

Alma Mater Studiorum Università di Bologna
Archivio istituzionale della ricerca

Medicine in early Graeco-Egyptian alchemical texts (1st-3rd century AD)

This is the submitted version (pre peer-review, preprint) of the following publication:

Published Version:

Martelli, M. (2023). Medicine in early Graeco-Egyptian alchemical texts (1st-3rd century AD). *TECHNAI*, 14, 9-27 [10.19272/202310501001].

Availability:

This version is available at: <https://hdl.handle.net/11585/931973> since: 2023-06-19

Published:

DOI: <http://doi.org/10.19272/202310501001>

Terms of use:

Some rights reserved. The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (<https://cris.unibo.it/>).
When citing, please refer to the published version.

(Article begins on next page)

This is the preprint version of:

Medicine in early Graeco-Egyptian alchemical texts (1st-3rd century AD), in «Technai. An International Journal for Ancient Science and Technology», 14 (2023): 9–27

The final published version is available online at:

<http://dx.medra.org/10.19272/202310501001>

Rights / License:

The terms and conditions for the reuse of this version of the manuscript are specified in the publishing policy. For all terms of use and more information see the publisher's website.

This item was downloaded from IRIS Università di Bologna (<https://cris.unibo.it/>)

When citing, please refer to the published version.

Medicine in Early Graeco-Egyptian Alchemical Texts (1st-3rd Century AD)

Matteo Martelli*

Abstract. Graeco-Egyptian alchemical texts share two peculiar features: they focus on a broad array of dyeing techniques and include many references to contemporary medical writings and practices. Insofar, scholars have only cursorily hinted at these medical elements without investigating their relevance. In this paper, I shall explore these relationships between alchemy and medicine, by comparing the earliest alchemical texts both with contemporary pharmacological treatises and with some relevant papyri that may offer a significant insight on a set of common practices shared by ancient druggists, dyers, and metalworkers.

Keywords: alchemy, collyrium, Dioscorides, Galen, medicine, simple drugs

1. Introduction

The earliest textual evidence for alchemy is written in Greek and comes from Graeco-Roman Egypt. Our understanding of the early phases of this discipline mainly depends on a few Byzantine anthologies that collect texts dating from the first up to the fourteenth century AD.¹ As far as the earliest treatises are concerned, just scattered excerpts have been included in these anthologies, whose compilers selected and epitomized only specific sections of the original writings. A particular interest in *chrysopoeia* (gold-making) often oriented this selection, which risks distorting our reconstruction of ancient alchemy. Graeco-Roman alchemy, in fact, encompassed a wide variety of dyeing procedures that should be investigated in their complex diversity in order to fully understand their overlaps with contiguous areas of expertise, and in particular with medicine.

For instance, just some sections on gold- and silver-making have been preserved of Pseudo-Democritus' four alchemical books (1st century AD). These books were originally devoted to

* matteo.martelli@unibo.it. University of Bologna. This publication is part of the research project *Alchemy in the Making: From Ancient Babylonia via Graeco-Roman Egypt into the Byzantine, Syriac, and Arabic Traditions*, acronym *AlchemEast*. The *AlchemEast* project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement no. 724914).

¹ Among the most important manuscripts that preserve these anthologies, we must mention *Marcianus* gr. 299 (10th century) and *Parisini* gr. 2325 (13th century) and 2327 (1478). On the basis of these witnesses, Marcelin Berthelot and Charles-Émile Ruelle published the first edition of these collections: *Collections des anciens alchimistes grecs*, 3 vols. (Paris: Steinheil, 1887-1888; hereafter *CAAG*).

a broader set of dyeing procedures involving metalworking as well as the making of precious stones and purple dyeing.² Moreover, the works of other ancient authors, such as Maria the Jewess, Agathodaimon, and Pebichius (2nd-3rd century AD), were left out of the Byzantine collections, so that we are obliged to rely on the information provided by later alchemists (in particular by Zosimus of Panopolis, 3rd-4th century AD). On the other hand, such a fragmented picture may be partially integrated by taking into account the Syriac and Arabic translations of texts that no longer survive in the original Greek as well as two important papyri (late 3rd century AD) that collect a wide range of recipes that circulated in Egypt during the first centuries AD.³

These earliest works – especially Pseudo-Democritus and the papyri – share two important features. On the one hand, they all emphasise dyeing processes that were performed in order to change the colour of various materials, in particular metals, stones (usually quartz), and wool. On the other hand, they often refer to medicine and medical texts, providing both verbatim quotations from pharmacological treatises and detailed information on drugs, including how they were prepared, used, and tested. Insofar, scholars have only cursorily hinted at these medical elements without investigating their relevance.⁴ A certain overlap between alchemy and medicine (especially pharmacology) is indeed detectable: both disciplines made use of a similar set of simple and compound drugs, and both adopted similar methods for approaching and inspecting the natural world. In the following pages I shall explore these relationships, by comparing the earliest alchemical texts both with contemporary pharmacological treatises and with some relevant papyri that may offer a significant insight on a set of common practices shared by ancient druggists, dyers, and metalworkers.

2. Dyeing and healing substances

Copied by the same scribe, the Leiden and Stockholm papyri (hereafter *P.Leid.* and *P.Holm.*) contain two hundred fifty-eight recipes which employ a wide range of dyeing techniques related to metallurgy, making of precious stones, and purple dyeing of wool. The compiler -- who might not coincide with the scribe -- is likely to have relied on various sources, mostly recipe-books that are briefly mentioned in the papyri. *P.Holm.* 53 explains how to dye a stone

² See below, n. 43.

³ The so-called Leiden and Stockholm papyri: edition and translation in HALLEUX 1981.

⁴ See, e.g., HALLEUX 1981, pp. 62-72; SCARBOROUGH 1971 (in part. p. 153, n. 25); for further bibliography, see below, n. 74.

according to the instructions available in ‘the books’ (ταῖς γραφαῖς).⁵ Three recipes on purple dyeing (*P.Leid.* 89; *P.Holm.* 96 and 100) explicitly refer to other passages where the same processes were probably described.⁶ The illustrated techniques encompass various areas of expertise, which were mastered by distinct craftsmen, such as dyers, blacksmiths, metalworkers, and glassworkers, sometimes mentioned in the recipes themselves.⁷ However, the compiler seems to have crossed the boundaries that delimited the activities of these individual experts (often organized in specific guilds), and extended his interest to dyeing techniques more generally, conceiving them as a unified field of investigation.

The compiler also reveals some familiarity with medical texts, as shown by the last two leaves of the Leiden papyrus (folia 14-16), which preserve various excerpts from Dioscorides’ *De materia medica* (1st century AD), one of our most preeminent ancient sources on Graeco-Roman pharmacy. The section is separately introduced by the title «From Dioscorides’ *On Materials (for Medicine)*» (Διοσκορίδου ἐκ τοῦ Περί ὕλης) and lists eleven entries regarding different minerals and ores, all taken from the fifth book of the pharmacological treatise:

Substances	Dioscorides	<i>P.Leid.</i> ⁸
Orpiment (ὄρσενικόν)	V 104	1 st entry
Realgar (σανδαράχη)	V 105	2 nd entry
<i>Misy</i> (μίσυ)	V 100	3 rd entry
Cadmia (καδμία)	V 74	4 th entry
Malachite (χρυσόκολλα)	V 89	5 th entry
Sinope’s <i>miltos</i> (μίλτος σινωπική)	V 96	6 th entry
Lemnian earth (lemma missing)	V 97	7 th entry
Alum (στυπηρία)	V 106	8 th entry
Soda (νίτρον)	V 113	9 th entry
Cinnabar (κιννάβαρι)	V 94	10 th entry

⁵ See HALLEUX 1981, p. 125. Pliny the Elder (*Naturalis historia*, XXXVII 197) and Diodorus Siculus (*Bibliotheca historica*, II 52) mention books on dyeing and counterfeiting precious stones, which already circulated in the late Hellenistic period.

⁶ See HALLEUX 1981, pp. 54-55.

⁷ See HALLEUX 1981, p. 28; LAGERCRANTZ 1913, pp. 142-144.

⁸ The Greek text of this section has been not reedited in HALLEUX 1981. It is available only in the late nineteenth-century edition by LEEMANS 1885, pp. 243-249.

Mercury (ὕδραργυρος)	V 95	11 th entry
----------------------	------	------------------------

Since the entries do not follow the same order attested in Dioscorides, they probably derive from notes made by the compiler while consulting the pharmacological work. Dioscorides' *De materia medica* seems to have circulated widely in Egypt: other papyri containing parts of the treatise have been so far identified and dated from the second to the fourth century AD.⁹ The work is made up of over eight hundred entries, each one reporting the name and the description of a natural drug (a plant, a mineral, or an animal substance), its treatment, and its medical uses.¹⁰ Among these ingredients we find the majority of the one hundred and ninety ingredients mentioned in the Leiden and Stockholm papyri, for some of which Dioscorides provides exact information about their dyeing properties.¹¹ However, the compiler of the papyri selected just a few entries, all relating to mineral ingredients that are mostly mentioned in the metallurgical recipes.¹² Perhaps he had at his disposal just one section of Dioscorides' treatise, or he was more expert (or interested) in metallurgical processes.

At any rate, we should not underestimate the simple fact that a collector of recipes on dyeing techniques decided to consult a pharmaceutical treatise.¹³ This tells us something about his degree of education and about the circulation of different kinds of sources apparently belonging to fields we usually consider as distinct and somehow compartmentalized. We can broaden this picture by considering an interesting account preserved by Galen, who mentions several experts in dyeing, wool working, and metallurgy, who became more and more interested in learning medicine. The context is strongly

⁹ See (1) *P.Mich.* inv. 3, edited in FLEMMING, HANSON 2001; (2) *P.Aberd.* 8 (inv. 5h), edited in WINSTEDT 1907, pp. 263-264; (3) *P.Köln* VII 312 (inv. 1766), edited in GRONEWALD, MARESCHE 1991, pp. 61-62; (4) *P.Oxy.* LXXX 5224-5226, edited by D. Leith in HIRT, LEITH 2014.

¹⁰ See TOUWAIDE 1997, pp. 266-267.

¹¹ See, e.g., Diosc. II 184 (ισάτις, 'woad'); II 185 (ισάτις ἀγρία, 'wild woad'); III 143 (ἐρυθρόδανον, 'madder'); V 98 (χαλκανθές, 'vitriol').

¹² The compiler probably made a mistake in excerpting Dioscorides' treatise, since he included the entry on Lemnian earth, an ingredient never mentioned in the papyri. In Dioscorides' text this earth follows Sinope's *miltos*, which is, on the contrary, used in alchemical recipes. It is likely that the compiler decided to copy two consecutive entries without realizing that the second was not consistent with the content of the papyri. On the contrary, Lemnian earth was highly esteemed by ancient physicians: see MARGANNE 1997; PHOTOS-JONES, HALL 2011, and Photo-Jones' paper in this issue.

¹³ Leiden and Stockholm papyri apart, according to the extant sources, Dioscorides' *De materia medica* was quoted only by medical authors (*in primis* by Galen) between the first and the fourth century AD.

polemical. Galen's target is Thessalus, a physician of the Methodic school who practiced medicine in Rome during Nero's reign:¹⁴

Because that man Thessalus recognized this (i.e., how to practice medicine for becoming rich and powerful), he not only used to flatter the rich in Rome in various ways but also, by promising to teach the craft (i.e., medicine) in six months, readily attracted a great number of students. For if those who would become doctors have no need of geometry, astronomy, dialectic, music, or any of the other noble disciplines, as the most high-minded Thessalus proclaimed, and further, if they have no need of extensive experience in, or familiarity with, the practices of the craft, there is now a ready way forward for anyone who wants to become a doctor easily. Because of this, cobblers, carpenters, dyers (βαφεῖς) and blacksmiths (χαλκεῖς) may now leap into the practices of medicine, forsaking their own original crafts. And these men, when they have displayed their meagre talents, also contend for preeminence.¹⁵

Moreover, a few pages later Galen again mentions a similar group of craftsmen --including cooks (μάγειροι), dyers (βαφεῖς), wool workers (ἐριουργοί), shoemakers (σκυτοτόμοι), weavers (ὀφάνται), and fullers (κναφεῖς) -- who comprised the audience for Thessalus' lectures on medicine.¹⁶

Behind Galen's sarcastic (and perhaps exaggerated) criticism against a medical system that, although denying Hippocrates' legacy, achieved wide popularity between Hellenistic and Roman times, it is possible to recognize the circulation of medical knowledge among many experts in different arts. Moreover, although Galen stresses their lack of experience in the practices of medicine, some artisans, such as dyers, metallurgists, and fullers, were certainly experienced in handling specific sets of "active" substances employed both in their own arts and in medicine. In a famous passage of his *Commentary on Epidemics* Galen himself -- in this case not concerned with Methodism and Thessalus' system -- lists a number of experts (τεχνῖται) who help the physician and act as 'servants' (ὕπηρέται) of medicine. Among them we find cooks and all those people who provide physicians with instruments and substances: blacksmiths who forge metallic surgical instruments, 'root-cutters' (ρίζοτομοί), 'herbalists' (βοτανικοί), and «those who process minerals and other similar products» (τὰ ἐκ τῶν μετάλλων ὅσα τ' ἄλλα τοιαῦτα παρέχοντας).¹⁷

¹⁴ On Methodism and Thessalus, see, e.g., PIGEAUD 1993; NUTTON 2005, pp.187-201.

¹⁵ *De methodo medendi*, I 1, KÜHN 1821-1833, vol. 10, p. 5. Translation by JOHNSTON, HORSLEY 2011, vol. 1, p. 9. The passage corresponds to fr. 155 in the collection of the fragments of the Methodists by TECUSAN 2004, pp. 404-405.

¹⁶ *De methodo medendi*, I 2, KÜHN 1821-1833, vol. 10, p. 19 = fr. 158 in TECUSAN 2004, pp. 411-415.

¹⁷ Galen, *In Hipp. Epid. VI Commentarium*, V 1, WENKEBACH 1956, p. 257 (= KÜHN 1821-1833, vol. 17b, p. 229). See BOUDON-MILLOT 2003, pp. 114-116.

These figures are all related to the flourishing trade of drugs that increasingly expanded during the first centuries AD, especially in ancient metropolises such as Rome and Alexandria.¹⁸ As scholars have already emphasized, this business involved a large group of dealers – such as dealers in *aromata* and perfumes (*aromatarius* – μυροπώλης), ‘druggists’ (*pharmacopola* – φαρμακοπώλης), and dealers in dyestuffs (*pigmentarius*)¹⁹ – who were able to obtain raw materials, process them, and sell a wide range of products, including medicaments, dyestuffs, ointments, and perfumes.²⁰ They are also credited with composing recipes that explain how to prepare specific drugs. These recipes were quoted by ancient writers on pharmacology, such as Asclepiades the Young (1st century AD), and through their works inherited by Galen in his pharmacological treatises.²¹

Regrettably, the degree of specialisation of these experts is difficult to assess, since ancient sources do not offer a clear-cut distinction among them. If we look closely at their names, the terms *pigmentum* and *pharmakon* (φάρμακον) lead to a certain ambiguity, since both refer to a variety of substances that could be used in different fields. For instance, in a recipe for eye salves, the physician Scribonius Largus (1st century AD) calls some of the ingredients (in particular cadmia and burnt copper) *pigmenta*, and in another passage he warns against the low quality of opium sold by *pigmentarii*.²² In the same period, Pliny the Elder compiles a detailed catalogue of pigments (*NH XXXV 29ff.*), which included several minerals suitable for producing both colours (*colores*) and remedies (*medicamenta*). Moreover, he does not confine the term *medicamentum* only to medicine, but introduces it again in reference to the mordants used by Egyptian dyers:

¹⁸ See, e.g., NUTTON 1985.

¹⁹ Greek literary texts did not use the term *πιμεντάριος/πημεντάριος* until the sixth century; it is however attested in two inscriptions dating to the Imperial period: see SAMAMA 2006, p. 12.

²⁰ See KORPELA 1995.

²¹ Galen quotes recipes of two ‘root-cutters’, namely Antonius (three recipes, all taken from Asclepiades’ work, in *De compositione medicamentorum secundum locos*, II 1 and 2, KÜHN 1821-1833, vol. 12, pp. 557,3-8 and 580,1-7, and in *De comp. med. secundum genera*, VI 5, KÜHN 1821-1833, vol. 13, p. 935,1) and Pharnakes (one recipe in *De comp. med. sec. loc.* VIII 7, KÜHN 1821-1833, vol. 13, p. 204,1-9) and of two peddlers (ὀχλαγωγοί), Chariton (throughout Asclepiades) and Simmias (both quoted in *De antidotis*, II 3, KÜHN 1821-1833, vol. 14, pp. 180,5ff. and 182,13ff.): see GUARDASOLE 2006, pp. 32-35. Moreover, Diocles (4th century BC) wrote a treatise entitled *On cutting* [ρίζοτομικόν; fr. 204 in VAN DER EIJK 2000, pp. 356-357], and Dioscorides (*praef.* 1,12) presents Crateuas (2nd-1st century BC), author of works on simple drugs, as a ‘root-cutter.’

²² *Compositiones*, 21,93 and 22,6-8 respectively. See SCHMIDT 1924, pp. 81-82.; JOUANNA-BOUCHET 2004, pp. 46-47.

They first thoroughly rub white fabrics and then smear them not with colours (*colores*), but with chemicals (*medicamenta*) that absorb colour. When this has been done, the fabrics show no sign of the treatment, but, after being plunged into a cauldron of boiling dye (*pigmentum*), they are drawn out a moment later dyed.²³

Such a ‘chemical agents’ or ‘active substances’ capable of fixing the colours that are provided by pigments, are called *stuptika pharmaka* (στυπτικά φάρμακα) in the Leiden papyrus. The papyrus, in fact, contains a catalogue of mordants, which interestingly corresponds with a list of astringent drugs compiled by Galen in his *On the Capacities of Simple Drugs*:

<i>P.Leid.</i> 92 ²⁴	Galen, <i>Simp.Med.Fac.</i> I 34 ²⁵
Astringent drugs (φάρμακα στυπτικά): shoemakers’ black, burnt ‘flower of copper’ (χάλκανθος), alum, <i>chalkitis</i> , cinnabar, lime, peel of pomegranate, pod of a thorn tree, urine with aloes. Use these (substances) as you do for dyeing.	Neither <i>chalkitis</i> , or oak-gall, or even rind of pomegranate, or juice of unripe grapes, or alum, or burnt copper, or much less scales of copper, or <i>misý</i> have the natural property of closing up wounds, and there are thousands of astringent drugs (στύφοντα) that are not able to close up. ²⁶

Galen includes these substances in his sophisticated method for healing wounds (especially ‘hollow wounds’), wherein he contrasts enfleshing and closing up drugs, which make flesh regrow and fill the cavity, with dry and astringent drugs, which make the regrown flesh look like skin (that is indeed drier and more contracted than flesh).²⁷ On the other hand, comparison with the Leiden papyrus shows that the same contracting or astringent properties were recognized and applied in different activities, linked to those people who either sold similar sets of ingredients or bought them for processing raw materials and retailing specific products. For instance, most of the abovementioned ingredients are recorded in the inventory of a druggist’s stock (φαρμακοπώλης) as preserved in *P.Oxy.* XXXI 2567 (253 AD), which lists alum, scissile alum, shoemakers’ black, ochre, and *miltos*.²⁸ Moreover, an interesting

²³ Pliny, *Naturalis Historia*, XXXV 150. Translation by HEALY 1999, p. 194.

²⁴ HALLEUX 1981, p. 106.

²⁵ KÜHN 1821-1833, vol. 11, pp. 440,16–441,3.

²⁶ A similar list is provided also by *De methodo medendi*, III 5 (KÜHN 1821-1833, vol. 10, p. 199,12ff.), where Galen adds also «fruit of Egyptian thorn tree» (τῆς Αἰγυπτίας ἀκάνθας ὁ καρπός).

²⁷ See *De methodo medendi*, III 5 (KÜHN 1821-1833, vol. 10, pp. 198-200); translation in JOHNSTON, HORSLEY 2011, vol. 1, pp. 303-305.

²⁸ All the substances recorded in *P.Oxy.* XXXI 2567 are described in the Dioscoridean passages selected by the compiler of the Leiden papyrus. In addition to this papyrus from Oxyrinchus, many pieces of mutilated papyri

bilingual *ostrakon* from Narmuthis (*O.Narm.Dem.* II 54, 2nd-3rd century AD) records different items ordered by an unnamed customer: in the first part (ll. 1-6, in Demotic) a specific kind of vessel for medicaments is commissioned; in the second (ll. 7-13, in Greek), nineteen dyeing substances are listed, among which orpiment, copper rust, cinnabar, and azurite. Even though the link between the two parts is not evident, we cannot exclude that the substances were used for preparing both pigments and remedies (to be kept in the vessel mentioned in the first part of the papyrus).²⁹

Among *pigmentarii*, druggists, and similar traders we can also find ‘alchemists’, at least the kinds of alchemists described by Zosimus in a passage from his book *On Mercury*, which survives only in a Syriac translation, preserved in an unedited Cambridge manuscript:³⁰

Therefore, traders must not give us a substitute of it [i.e., mercury] -- they have, in fact, the adulterated book of chemistry, the book that [instructs how to] adulterate [metallic] bodies and produce *diplōsis* [lit. ‘duplication’]. And the same goes for the other similar arts. Each of these arts thought up some trick that was suitable for it and invented a book. For dealers in perfumes invented a suitable book on perfumes, tavern-keepers a book on wines, and dealers in ointments [a book] on ointments. Therefore, people counterfeiting pure substances belong to any art.³¹

Then Zosimus goes on to describe different methods for detecting adulterated mercury, concluding: «Any expert knows these methods when he is buying, but in selling he swears to himself that he does not know how to examine (*scil.* the substances he sells)».³²

Zosimus’ criticism insists on techniques for doubling the weight of precious metals (by adding copper, tin, or zinc; i.e., *diplōsis*) and for producing metals that look like gold and silver. The Leiden and Stockholm papyri also describe similar techniques: some recipes explicitly refer to *diplōsis* techniques³³ and others claim that the result of these processes may

report lists of items, without preserving further information on their possible use: *P.Oxy.* 4979 (2nd-3rd century AD), for instance, records a cap (πλίον) and a chest (γλωζόκομον), along with saffron, realgar, and orpiment; *P.Michael.* 36 (4th century AD) lists several ingredients with their prices, such as white lead, different kinds of resin, rust, realgar, and so on.

²⁹ See MENCHETTI, PINTAUDI 2007, pp. 245-247.

³⁰ Only a French translation has been edited in BERTHELOT, DUVAL 1893, pp. 249-250.

³¹ MS Mm. 6.29, fol. 63^v6-13. The English translation is based on a new analysis of the Syriac manuscript.

³² MS Mm. 6.29, fol. 64^r7-9. A similar attitude against traders is well attested among physicians and especially in Galen; see, e.g., BOUDON-MILLON 2003.

³³ See, in particular, *P.Leid.* 6, 7, 10 and 85 in HALLEUX 1981, pp. 85-86 and 104.

deceive even experts (τεχνῖται).³⁴ In addition, the papyri include docimastic techniques for testing the pureness of products³⁵ – the kind of expertise that, according to Zosimus' passage, was necessary in ancient markets. Finally, if we go back to the passages from Dioscorides transcribed at the end of the Leiden papyrus, we may interpret such a section (as Halleux pointed out) as an *aide-mémoire* that helped practitioners to recognize the substances and select the best ingredients from among the various and possibly adulterated substances sold by traders.³⁶ Indeed, the compiler of the alchemical papyrus summarizes Dioscorides' entries, transcribing only the descriptions of the ingredients and leaving the accounts of their medical properties aside. This is evident, for instance, if we compare Dioscorides' entry on mercury with the corresponding section in the papyrus (in the following quotation I have put the parts omitted by *P.Leid.* in square brackets):

Mercury is made from what is called *minion*, which is wrongly called also cinnabar: for they place an iron spoon that has cinnabar on a clay vessel, they turn over it a cup, luting it with clay, and burn it on coals. For the soot that settles on the cup becomes mercury when scraped off. It is also found condensed in drops from ceiling when they process silver ore. Some report that mercury even occurs naturally in the mines. It is kept in glass [or lead, or tin, or silver] containers, because it eats through all other materials and flows away. [It has deadly properties when drunk, eating away the inner parts with its weight. Large quantities of milk drunk and vomited help, as does wine with wormwood (*artemisa absinthium*), or seed of celery, or clary and either oregano or hyssop with wine.]³⁷

The passage is one of the earliest accounts describing a sublimation technique for extracting mercury from its natural ore (i.e., cinnabar).³⁸ Dioscorides' interest in mercury is probably linked to the great development of toxicology that began in Hellenistic times, especially among the so-called Herophileans.³⁹ According to Pliny the Elder (*NH* XX 34) the famous pharmacologist Heracleides of Tarantum (1st century BC) administered a species of

³⁴ See, e.g., *P.Leid.* 8 and 39 (HALLEUX 1981, pp. 86 and 95). In addition, several recipes suggest some possible uses of the metals after being treated according to the described processes: for instance, purified and whitened zinc and copper were used for casting silver plate (*P.Leid.* 3, 40 in HALLEUX 1981, pp. 84 and 95); *P.Leid.* 45 and 47 (HALLEUX 1981, p. 96) instructs how to clean metal plate. All these processes seem to hint at the work of experts who sell their products.

³⁵ See HALLEUX 1981, p. 52.

³⁶ See HALLEUX 1981, p. 30.

³⁷ Diosc. 5.95 vs. *P.Leid.X* as edited in LEEMANS 1885, p. 249,15-28. Translation by BECK 2005, p. 375.

³⁸ The same technique is described by Pliny the Elder, *Naturalis Historia*, XXXIII 143. On this technique, tested in modern laboratories, see MARCHINI *et alii* 2022, pp. 3-6.

³⁹ See VON STADEN 1989, pp. 147 (n. 18) and 450.

Bellflower (*siser erraticum*) against mercury's intoxication (Fr. 26 Guardasole).⁴⁰ However, it is not clear whether Dioscorides refers to accidental ingestions of mercury or to a kind of therapeutic consumption. Ancient sources do not allow us to fully understand the possible role played by mercury in medicine, and Galen admits having no experience on how to administer the drug, whether it was drunk or applied topically.⁴¹

At any rate, while Pseudo-Democritus and Zosimus confirm the dangerous properties of mercury,⁴² the compiler of the Leiden Papyrus shows no interest in the second section of Dioscorides' text. He rather focuses his attention on the first part, which he transcribes and apparently even corrects. The compiler, in fact, seems to have deliberately omitted the reference to lead, tin, and silver vessels as possible containers of mercury: mercury would have dissolved metals and run away.

Such an expertise in the properties of the employed substances combined with a certain level of education, high enough for excerpting Dioscorides' text and collecting recipes, seems to fit well the figures sketched by Zosimus. These people could rely both on their own expertise and on some kinds of handbooks dealing with a set of ingredients exploited in many and partially overlapping activities. Useful information was not only shared in the course of everyday practice, but was also conveyed by written sources that somehow entered the workshops of ancient dealers in medicaments, dyestuffs, ointments, and perfumes. In such a picture it is not surprising that a collector of recipes on dyeing techniques also had pharmacological handbooks at his disposal, and used and 'exploited' them according to his interests and needs.

3. Alchemical and pharmacological method

A different approach to medicine (in particular to pharmacology) is detectable in Pseudo-Democritus' four books on dyeing. Regrettably, the books do not survive in their original

⁴⁰ GUARDASOLE 1997, p. 140. See also Aelius Promotus, *On Venomous Beasts and Poisonous Drugs*, § 70, in IHM 1995, pp. 74-75.

⁴¹ Galen, *De simplicium medicamentorum facultatibus*, IX 3.32, KÜHN 1821-1833, vol. 10, p. 237,12-15. It is worth mentioning that the 7th-century Byzantine physician Paul of Aegina (*Pragmateia*, VII 3, letter Y, s.v. ὑδράργυρος, HEIBERG 1924, p. 268,11-3), after mentioning the toxicity of mercury, says that some people burned mercury, mixed its ashes with other ingredients, and administered it as a beverage. TEMKIN 1955 commented on the passage (p. 135): «Were they medical men like Dioscurides and Galen, or were they alchemists, or possibly alchemists practicing medicine?».

⁴² See, for instance, the above mentioned Zosimus' book *On Mercury* in BERTHELOT, DUVAL 1893, p. 248: «Le mercure a une nature froide et tue ceux qui le boivent. Le philosophe (i.e., Pseudo-Democritus) a dit que celui qui en subit l'action ressemble à un homme ivre et altéré».

form, but primarily in two portions (from the books on gold and silver respectively) that were incorporated into Byzantine alchemical anthologies.⁴³ Consequently, the following pages will focus especially on these sections, which collect several recipes for yellowing and whitening base metals in order to transform them into gold or silver. Even though Pseudo-Democritus grounds his exposition on the same set of ingredients and techniques described in the Leiden and Stockholm papyri, he never presents these techniques as counterfeiting practices.⁴⁴ The art of dyeing constitutes rather a privileged field that allows its practitioners to inspect nature, understand the rules governing the interactions and transformations of natural substances, and master the necessary techniques for controlling them. In this context medicine provides a well-established method of investigation, which Pseudo-Democritus presents as a model for those who seek learning the art of dyeing. In the book on gold making, after presenting the first set of recipes, he exclaims:

O natures, artificers of natures! O greatest natures that conquer natures with your transformations! O natures above nature, which delight in natures! These are the substances that have a great nature; no other natures are greater than these natures in dyeing, no others are equivalent, no others are subordinated [...] And you know that because of their ignorance of (natural?) materials young men will be hesitant and distrustful of this writing, since they do not know that students of physicians who want to prepare a beneficial drug do not set about making it in a rash and untried way, but first of all they test (δοκιμάζειν) which [*scil.* drug] is hot, which one, when joined to it, shall produce a balanced mixture, which one is cold or wet, and of which kind is the disease, whether it [the drug?] is appropriate for the balanced mixture; in this way they administer the drug that has been judged suitable for good health.⁴⁵

The author first praises the wonderful properties of nature, which are activated by the dyeing techniques, and afterwards focuses his attention on the correct method that practitioners ought to follow when investigating natural substances. He warns young practitioners against a distracted and hasty approach to the art and draws an instructive comparison with the method of physicians. For the first time in the history of western alchemy, the dyeing *pharmakon* –

⁴³ Byzantine MSS preserve two sections ascribed to Democritus, namely: (1) a compendium of books 1 and 4 (on gold-making and purple dyeing) under the title of *Natural and Secret Questions* (Φυσικὰ καὶ μυστικά; hereafter *PM*); (2) an epitomized version of book 2 on silver-making (Περὶ ἀσήμου ποιήσεως; hereafter *AP*). See MARTELLI 2013, pp. 7-26.

⁴⁴ No recipes included in the extant sections of Pseudo-Democritus mention products that can deceive experts and be sold. In all the recipes the author first describes how to prepare the dyeing compound, and afterwards instructs how to apply it to base metals in order to transform their natures and produce gold or silver. See MARTELLI 2013, pp. 135-148.

⁴⁵ *PM* 15 in MARTELLI 2013, pp. 94-96 (hereafter Martelli or M.) = *CAAG* II 46,21-47,11.

mentioned in the previous recipes⁴⁶ – is explicitly compared with that of medicine, in a context that clearly refers to the theory of the four elements and their qualities.⁴⁷ This comparison does not just insist on the similarity of the ingredients employed by ‘dyers’ and physicians, but also invokes physicians as examples of the right way of working that ‘dyers’ must adopt to ground their practices on a firm basis. Medicine provides the methodological tools that combine reason and experience. Untried and rash empirical research results in the collection of a huge bulk of data, which may disorient the practitioners who – as Pseudo-Democritus repeatedly says – risk losing themselves in a confused plurality of materials.⁴⁸ Young practitioners, on the contrary, must approach the study of natural substances with good judgment and follow the example of physicians, who test (δοκιμάζειν) the ingredients, detect their main qualities, and choose those that are most appropriate for the disease they want to heal. One century later, Galen would strongly emphasize the centrality of a correct use of experience in pharmacology by introducing the key concept of ‘qualified experience’ (διωρισμένη πείρα) as an important instrument for testing (δοκιμάζειν) the power of drugs.⁴⁹ The empirical test must take into account a wide range of factors (or διορισμοί, ‘qualifications, distinctions’) on which the correct interpretation of the findings depends: the mixture of the drug and the body, the nature of the disease, the consistency of drugs, the ways and proportions in which they are administered, and so on.⁵⁰

The texture of dyeing drugs is adopted by Pseudo-Democritus himself as an important criterion for classifying the different recipes on gold and silver making. He distinguishes between dry drugs, called *ta xēria* (τὰ ξηρία), and moist drugs, called *zōmoi* (ζωμοί), ‘washes’, and he accordingly groups the recipes in two main classes both in the book on gold and in the book on silver.⁵¹ He first explains the recipes based on dyeing *xēria*,⁵² then those

⁴⁶ See in particular *PM* 13,135 (p. 92 Martelli = *CAAG* II 46,10). The term occurs also in many recipes that come after our passage: *PM* 17,189ff. (p. 98 M. = *CAAG* II 48,7ff.); *AP* 2,13 (p. 106 M. = *CAAG* II 50,12); *AP* 3,17 (p. 106 M. = *CAAG* II 51,7); *AP* § 4,34 (p. 108 M. = *CAAG* II 51,14); *AP* § 6,57 (p. 110 M. = *CAAG* II 52,12); *AP* § 7,67f. (p. 112 M. = *CAAG* II 51,22f.); *AP* § 8,78 (p. 112 M. = *CAAG* II 53,6).

⁴⁷ The complete formulation of this theory is clearly phrased in the Hippocratic treatise *On the Nature of Man* and afterwards inherited by Galen, who built up his own pharmacology on this system. See in particular the third book of *De temperamentis* and the first five books of *De simplicium medicamentorum facultatibus*.

⁴⁸ See, in particular, *PM* 4,66 (p. 86 Martelli = *CAAG* II 43,23) and 20,223ff. (p. 102 M. = *CAAG* II 49,17ff.).

⁴⁹ See VAN DER EIJK 1997, p. 43.

⁵⁰ VAN DER EIJK 1997, pp. 42–47.

⁵¹ *PM* 16,183ff. (p. 98 Martelli = *CAAG* II 48,1ff.).

based on dyeing *zōmoi*.⁵³ The adopted terminology is peculiar. The term *xēria* seems to be equivalent to *xēra* (τὰ ξηρά), both used in medical texts to refer to «a remedy in form of dry, desiccating powder», which could be either administered on its own or mixed with liquid ingredients.⁵⁴ The form *xēria* is however uncommon in the first centuries AD, and Pseudo-Democritus' text represents its earliest occurrence,⁵⁵ comparable just with two (dubious) passages by Archigenes (late 1st-early 2nd century AD) and Galen.⁵⁶ The recipes that Pseudo-Democritus considered to deal with dry drugs describe how to process mineral substances, which are usually roasted and ground (often with liquid adjuvants). Some recipes specify that the final dyeing compound resembles gold dust or white lead.⁵⁷ On the other hand, *zōmos* is borrowed from the culinary vocabulary and refers to a 'soup, sauce' usually made of vegetable. In his recipes, Pseudo-Democritus uses the term to refer to dyeing drugs that could form either a liquid bath into which to dip metallic leaves, or a salve (κηρωτή, *AP* 6,59 M.) as thick as wax that is smeared on the metallic leaves.⁵⁸ Although the author never explicitly qualifies these 'washes' as moist, their watery consistency clearly points to their 'moistness,'

⁵² *PM* 5-14 (pp. 86-94 M. = *CAAG* II 44-46); *AP* 1-5 (pp. 104-108 M. = *CAAG* II 49-52). Although the term *xērion* (or *xēron*) is never mentioned in these recipes, in *PM* 16,183 (p. 98 M. = *CAAG* II 48,2) Pseudo-Democritus clearly considers the previous recipes (*PM* 5-14) to deal with dry substances.

⁵³ *PM* 17-19 (pp. 98-100 M. = *CAAG* II 48-50); *AP* 6-9 (pp. 110-112 M. = *CAAG* II 52-53). Pseudo-Democritus followed a similar distinction between dry and moist substances when compiling his catalogues of the substances suitable for gold and silver making. See, in particular, the information provided by the alchemists Olympiodorus (*CAAG* II 99,20-100,4 = *CAAG* II 199,25-220,6) and Synesius (MARTELLI 2013, pp. 26-29).

⁵⁴ See the very well informed comment on *P.Oslo* inv. 1654 (4th to 5th century AD) in MARAVELA-SOLBAKK 2009, p. 117.

⁵⁵ We must mention that the form *xēria* (ξηρία) is attested by the earliest manuscript (*Marcianus* gr. 299), while later manuscripts (*Parisini* gr. 2325 and 2327) have the more common *xēra* (ξηρά), which seems however a *lectio facilitior*.

⁵⁶ See Galen, *De compositione medicamentorum secundum locos*, IX 5 (KÜHN 1821-1833, vol. 13, p. 297,14), where Galen reports the formula of a clyster attributed to the physician Heras (see FABRICIUS 1972, pp. 183-184): here, the term *xērion* refers to a dry powder composed of burnt papyrus, white lead, cadmia, and orpiment, which is to be mixed with blueberry juice. Archigenes' passage is preserved by a later source (the Byzantine physician Aetius) and contains a recipe for a *xērion* (dry remedy) suitable for person suffering in the bowels: see BRESCIA 1955, p. 22, l. 4.

⁵⁷ For gold dust (ψήγμα χρυσοῦ), see *PM* 7,86 (p. 88 Martelli = *CAAG* II 44,16); for white lead (ψιμύθιον), see *AP* 2,13 and 5,46 (pp. 106-108 M. = *CAAG* II 50,12 and 52,1).

⁵⁸ It seems relevant to note that *kērōtē* is a technical term mainly attested in medical treatises. In the alchemical literature it appears also in *P.Leid.* 53 (HALLEUX 1981, p. 97) and in a few later recipe-books.

and later alchemists, from Zosimus onwards, had no doubt in identifying *zōmoi* with moist drugs (τὰ ὑγρὰ).⁵⁹

Terminological issues apart, we may wonder whether such a classification based on the division between dry and moist drugs could reflect or even depend on the structure of contemporary pharmacological treatises. Regrettably, most works on this topic composed in the Hellenistic and early Roman period are lost, and we must rely only on indirect information. However, in his account on ophthalmic remedies Galen offers some interesting details on nine books of a work on internal and external diseases written by Asclepiades Pharmakion (1st century AD).⁶⁰ Galen, in fact, explicitly follows the classification introduced in the first book of the earlier pharmacist:

Since Asclepiades described most of the best (medical) materials among dry drugs, moist drugs, and *kolluria* [πλείστην καὶ μεγίστην ὕλην τῶν ξηρῶν καὶ τῶν ὑγρῶν καὶ τῶν κολλυρίων] and he started from the dry ones, I too have judged it convenient to proceed in this way by adopting the same order than his book. So after describing my own dry remedy, I will afterwards transcribe all the remedies that Asclepiades set down in order in the first of his books on external (remedies), entitled *Marcella*.⁶¹

In the following pages Galen seems to follow this order: after explaining his own *xēron*, he first collects the recipes on dry ophthalmic remedies as reported by Asclepiades, and afterwards the recipes on moist remedies.⁶² The precise difference between these two kinds of drugs – often called dry *kolluria* (roughly, ‘eye salves’) and moist *kolluria* -- is not evident, but it might depend both on their therapeutic properties (the first more appropriate for ‘moist’ eye diseases, the second for ‘dry’ ones) and on how they were administered. It is sometimes specified that dry *kolluria* should be applied in the form of dust, and moist *kolluria* as ointments.⁶³ At any rate, in the preparation of both the *kolluria* ancient medical sources stress the fact that simple ingredients – both minerals and plants – were to be finely ground, often

⁵⁹ See, for instance, Synesius’ commentary (4th century AD) on Pseudo-Democritus’ catalogues (MARTELLI 2013, pp. 122-149 = *CAAG* II 56-69).

⁶⁰ On Asclepiades, see FABRICIUS 1972, pp. 192-199.

⁶¹ *De compositione medicamentorum secundum locos*, IV 6 (KÜHN 1821-1833, vol. 12, p. 726,9-16).

⁶² See the following three sections: (1) *De comp. med. sec. loc.* IV 6 (KÜHN 1821-1833, vol. 12 pp. 727,5–730,4,) on Galen’s dry medicine; (2) *De comp. med. sec. loc.* IV 7 (KÜHN 1821-1833, vol. 12, pp. 730,5–735,7) on Asclepiades’ dry medicines; (3) *De comp. med. sec. loc.* IV 8 (KÜHN 1821-1833, vol. 12, pp. 735,7–790,9) on moist medicines for the eyes (ὑγρὰ ὀφθαλμικά). Although Galen does not mention the name of Asclepiades again in reference to moist remedies, it is likely that this section also depends on Asclepiades’ book: see FABRICIUS 1972, p. 195.

⁶³ See PARDON-LABONNELIE 2013, pp. 38-43.

with liquid adjuvants.⁶⁴ This process is also evoked in ancient alchemical texts, which mention eye salves in reference to grinding procedures. According to a quotation by Zosimus, Agathodaimon prescribed to grind the substances as physicians do for preparing *kolluria*.⁶⁵

If similar passages point to a certain acquaintance of ancient alchemists with medical remedies, it is nonetheless difficult to judge to what extent the wide pharmacological production that developed from Hellenistic period onwards influenced the structure of the earliest alchemical texts. Pseudo-Democritus was surely familiar with the medical uses of various substances, as emerges clearly from the last section of his book on gold making:

The matter for the making of gold extends up to these natural substances. But do not marvel that just one species can perform such a mystery. Do you not see that many drugs can (only) with difficulty, even given time, close up a wound made by iron, while human excrement produces this effect immediately? And often, when many drugs are administered for cauterizing, they do not produce any effect, while treated lime alone cures the disease. And often, when a complex treatment is provided for *ophthalmia* it can be harmful, while the *rhamnos* plant, which has an effect on any disease of this kind, does not fail. So we have to disregard such a worthless and unsuitable matter, and make use only of natural substances.⁶⁶

The author contrasts the use of simple drugs with the tendency to employ a complex and too rich pharmacology, which risks even harming the patient. Such an approach is consistent with his effort to investigate the basic properties of natural substances, as already discussed at the beginning of this paragraph. Pseudo-Democritus provides three examples regarding the treatment of two common pathologies, wounds and eye diseases. The suggested therapies match the information provided by ancient pharmacological treatises. Dung, although apparently linked to folk medicine or magic, is often mentioned and described by ancient pharmacologists, who classified the excrements of several animals. According to Galen, Asclepiades the Young stressed the therapeutic virtues of dung.⁶⁷ Moreover, Galen himself composed a wide catalogue of this kind of *Dreckapotheke*, including ‘human excrements’, whose drying and cicatrizing properties had been personally tested by the physician.⁶⁸ Similar

⁶⁴ See, for instance, the chapter on *kolluria* quoted by Oribasius, *Collectiones medicae*, X 23,1-19 (RAEDER 1929, pp. 64-65) from the first book of Antyllos’ treatise *On Remedies* (2nd century AD).

⁶⁵ *CAAG* II 183,15-17. See also *P.Leid.* 68 (HALLEUX 1981, p. 100) and *P.Holm.* 2 (HALLEUX 1981, p. 110).

⁶⁶ *PM* 20 (pp. 100-102 Martelli = *CAAG* II 49,9-18).

⁶⁷ Galen, *De simplicium medicamentorum facultatibus*, X 2.18 (KÜHN 1821-1833, vol. 12, p. 291).

⁶⁸ See the chapter ‘on human excrement in Galen, *De simpl. med. fac.* X 2.18 (KÜHN 1821-1833, vol. 12, p. 290-309). For the use of excrement in medical papyri, see GAZZA 1956, p. 108.

powers were attributed to lime, as clearly explained by Dioscorides and Galen.⁶⁹ Finally, as far as *rhamnos* is concerned, ancient physicians mentioned various species of *Rhamnus*, some of which were used for treating eye diseases (*ophthalmia*). Both Dioscorides and Galen recommend *lukion* (λύκιον) -- a term indicating both the plant and the drug extracted from it -- in cases of *hupōpia* (or *hyposphagma*), that is, a blackness/shadow casted over the pupil by the rupture of a vein in the eyes.⁷⁰ In regard to *rhamnos* (ράμνος), only the Byzantine physician Aetius (6th century AD) specifies that the plant was administered in cases of *leukōma* or *houlē*, that is, when «the pupil of the eye becomes white».⁷¹ The author reports the recipe for an eye salve based on juice of *rhamnos* mixed with many ingredients, but specifies at the end: «some grind only ammoniac salt with *rhamnos*' juice and smear it (on the eyes). When properly smeared the juice of *rhamnos* alone dyes the white parts (of the pupil)».⁷²

These comparisons confirm Pseudo-Democritus' expertise in the therapeutic properties of natural substances. Even if the author, unlike the compiler of the Leiden and Stockholm papyri, never quotes a specific pharmacological treatise, he was probably familiar with the kind of technical literature that widely circulated in Egypt during the first century AD. His interest in pharmacology encompasses a variety of aspects, which cannot be reduced to a mere use of the practical information that medical texts conveyed about the physical characteristics and the treatments of natural ingredients.⁷³ Pseudo-Democritus focuses his attention on the healing virtues of drugs, on their interaction with the body, and on the method that physicians followed for preparing their remedies. This more comprehensive approach leads the author to draw a closer comparison between the arts of dyeing and medicine, thereby

⁶⁹ Diosc. V 115; Galen, *De simpl. med. fac.* IX 3.31 (KÜHN 1821-1833, vol. 12, p. 237,3-11).

⁷⁰ Diosc. I 100; Galen, *De simpl. med. fac.* VII 11.20 (KÜHN 1821-1833, vol. 12, pp. 63f.) and *De comp. med. sec. loc.* IV 3 (KÜHN 1821-1833, vol. 12, pp. 713f.). For a description of this disease, see, e.g., Ps.-Galen, *Introductio sive medicus*, 16.7 (PETIT 2009, pp. 82-83 = KÜHN 1821-1833, vol. 14, p. 773).

⁷¹ Aetius, *Libri medicinales*, VI 40 (OLIVIERI 1950, p. 290,13f.) Pliny the Elder (*NH* XXIV 124), on the other hand, claims that *rhamnos* is the plant from which *lykion* was produced.

⁷² Aetius, *Libri medicinales*, VI 41 (OLIVIERI 1950, p. 292,15-19). Another similar recipe is given in Aetius VII 102 (OLIVIERI 1950, p. 358,1-5) In both cases, the source of Aetius is unknown.

⁷³ Nevertheless, a rigorous analysis of Pseudo-Democritus' recipes, with particular attention to those passages that stress the chromatic transformations undergone by mineral substances, would doubtless reveal similarities with analogous descriptions proposed in medical texts.

paving the way for his followers, who would amplify this attitude by incorporating various medical elements into their alchemical systems.⁷⁴

Bibliography

LILY Y. BECK, *Pedanius Dioscorides of Anazarbus, De Materia medica*, Hildesheim-Zürich-New York, Olms-Weidmann, 2005.

MARCELIN BERTHELOT, CHARLES-ÉMILE RUELLE, *Collection des anciens alchimistes grecs* (= CAAG), 3 vols., Paris, G. Steinheil, 1887-1888.

MARCELIN BERTHELOT, RUBENS DUVAL, *La chimie au Moyen-Âge*, vol. 2: *L'alchimie syriaque*, Paris, Imprimerie Nationale, 1893.

VÉRONIQUE BOUDON-MILLOT, *Au marges de la médecine rationnelle: médecins et charlatans à Rome au temps de Galien (IIe s. de notre ère)*, «Revue des études grecques», CXVI, 2003, pp. 109-131.

CESARE BRESCIA, *Frammenti medicinali di Archigene*, Napoli, Libreria scientifica editrice, 1955.

BERENICE CAVARRA, *Medicina e alchimia nei testi bizantini*, in *Alchimia e medicina nel medioevo*, edited by Chiara Crisciani and Agostino Paravicini Bagliani, Firenze, ed. del Galluzzo, 2003, pp. 1-17

CAIUS FABRICIUS, *Galens Exzerpte aus älteren Pharmakologen*, Berlin-New York, De Gruyter, 1972.

REBECCA FLEMMING, ANN ELLIS HANSON, *Dioscorides, De materia medica II 76.2 and 76.7/18*, in *Greek Medical Papyri*, vol. 1, edited by Isabella Andorlini, Firenze, Istituto Papirologico «G. Vitelli», 2001, pp. 9-35.

VITTORINO GAZZA, *Prescrizioni mediche dell'Egitto Greco Romano, parte II*, «Aegyptus» XXXVI, 1956, pp. 73-114.

MICHAEL GRONEWALD, KLAUS MARESCH, *Kölner Papyri (P. Köln)*, vol. 7, Opladen: Westdeutscher Verlag, 1991.

⁷⁴ A deep investigation of the relationship between medicine and alchemy in later authors, such as Stephanus of Alexandria and other Byzantine alchemists is still a *desideratum*. Interesting remarks are provided by TEMKIN 1955, CAVARRA 2003 and PAPATHANASSIOU 1990.

ALESSIA GUARDASOLE, *Galien et le marché des simples au Ier et IIe siècle de notre ère*, in *Pharmacopoles et Apothicaires. Les «pharmaciens» de l'Antiquité au Grand Siècle*, edited by Franck Collard and Évelyne Samama, Paris, L'Harmattan, 2006), pp. 29-39.

——, *Eraclide di Taranto, frammenti*, Napoli, D'Auria editore, 1997.

ROBERT HALLEUX, *Papyrus de Leyde, papyrus de Stockholm, recettes*, Paris: Les Belles Lettres, 1981.

JOHN F. HEALY, *Pliny the Elder on Science and Technology*, Oxford, Oxford University Press, 1999.

JOHAN LUDVIG HEIBERG, *Paulus Aegineta, Libri V-VIII*, Leipzig-Berlin, Teubner (*Corpus Medicorum Graecorum*, vol. IX 2), 1924.

MARGUERITE HIRT, DAVID LEITH, *The Oxyrhynchus Papyri, volume LXXX*, London, Egypt Exploration Society, 2014.

SYBILLE IHM, *Der Traktat Περὶ τῶν ἰοβόλων θηρίων καὶ δηλητηρίων φαρμάκων des sog. Aelius Promotus*, Wiesbaden, Ludwig Reichert Verlag, 1995.

IAN JOHNSTON, GREG H.R. HORSLEY, *Galen, Method of Medicine*, 3 vols., Cambridge, MA-London, Loeb, 2011.

JOËLLE JOUANNA-BOUCHET, *Médecins et guérisseurs chez Scribonius Largus ou comment faire la distinction entre le bon médecin et les autres thérapeutes*, in *Mires, physiciens, barbiers et charlatans. Les marges de la médecine de l'Antiquité au xvie siècle*, edited by Franck Collard and Évelyne Samama, Langres, Dominique Guéniot éditeur, 2004, pp. 33-53.

JUKKA KORPELA, *Aromatarii, pharmacopolae, thurarii et ceteri. Zur Sozialgeschichte Roms*, in *Ancient Medicine in its Socio-Cultural Context*, 2 vols., edited by Philip J. van der Eijk, Manfred F.J. Horstmanshoff, and Pieter H. Schrijvers, Amsterdam-Atlanta, Rodopi, 1995, vol. 1, pp. 101-18.

KARL GOTTLÖB KÜHN, *Claudii Galeni Opera Omnia*, 20 vols. in 22, Leipzig, Knobloch, 1821-1833.

OTTO LAGERCRANTZ, *Papyrus Graecus Holmiensis, Recepte für Silber, Steine und Purpur*, Uppsala-Leipzig, Harrassowitz, 1913.

CONRAD LEEMANS, *Papyri Graeci Musei Antiquarii Publici Lugduni Batavi*, vol. 2, Leiden, Brill, 1885.

ANASTASIA MARAVELA-SOLBAKK, *Two Prescriptions for Ophthalmic Remedies on a Papyrus from the Collection of the Oslo University Library*, in *Greek Medical Papyri*, vol. 2, edited by Isabella Andorlini, Firenze, Istituto Papirologico G. Vitelli, 2009, pp. 111-122.

MARIANNA MARCHINI, MASSIMO GANDOLFI, LUCIA MAINI, LUCIA RAGGETTI & MATTEO MARTELLI, *Exploring the Ancient Chemistry of Mercury*, «PNAS» cxix, 24, 2022, pp. 1-8.

MARIE-HÉLÈNE MARGANNE, *Les médicaments estampillés dans les corpus galénique*, in *Galen on Pharmacology. Philosophy, History and Medicine*, edited Armelle Debru, Leiden-New York-Köln, Brill, 1997, pp. 153-174.

MATTEO MARTELLI, *The Four Books of Pseudo-Democritus, Sources of Alchemy and Chemistry*, (Sources of Alchemy and Chemistry, Sir Robert Mond Studies in the History of early Chemistry, Vol. 60 Supplement 1), Leeds, Maney Publishing, 2013.

ANGIOLO MENCHETTI, ROSARIO PINTAUDI, *Ostraka bilingui da Narmuthis*, «Chronique d'Égypte», LXXXII, 2007, pp. 227-280.

VIVIAN NUTTON, *Ancient Medicine*, London-New York, Routledge, 2005.

——, *The Drug Trade in Antiquity*, «Journal of the Royal Society of Medicine», LXXVIII, 2, 1985, pp. 138-145.

ALESSANDRO OLIVIERI, *Aetii Amideni Libri medicinales V-VII*, Leipzig-Berlin, Teubner (*Corpus Medicorum Graecorum*, vol. VIII 2), 1950.

MARIA PAPATHANASSIOU, *Stephanus of Alexandria: Pharmaceutical Notions and Cosmology in his Alchemical Works*, «Ambix», xxxvii, 3, 1990, pp. 121-133.

MURIEL PARDON-LABONNELIE, *Du κολλύριον au «collyre»*, in *La coupe d'Hygie. Médecine et chimie dans l'Antiquité*, edited by Muriel Pardon-Labonnelie, Dijon, Editions Universitaires de Dijon, 2013, pp. 38-43.

CAROLINE PETIT, *Galien, Le médecin, Introduction*, Paris, Les Belles Lettres, 2009.

JACK PIGEAUD, *L'introduction du Méthodisme à Rome*, in *Aufstieg und Niedergang der Römischen Welt*, vol. 37.1: *Wissenschaften (Medizin und Biologie)*, edited by Wolfgang Haase, Berlin-New York, De Gruyter, 1993, pp. 565-599.

EFFIE PHOTOS-JONES, ALLAN J. HALL, *Lemnian Earth and the Earths of the Aegean: An Archaeological Guide to Medicines, Pigments and Washing Powders*, Glasgow, Pottingair Press, 2011.

JOHANNES RAEDER, *Oribasii Collectionum medicarum reliquiae, libri IX-XVI*, Leipzig-Berlin, Teubner (*Corpus Medicorum Graecorum*, vol. VI 1,2), 1929

ÉVELYNE SAMAMA, *Thaumatopoioi pharmakopôlai. La singulière image des préparateurs et vendeurs de remèdes dans les textes grecs*, in *Pharmacopoles et Apothicaires. Les «pharmaciens» de l'Antiquité au Grand Siècle*, edited by Franck Collard and Évelyne Samama, Paris, L'Harmattan, 2006, pp. 7-27.

JOHN SCARBOROUGH, *Gnosticism, Drugs, and Alchemy in Late Roman Egypt*, «Pharmacy in History», XIII, 1971, pp. 151-157.

ALFRED SCHMIDT, *Drogen und Drogenhandel im Altertum*, Leipzig: Verlag von Johann Ambrosius Barth, 1924.

MANUELA TECUSAN, *The Fragments of the Methodists: Methodism outside Soranus*, vol. 1: *Text and Translation*, Leiden, Brill, 2004.

OWSEI TEMKIN, *Medicine and Graeco-Arabic Alchemy*, «Bulletin of the History of Medicine» xxix, 1955, pp. 134-153

ALAIN TOUWAIDE, *La Thérapeutique médicamenteuse de Dioscoride à Galien: du pharmacocentrisme au médico-centrisme*, in *Galen on Pharmacology. Philosophy, History and Medicine*, edited by Armelle Debru, Leiden-New York-Köln: Brill, 1997, pp. 255-82.

PHILIP VAN DER EIJK, *Galen's Use of the Concept of Qualified Experience in his Dietetic and Pharmacological Works*, in *Galen on Pharmacology. Philosophy, History and Medicine*, edited by Armelle Debru, Leiden-New York-Köln, Brill, 1997, pp. 35-58.

——, *Diocles of Carystus, a Collection of the Fragments with Translation and Commentary*, 2 vols., Leiden-Boston-Köln, Brill, 2000-2001.

HEINRICH VON STADEN, *Herophilus and the Art of Medicine in Early Alexandria*, Cambridge, Cambridge University Press, 1989.

ERNST WENKEBACH, *Galenus In Hippocratis Epidemiarum librum VI commentaria I-VI*, Berlin, Akademie Verlag (*Corpus Medicorum Graecorum*, vol. V 10,2,2), 1956

ERIC O. WINSTEDT, *Some Greek and Latin Papyri in Aberdeen Museum*, «The Classical Quaterly», I, 1907, pp. 257-267.