned passage by Sinesius the name *κηροταχίς* is related to the source of heat which was contained in the lower vessel (A). In fact, according to the Berthelot-Ruelle edition (which follows, in this case, the earliest manuscript, the *Marcianus gr.* 299), *κηροταχίς* was the name of the *θερμοσποδιά πραεῖα*, 'ashes a milder temperature'.¹²⁸ In addition, the two manuscripts from Paris

¹²³ See, for instance, Zos. Alch. CAAG II 146,13 ἐν τῷ πετάλῳ τῆς κηροταχίδος, "in the *kerotakis* leaf" (quotation from Maria the Jewish); Zos. Alch. CAAG II 169,12s. διὰ τοῦ πετάλου τῆς κηροταχίδος, "by the *kerotakis* leaf" (quotation from Maria the Jewish); Olymp. Alch. CAAG II 102,20 τὸ πέταλον τῆς κηροταχίδος, "the *kerotakis* leaf" (quotation from Maria the Jewish).

¹²⁴ See, in particular, VII 17-46 Mertens, discussed in Mertens, *Zosime de Panopolis* (cit. note 40), pp. cxxxii-cxxxvii.

¹²⁵ Now collected in Mertens, *Zosime de Panopolis* (cit. note 40), pp. 246-251; see already Taylor, "A Survey of Greek Alchemy" (cit. note 107), pp. 132-134.

¹²⁶ Taylor, "A Survey of Greek Alchemy" (cit. note 104), pp. 133-137; Mertens, *Zosime de Panopolis* (cit. note 40), pp. cxxxviii.

¹²⁷ See, in particular, Zos. Alch. CAAG II 146,13s. καὶ ἐν τῷ πετάλῳ τῆς κηροταχίδος ἐχέτω, φησί, τὸ ὕδωρ τοῦ θείου, κόμμι ὀλίγον, κτλ., "and on the *kerotakis* leaf there must be the sulphur water, some gum, etc."

¹²⁸ In different passages of the *Corpus alchemicum* the word *κηροταχίς* is explicitly associated to a specific source of heat: Zos. Alch. CAAG II 158,1 διὰ πρίσματος ἢ κηροταχίδος, "by a fire of sawdust or a *kerotakis*" (quotation by Pseudo-Democritus); Zos. Alch. CAAG II 183,13s. ἐψοῦσιν καὶ ὀπτῶσιν ἐπὶ τῆς κηροταχίδος, "they boil or roast by the *kerotakis*." See Mertens, *Zosime de Panopolis* (cit. note 40), p. cxxxix.

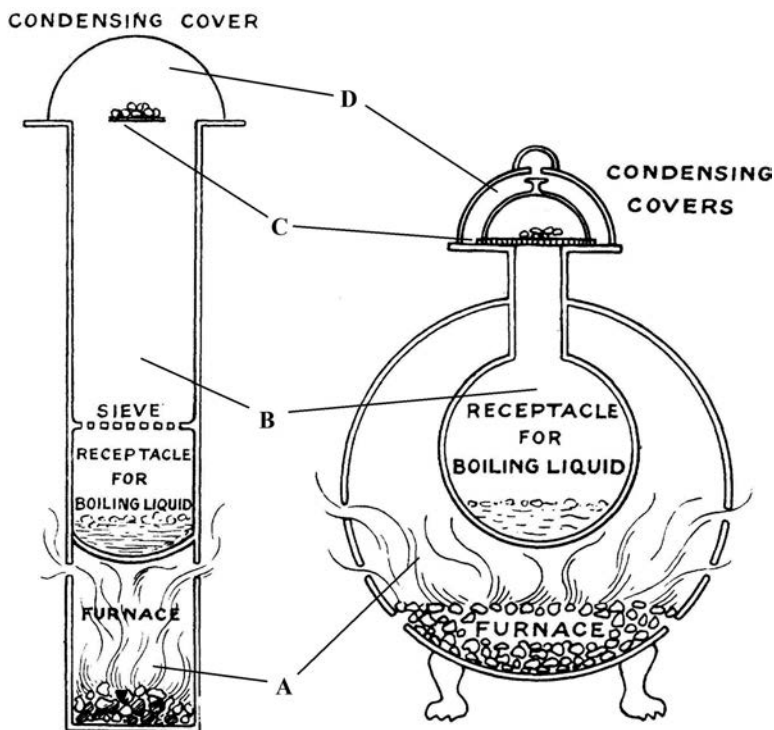


Figure 7. Two types of kerotakis, (from Taylor "A Survey of Greek Alchemy" (cit. note 104), pp. 132–134).

(*Parisini gr.* 2325 and 2327) preserve the reading ὁ δὴ βοτάριον (*sic*) ἐστὶν κηροτακίς, "the *botarion* is the *kerotakis*," where the term is a synonym of the name that has been used by Pseudo-Democritus to indicate the lower vessel of his still. Both readings appear to be an intrusive note, most probably added later in order to clarify the original text, possibly in connection to the rare word βοτάριον/ βοτάριον. However, a similar *glossa* suggests that the word *kerotakis* was employed also for a container, probably the lower vessel where alchemists used to put hot ashes or other sources of heat, such as hot sawdust.¹²⁹ A similar meaning is confirmed by another alchemical passage:

¹²⁹ See *supra*, note 128.

They have not only unified the quicksilver, but they have also made the compound white or yellow by boiling it with a light fire [...]. They boil it until its color is satisfying, some for nine hours, others for nine days. When that is accomplished, they cover the *troullos* (vessel)¹³⁰ with a bowl and put it on a *kerotakis* or on a *botarion*, upon the oven etc. (CAAG II 164,22–165,5).¹³¹

In this case the term βωτάριον is a synonym of *κηροτακίς* and does not refer to a part of the still where to put the ingredients to process, but it seems to indicate a vessel which was interposed between the oven and the alembic itself or any other alchemical instrument: it could contain ashes or other hot substances and it was probably employed in order to avoid a direct contact between the treated substances and the source of heat. Especially the Syriac tradition hands down images that may confirm a similar interpretation (see, for instance, Fig. 8), as they represent a container (B) which divides the oven from the still.

Similar devices show the attention paid by ancient alchemists to the intensity of the heat and to the different possible ways to warm the processed substances. In fact, the results of the alchemical operations were very often depending on how alchemists cooked or roasted the ingredients, whose reactions could be compromised by using the wrong heating devices. One may suppose that this concern was related especially to the ovens and furnaces, which were known and exploited by ancient alchemists. According to the first passage that has been quoted at the beginning of this paragraph, Maria the Jewish would have dealt with the description of κάμινοι. This information is confirmed by a second passage by Zosimus,¹³² where the alchemist explicitly claims that Maria wrote a treatise entitled *Καμινογραφία*, “Writing on furnaces.” Unfortunately, this book has not been included in the Byzantine alchemical anthologies and we are not able to reconstruct its original content. The only passage which may be attributed to the *Καμινογραφία* with some degree of certainty is the description of a κάμινος

¹³⁰ See LSJ⁹ 1827, ‘a kind of vessel’; Berthelot (CAAG II 164, n. 1) briefly commented: “C’est quelque instrument inconnu.” The word, which in Byzantine chronographers indicated a ‘dome, cupola’, is already attested in Hero of Alexandria (*Pneum.* I 8,8) and appears to be related to the Latin forms *trulleus* and *truleum*, ‘cup, vessel’.

¹³¹ The Greek text reads: καὶ οὐ μόνον ἤγνωσαν τὴν ὑδράργυρον, ἀλλὰ καὶ ἐλεύκαναν καὶ ἐξάνθωσαν τὸ σύνθεμα ἐψούντες λεπτῷ πυρὶ [...]. Ἐψοῦσι δὲ ἕως ἂν ἀραιώσῃ τὸ χρῶμα, οἱ μὲν ὥρας θ', οἱ δὲ ἡμέρας. Ὅταν δὲ οὕτως γένηται, περισκεπάζουσι τὸν τρούλλον φιάλῃ, καὶ τιθέασιν ἐν κηροτακίδι ἢ ἐν βωταρίῳ κτλ. The attribution of the *excerptum* (entitled *Περὶ τῆς κατὰ πλάτος ἐκδόσεως τοῦ ἔργου*) to Zosimus is questioned: see Letrouit, “Chronologie des alchimistes grecs” (cit. note 100), p. 36.

¹³² The passage is included in the work *Πρώτον βιβλίον τῆς τελευταίας ἀποχῆς*: see Festugière, *La révélation d'Hermès* (cit. note 39), p. 365, l. 3 (= CAAG II 90,19).

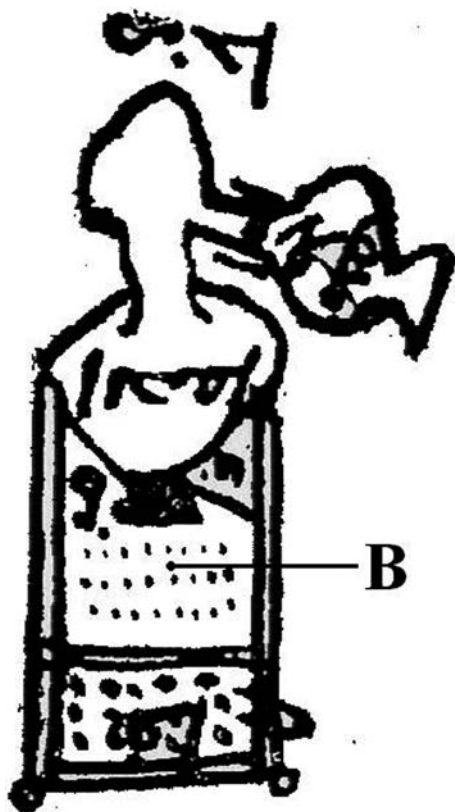


Figure 8. Alembic upon a *kerotakis*, from CMA II 108.

φουρνοειδής, ‘reverberatoy furnace’, quoted in the Zosimus excerpt *Περὶ ὀργάνων καὶ καμίνων* (VII 33–39 Mertens).¹³³

As Mertens already pointed out,¹³⁴ we have a lack of information about the types of ovens and furnaces which were used by alchemists: ancient texts, in fact, preserve just a few references to similar devices and the illustrations of the manuscripts are very stylized and poor. Halleux¹³⁵ specifies that the processes in the Leiden and Stockholm papyri were based especially on furnaces that are not described in the texts: “Il doit s’agir d’un petit

¹³³ See, also, Mertens, *Zosime de Panopolis* (cit. note 40), pp. clxviii–clxix.

¹³⁴ Mertens, *Zosime de Panopolis* (cit. note 40), pp. clxviis.

¹³⁵ Halleux, *Papyrus de Leyde* (cit. note 42), p. 34.

four à creusets, classique en métallurgie ancienne, chauffé à la paille, au bois ou au charbon de bois avec une soufflerie artificielle.” However, we must remember that the only passage in the *Corpus alchemicum* that shows an alchemist while he is performing an ‘experiment’ (CAAG II 191,3–18) – namely the priest Νεῖλος – gives a rather surprising picture: the Egyptian priest, in fact, tried to make a copper-lead alloy (μολυβδόχαλκος) white by processing it with κωβάθια (likely arsenic ores)¹³⁶ and roasting it in a κλίβανος (or κρίβανος), a “portable dome-shaped earthenware oven whose most obvious use was to bake bread.”¹³⁷ Most probably the extemporary nature of the ‘alchemical performance’ needed a small and portable device, even if we can rule out that domestic equipment was used by alchemists in their practices.¹³⁸

Besides, a fairly wide set of sources of heat seems to have been known by alchemists. We have already noted that many alchemical recipes often mention different kinds of furnaces, such as the glass-makers’ and the potters’ furnaces, which appear to have been suitable also for carrying out alchemical processes. We do not know, however, whether Maria described similar devices in her treatise and tried to highlight which ones were more appropriate for alchemy. It is likely that similar treatises represent the beginning of a tradition that later culminated in important Arabic works, where the alchemical equipment was then described in a specific way. In Al-Rāzī’s (10th c. CE) opinion, for instance, all the alchemical instruments were divided in two categories, the instruments for melting metallic bodies and the instruments for processing natural substances; both categories included different kinds of ovens and sources of heat, such as Blacksmith’s

¹³⁶ An entry of the *Lexicon on the making of gold* (CAAG II 4–17) reads in the Berthelot-Ruelle edition (CAAG II 9,15): Καπνὸς κωβαθίων ἐστὶν αἰθάλη, “The smoke of *kōbathia* is a vapour.” However, the text must be integrated according to the reading of the Paris manuscripts (*Parisini gr.* 2325 and 2327), which add the alchemical symbol for the orpiment (ἀρσενικόν) after αἰθάλη (see also CAAG II 10,15).

¹³⁷ Andrew Dalby, *Food in the Ancient World from A to Z* (London-New York: Routledge, 2003), p. 101; see also Robert I. Curtis, *Ancient Food Technology* (Leiden: Brill 2001), pp. 368s. and LSJ⁹ 995, s.v. κρίβανος, “covered earthen vessel, wider at bottom than at top, wherein bread was baked by putting hot embers round it.”

¹³⁸ The same kind of oven is mentioned in many alchemical recipes: see CAAG II 346,13 (καὶ θερμάνας κλίβανον) and 14s. (βάλε τὸ σκεῦος ἐν τῷ κλιβάνῳ, προσπηλὼν τὸ στόμα τοῦ κλιβάνου); 369,16 (καὶ ὅπτα φούρνῳ καὶ κλιβάνῳ); 370, 20s. (ὅπτα ἐν κλιβάνῳ = CAAG II 288,13); 391,18s. (βάλε εἰς κλίβανον). In addition, Halleux, *Papyrus de Leyde* (cit. note 42), p. 34, pointed out how also some recipes in the Leyden and Stockholm papyri specify to employ domestic ovens (ὀπτάνιον): see *P.Leid.X.* 98,3 (καύσας ὀπτάνιῳ) and *P.Holm.* 66,4 (εἰς ὀπτάνιον πέμπε).

hearth (*Kūr*), Baker's oven (*Tannūr*), potter's kiln (*Atūn*), small stoves for heating the Aludel (*Mustauqad* or *Mauqid*), lamps (*Qanādīl*).¹³⁹ Similar lists show a tendency to the classification of several instruments which derived from the different arts we have mentioned in the first paragraph of this paper. We cannot rule out that a similar attitude was typical of the first alchemists, who perhaps tried to classify and organize this material already in their first treatises, among which we may include also the Maria's *Καμινογραφία*.

3. Conclusions

The importance of the treatises describing specific instruments and tools which were considered central for the alchemical practices is often highlighted by Zosimus, who invites his pupil Theosebia to study carefully the works of the earliest authors.¹⁴⁰ According to such passages, the ancient alchemist appears to have been depicted more often while he was reading and interpreting the written descriptions of particular devices, rather than while he was conducting practical 'experiments' based on the use of such equipment. Zosimus himself (VIII 1-30 Mertens) tells us how one day, at Theosebia's home, he saw in the kitchen a uncommon instrument used for cooking (and steaming) poultry: however, the Egyptian alchemist, instead of testing as soon as possible this tool during his own practice, decides to take the Jewish books from the bookshelves and to look for a description of a similar device. After finding a suitable passage most probably in the Maria's treatises, next to the illustration of the still called *τρίβικος*, Zosimus quotes the passage and starts to comment it.

A similar attitude is indeed remarkable, as ancient texts often appear to emphasize the 'intellectual side' of alchemy, which was based on an intense and prolonged study of the earlier written tradition concerning the 'Art'. Unfortunately, our sources do not preserve analogous passages that focus on the practical work of alchemists and that refer to the space where they tried to exploit the instruments described in the above mentioned 'literature'. Therefore, one is not allowed to reconstruct how during such

¹³⁹ These instruments are described in the *Kitāb al-asrār*: see Henry E. Stapleton, Rizkallah F. Azo, M. Hidāyat Husain, "Chemistry in 'Irāq and Persia in the Tenth Century A.D.," *Memoirs of the Asiatic Society of Bengala*, 1927, 8: 317-417, pp. 324-326. This text should be compared with CMA II 149-154.

¹⁴⁰ See, for instance, Zosimus Alch. III 1-2, IV 1-40 and VII 1-7 Mertens.

tradition alchemists tried to build a specific working space, where to conduct their experiments, and to put into practice the many processes collected in the alchemical recipe-books and treatises.

On the one hand, on the basis of the several references to the tools used by ancient craftsmen (see paragraph 1), we cannot rule out that alchemists, at least at the beginning, shared working spaces with the experts in different arts. On the other hand, the detailed descriptions of specific equipment, which were already available in the writings of the first authors, show a dialectical relation between alchemy and craftsmanship. Already during the first steps of alchemy, the authors appear to have been interested in the explanation of a particular set of instruments that became peculiar to the alchemical practice. The continuous interest in this tradition by the later authors most probably guaranteed a progressive improvement and specialization of this technology, since any alchemist was likely to have needed specific tools to carry out his own activity. During this process we are allowed to suppose that alchemists gradually tried to develop a specific space where to accommodate their apparatus. Unfortunately the earliest sources do not mention any specific name of a similar space and do not provide us with any description focused either on its possible location or on its most important features.