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Inks as Instruments of Writing

Ibn al-Ǧazarī's Book on the Art of Penmanship

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Abstract

A short treatise attributed to Ibn al-Ǧazarī (born Damascus 751/1351) deals with what was considered necessary knowledge about the art and craft of penmanship. Along with linguistic and antiquarian remarks, scribal practices, and social applications of writing, an entire section is devoted to the preparation of inks. The selection of recipes includes different ink typologies and technical approaches to ink making, with a preference for metallic compounds; the manipulation of metallic substances often absorbed technological aspects of alchemical practice. This article provides an edition and a commented English translation of the section on inks in the *Book on the Art of Penmanship*, as preserved by its unique manuscript witness, MS Berlin Sprenger 1918. A recipe for the distillation of an artificial golden ink has been replicated in order to better understand the interaction between the text and the chemical reality behind it.

Keywords

inks – Arabic manuscripts – recipes – alchemy – *codex unicus* – chrysography – replication

1 The Text, Its Carrier and Its Author[1,2]

The title page of MS Berlin Sprenger 1918 [Fig. 1] informs us that the following pages contain the *Kitāb al-iṣāba fī lawāzim al-kitāba* ('Book on the art of pen-

1 Submitted in an earlier version on August 27, 2017. Accepted for publication on April 12, 2019.
2 This article is published within the framework of the *AlchemEast* project, which has received

manship')[3] and attributes it to Ibn al-Ǧazarī. Scholars have viewed both this title and the attribution with suspicion. Aloys Sprenger—who acquired this manuscript in Damascus—penned a note on the title page, which suggested the manuscript could be attributed to one of the Ibn al-Aṯīr brothers (d. 606 H / 1210 CE):[4]

> History of the art of writing, and | various alphabets, recipes for ink as | by Majd uDyn Abú-lsa'ádàt al-Mobárak | Ibn al-Athyr Jazary who died the last day of 606 | ASprenger | Damascus 24 December 844

Ahlwardt, too, was concerned with the authenticity of this claim. For him, the title is questionable and the attribution doubtful, especially given the number of intellectuals who bore the name Ibn al-Ǧazarī.[5] Among them, he cautiously indicated the traditionist Šams al-Dīn Ibn al-Ǧazarī, born in Damascus in 751 H / 1350 CE, as a possible author of the text.[6] Modern Arab editors of other

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3 The digitized version of this manuscript is available in the digital collection of the Staatsbibliothek Berlin, https://digital.staatsbibliothek-berlin.de/werkansicht?PPN=PPN668065125&PHYSID=PHYS_0005&DMDID= (last accessed on 22 March 2019). A more literal translation of the title would be 'Book of the goal in the requirements for writing'. The word *kitāba* refers to the act and practice of writing, or penmanship. In the text, however, the word is also used to mean 'script', referring to the Arabic writing system, whereas other scripts were called *aqlām* (lit., 'pens'). The word *ḫaṭṭ* is translated here as 'handwriting', since it refers to a particular act of writing performed by a single person in his own style.

4 This family name was given lustre by the scholarly activity of three brothers: Maǧd al-Dīn (544–606 H / 1149–1210 CE), 'Izz al-Dīn (555–630 H / 1160–1233 CE) and Ḍiyā' al-Dīn (558–637 H / 1163–1239 CE). The three were active, respectively, in the fields of philology and religious studies, historiography and literary criticism. Their father gained the *nisba* al-Ǧazarī serving in Ǧazīrat ibn 'Umar as high officer of the Zangid rulers of Mosul. Throughout his life, Maǧd al-Dīn Ibn al-Aṯīr held an important administrative post in Mosul. He also wrote on prophetic traditions of pious early Muslims; a large part of his scholarly output has not yet been retrieved. See Franz Rosenthal, "Ibn al-Athīr", in: *Encyclopaedia of Islam, Second Edition*, Edited by: P. Bearman, Th. Bianquis, C.E. Bosworth, E. van Donzel, W.P. Heinrichs. Consulted online on 20 September 2018 http://dx.doi.org/10.1163/1573-3912_islam_SIM_3094. See also, Carl Brockelmann, *Geschichte der arabischen Litteratur*, vol. 1, Leiden: Brill, 1943, p. 438. Later, a printed label, quoting from this description, was pasted onto the title page.

5 See also, Wilhelm Ahlwardt, *Die Handschriften-verzeichnisse der Königlichen Bibliothek zu Berlin*. Berlin: A.W. Schade's Buchdruckerei, 1887, vol. 1 p. 6 (no. 6).

6 Šams al-Dīn Ibn al-Ǧazarī (751–833 H / 1350–1429 CE) began studying Islamic traditions, Qur'anic readings, and Islamic law in Damascus. After performing the pilgrimage, he continued his studies in Cairo. With a view to completing his training, and then in pursuit of various political turns and postings, Ibn al-Ǧazarī travelled mainly in Iran, Iraq, Turkey, Ara-

works by Ibn al-Ǧazarī tend to include the *Kitāb al-iṣāba fī lawāzim al-kitāba* in the author's literary output, listing it under the rubric 'various subjects'.[7] The attribution indeed presents some problematic and potentially weak points; the match between this text and more than one Ibn al-Ǧazarī remains plausible, taking into account the scholarly and professional background of these scholars. This same element, however, would also work perfectly in the construction of a pseudo-epigraphic attribution.

The text survives in this single manuscript witness and the *codex unicus* is a delicate tradition to handle.[8] The lack of other witnesses avoids an accumulation of variants and this may lure readers into a false sense of security. In fact, the philologist is left alone with a single, randomly extant copy of the text. The fact that a witness represents the last handhold for a text before it falls into oblivion does not automatically grant this unique witness any other special quality. Indeed, the last surviving witness of a text has an equal chance of being its least, or even its most refined version, and anything in between.[9]

The structure of the text presents some oddities: these can be detected but remain hard to explain in the narrow perspective of a tradition witnessed by a single codex. Ahlwardt remarked that the first and last leaf had been replaced and that the introduction announced three sections, whereas the text preserved in MS Berlin Sprenger 1918 has six. The first three speculations (*anẓār*) are extremely concise and describe three basic aspects of writing: the technical and material aspects connected to pen, paper and ink; the grace of God in

bia, and Central Asia. He was a quite prolific author and his literary output includes a large number of titles dealing with his scholarly and professional interests. See M. Ben Cheneb, "Ibn al-Djazarī", in: *Encyclopaedia of Islam, Second Edition*, Edited by: P. Bearman, Th. Bianquis, C.E. Bosworth, E. van Donzel, W.P. Heinrichs. Consulted online on 20 September 2018, http://dx.doi.org/10.1163/1573-3912_islam_SIM_3141. See also, Carl Brockelmann, *Geschichte der arabischen Litteratur*, vol. II Leiden: Brill, 1949, pp. 201–2013; and Carl Brockelmann, *Geschichte der arabischen Litteratur*, S. II Leiden: Brill, 1938, pp. 274–278.

7 See, for instance, Ibn al-Ǧazarī, *Al-tamhīd fī ʿilm al-taǧwīd*, ed. Farġalī Sayd ʿArbāwī. Bayrut: Dār al-kutub al-ʿilmīya (1971), p. 32; and Ibn al-Ǧazarī, *Kitāb taḥbīr al-taysīr fī-l-qirāʾāt al-ʿašar*, ed. Aḥmad Muḥammad Mufliḥ Luqḍāt. Riyadh: Dār al-furqān li-l-našr wa-l-tawzīʿ (1421/2000). This attribution, however, seems to be based solely on the title page of the Berlin manuscript. In this case, it would be a circular argument and add little to the debate on the question of the attribution.

8 See Jan Just Witkam, "Establishing a Stemma: Fact or Fiction?", *Manuscripts of the Middle East* 3 (1988), pp. 88–101, in particular pp. 90–92; Alessandro Bausi, A et al., *Comparative Oriental Manuscript Studies. An Introduction*. Hamburg: Tredition 2015, pp. 336 and 342; and Lucia Raggetti, "Arabic Philology", in Philipp Roelli et al. *Introduction to Stemmatology in the Digital Age*. Berlin: De Gruyter (forthcoming).

9 The case is obviously different if the only surviving witness is an autograph or a copy corrected, revised, or annotated by the author himself or under his direct supervision.

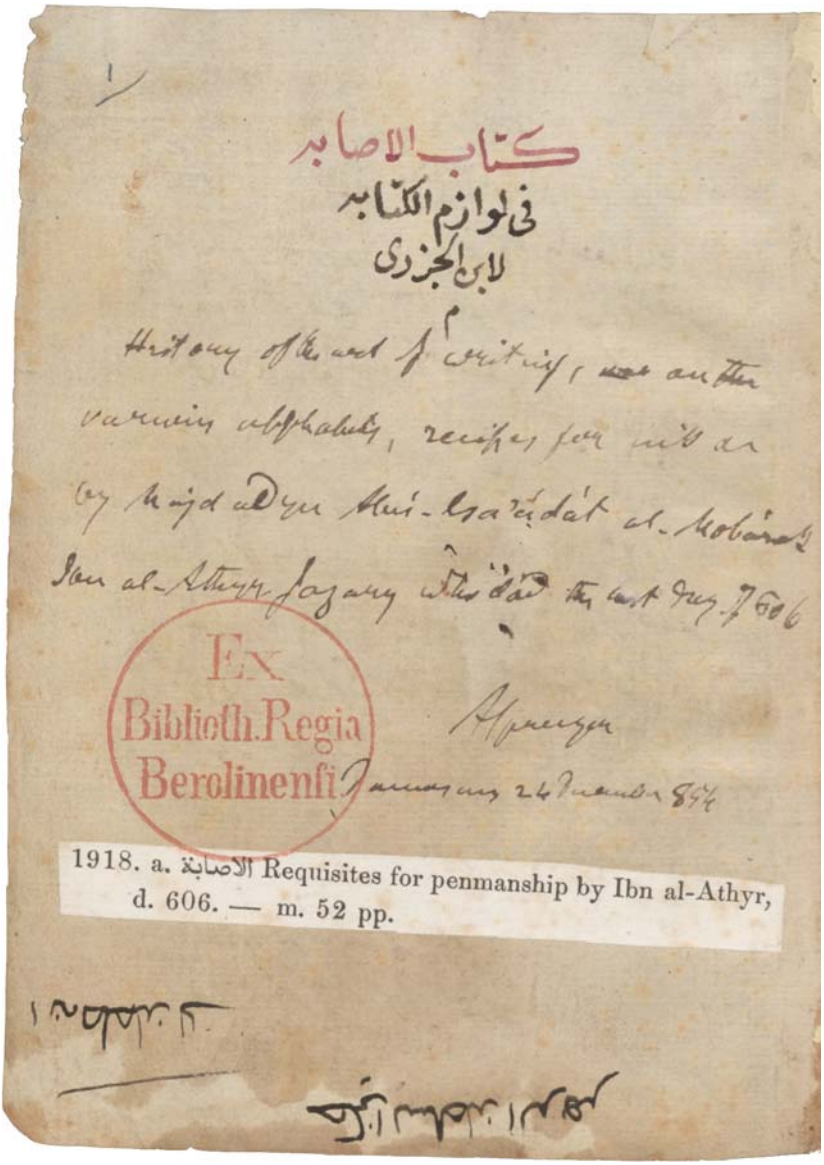

FIGURE 1 Title page of Ibn al-Ǧazarī's 'Book on Penmanship' with Sprenger's annotation, MS Berlin Sprenger 1918 f. 1r
PHOTO: STAATSBIBLIOTHEK ZU BERLIN

revealing His Scripture; and the mental process that leads a man to write down his thoughts and impressions. The other three speculations are longer and deal with the advantages of writing, the different kinds of script, and the causes of writing. The simplest explanation for this discrepancy is a problem of transmission with the number of speculations, giving the introduction 'three' instead of 'six', though, admittedly, this hypothesis is on shaky palaeographical ground. One must also consider the case in which an entire sentence in the introduction, referring to the second three speculations, was lost. Another possibility is that the text originally had a core of three parts, that the rest is a later addition, and that, in the course of this process, the reference to the number of its components in the introduction passed unnoticed and was not updated. Since the manuscript does not surrender any other clue, and in the absence of other witnesses, this list of plausible hypotheses is the point at which the philological guesswork must stop.

A further minor incoherence emerges in the passage dealing with secret messages (*al-mulāṭafāt*) to be written with invisible inks.[10] The text suggests following a previously indicated procedure, but there is no trace of it in the rest of the section dealing with anecdotes on the subject. This mismatched internal reference may derive from a source considered for the compilation, or it may bear witness to the loss of part of the text that preceded this remark. Apart from the first and the last folio, the whole text was copied by the same hand, in a very cursive and not particularly refined or accurate style, even more when it comes to technical expressions. This lack of familiarity with technical terminology usually produces only trivial mistakes that do not increase our knowledge of the textual tradition (for instance, جذع for جزع 'onyx' in recipe no. 19).

Whether introduced by this copyist or entered in the tradition at another stage, the Arabic of the text is mixed and include several expressions that can be reconnected to spoken language. This could also be the reason behind the peculiar spelling of some words. Some pages are annotated by more than one hand, including the one that left an undated reading note on fol. 27r.

This is not the only short treatise on penmanship preserved in Arabic literature. Al-Tawḥīdī (d. 414 H / 1023 CE) composed an essay on calligraphy entitled *Risāla fī ʿilm al-kitāba*. ('Book on the science of penmanship').[11] Similar contents can also be found in another textual genre, the *Adab al-kuttāb* ('Etiquette of scribes'), as illustrated by many different titles, from the early work written

10 See Adam Gacek, *Arabic Manuscripts: A Vademecum for Readers*. Leiden: Brill, 2009, p. 134.

11 See Franz Rosenthal, "Abū Ḥayān al-Tawḥīdī on Penmanship", *Ars Islamica* 13 (1948), pp. 1–30.

by al-Ṣūlī (d. 335 H / 947 CE) to the Mamluk *Ṣubḥ al-aʿšā* ('The dawn for the blind') composed by al-Qalqašandī four centuries later (d. 804 H / 1401 CE).[12] What our manuscript, the *Kitāb al-iṣāba fī lawāzim al-kitāba*, has in common with this other composition is that a consistent part of the text is represented by a collection of anecdotes. A number of passages from the *Kitāb al-iṣāba fī lawāzim al-kitāba* echo parallel sections in this array of compositions. What emerges from Rosenthal's study of al-Tawḥīdī's *Risāla*, however, is that different authors tapped into the same sources, using them freely in the composition of the textual blocks they chose to include in their work. Both the choices of the different authors and the transmission of the texts introduced significant variance with regard to the exact wording of sayings and anecdotes.[13]

The differences clearly emerge, however, when looking at specific contents. If, on the one side, the *Adab al-kuttāb* ('Etiquette of secretaries') provides a long list of writing implements—to which various lexicographical remarks and poetic quotations are attached—on the other, the *Kitāb al-iṣāba fī lawāzim al-kitāba* exclusively focuses on inks (MS Berlin Sprenger 1918, ff. 11v–16v), listing recipes rather than anecdotes and verses. The interest in different historical manifestations of writing represents another peculiar feature of this treatise. The *Kitāb al-iṣāba fī lawāzim al-kitāba* stands out as a particular composition that sits at the intersection of different motives and genres related to the activity of writing: *adab* handbooks, technical treatises on ink making and calligraphy, and collections of traditions.

The text, as preserved in MS Berlin Sprenger 1918, is arranged in six speculations meant to cover the necessary knowledge for those wanting to practice the art of writing. A writing-related topic frequently becomes an occasion to mention anecdotes taken from history and religious traditions. The author viewed the art of writing from many different perspectives, showing a linguistic and antiquarian interest in the description of non-Arabic alphabets, either connected to sacred books, or to remarkable ancient civilizations.[14]

12 See al-Qalqašandī, *Ṣubḥ al-aʿšā fī ṣināʿat al-inšā*, ed. Muḥammad ʿAbd al-Rasūl Ibrāhīm. Cairo: Dār al-kutub al-ḥudaywīya, 14 vols, 1331–8 H / 1913–1920 CE.

13 See Rosenthal, "Abū Ḥayān al-Tawḥīdī", pp. 1–3.

14 As for the edition of the Arabic text, I have reintegrated the dots whenever these were omitted and normalized minor aspects of orthography (for instance, the *hamza*, the *tāʾ marbūṭa* and the alternation between *yāʾ* and *alif maqṣūra*). Whenever a reading has been significantly revised or presents problematic aspects, it is discussed in the footnotes. Although the *codex unicus* can be the object of a diplomatic edition, I have opted for some linguistic and orthographic adjustments that improve the readability of the text.

1.1 *MS Berlin Sprenger 1918, ff. 1r–1v*

[Ibn al-Ǧazarī's *Book on the art of penmanship*]	[كتاب الاصابة في لوازم الكتابة لابن الجزري]
In the name of God, the Merciful the Compassionate.	بسم الله الرحمن الرحيم
Praise to the One "who taught in writing to the man what he did not know." (Qur'ān 96:4–5)	الحمد الله الذي علم بالقلم على الانسان ما لا يعلم
Blessing and Peace upon his Prophet Muhammad, and Peace upon his family and companions.	والصلاة والسلام على نبيه محمد وعلى اله وصحبه وسلم
As for what follows, this is a composition (*risāla*) of little extension, but of great value and science.	اما بعد فهذه رسالة صغيرة الحجم كبيرة القدر والعلم
I made it into a memorandum (*taḏkira*) for myself and for whomever God wants [to come] after me.	وجعلتها تذكرة لنفسي ولمن شاء الله تعالى من بعدي
I composed it about the art of penmanship, and about the miss and hit that it concerns.	وضعتها في فن الكتابة وما يعرض لها من الخطأ والاصابة
I ask God, may He be exalted, that the one who studies these [things] may profit from them, and that he carefully approaches what has been imposed on him.	وانا اسأله تعالى ان ينفع طالبها بها ويجعله لما املى عليه منتبها
God, may He be exalted, said: "Let no scribe refuse to write as Allah has taught him. So, let him write and let the one who has the obligation dictate. And let him fear Allah, his Lord." (Qur'ān 2:282)	قال تعالى ولا يابى كاتب ان يكتب كما علمه الله فليكتب وليملى للذي عليه الحق وليتق الله ربه
Writing has three speculations of high importance.	وللكتابة ثلاثة انظار عالية المقدار

The chapter headings, often rubricated, outline a table of contents for the text.[15]

15 For the transcription of the Arabic, see Ahlward, *Die Handschriften-verzeichnisse*, vol. 1, p. 6.

[f. 1r] *Kitāb al-iṣāba fī lawāzim al-kitāba li-Ibn al-Ǧazarī*
(Handwritten note in English by Sprenger: *History of the art of writing, and* | *various alphabets*, recipes for ink as | by Majd uDyn Abúlsaʾádàt al-Mobárak | Ibn al-Athyr Jazary who died the last day of 606 | ASprenger | Damascus 24 December 844).

[f. 1v] First speculation (*Al-naẓar al-awwal*)

[f. 1v] Second speculation (*Al-naẓar al-ṯānī*)

[f. 2r] Third speculation, on the circumstances of the occurrence of writing (*Al-naẓar al-ṯāliṯ fī kayfīya ḥudūṯ al-kitāba*)

[f. 3v] Fourth speculation, on the advantages of writing (*Al-naẓar al-rābiʿ fī fawāʾid al-kitāba*)

- among them, what God mentioned in His Noble Book (*wa-minhā mā ḏakarahū Allāh fī Kitābihī al-ʿAzīz*)
- among them, the regulation of properties (*wa-minhā taqrīr al-amlāk*)

[f. 4r]
- among them, the record of contracts (*wa-minhā muḥāfaẓat al-ʿuhūd*)
- among them, the protection of estates for their owners against fraud (*wa-minhā ḥifẓ al-amwāl ʿalā aṣḥābihā ʿan ḫiyāna*)
- among them, the protection of wealth (*wa-minhā ḥifẓ al-arzāq*)
- among them the epistolary exchanges (*wa-minhā al-murāsalāt*)

[f. 4v]
- among them, the signs of what it is hidden and what is open with a concealed secret (*wa-minhā aʿlām al-ġāʾib wa-l-ḥāḍir bi-l-sirr al-ḫafī*)
- among them, safety from forgetfulness (*wa-minhā al-salāma ʿan nisyān*)
- among them the safety of sciences from extinction (*wa-minhā salāma al-ʿulūm ʿan al-durūs*)
- among them, when something comes to your mind [to record thoughts and feelings] (*wa-minhā iḏā ḫaṭara fī qalbihī šayʾ*)

[f. 5r]
- among them, what some learned men mentioned about writing standing in the place of eloquence (*wa-minhā mā ḏakarahū baʿḍ al-ḥukamāʾ an al-kitāba qāʾima maqām al-bayān*)

[f. 5r] Fifth speculation, on the kinds of scripts (*Al-naẓar al-ḫāmis fī anwāʾ al-kitāba*)

[f. 5v]
- first kind: Arabic (*al-nawʿ al-awwal al-ʿarabīya*)
- first section, about its inventor (*al-faṣl al-awwal fī wāḍiʿihā*)
- second section, on the origin of the letters (*al-faṣl al-ṯānī fī aṣl al-ḥurūf*)

[f. 7r]
- third section, on the number of letters of the Arabic script (*al-faṣl al-ṯāliṯ fī ʿadad ḥurūf al-kitābat al-ʿarabīya*)

[f. 7r] – fourth section, on the order of letters (*al-faṣl al-rābiʿ fī tartīb al-ḥurūf*)

[f. 8v] – fifth section, on what the scribes agree upon (*al-faṣl al-ḫāmis fī mā ittafaqa ʿalāhī al-kuttāb*)

[f. 10r] – second kind, Hebrew scripts, and this is the script in which the Torah is written (*al-nawʿ al-ṯānī min aqlām al-ʿibranīya wa bi-hāḏā al-qalam kutibat al-Tūrāh*)

[f. 10v] – third kind, Syriac scripts, and this is the script in which the Gospels are written (*al-nawʿ al-ṯāliṯ min aqlām al-Suryānīya wa bi-hāḏā al-qalam kutiba al-Inǧīl*)

– fourth kind, Indian scripts and the importance of learning this kind [of script] (*al-nawʿ al-rābiʿ min aqlām al-Hindīya wa-l-ḥāǧāt ilā taʿallum hāḏā al-nawʿ*)

[f. 11r] – fifth kind, Ḥimyarite scripts, it is maintained that it was created in the ancient time (*al-nawʿ al-ḫāmis min aqlām al-Ḥimyarīya zaʿamū annahū kāna mustaʿmal*^{an} *fī qadīm al-zamān*)

[f. 11v] ***Al-naẓar al-sādis fī asbāb al-kitāba***—Sixth speculation on the causes of writing

– first section, on its causes ([*al-faṣl*] *al-awwal fī asbābihā*)

– second section, on the instruments of writing and its tools (*al-faṣl al-ṯānī fī ālāt al-kitāba wa-adwātihā*)

– section on the ways of preparing ink (*faṣl fī aʿmāl al-ḥibr*)

[f. 15v] – section on writing with the 'bodies' [the metals] (*faṣl fī al-kitāba bi-l-aǧsād*)

[f. 16v] – section on dissolving the seven 'bodies' [the seven metals] (*faṣl fī ḥall al-aǧsād al-sabiʿa*)

– on the ways of preparing secret messages (*faṣl fī aʿmāl al-mulāṭafāt*)

[ff. 17r–19v] Traditions and anecdotes on verbosity and eloquence, praise and deprecation

[ff. 19v] Letters sent by some governors to the Abbasid caliphs

[ff. 19v–27r] Section on epistolary exchanges (*faṣl fī al-mukātabāt*)[16]

16 This section includes a considerable number of letter incipits or excerpts, arranged in chronological order: the message that Salomon sent to the Queen of Sheba; the letters that the Prophet Muḥammad sent to the emperors of Persia and Byzantium; and the messages that his Companions and the well-guided Caliphs sent to their governors; messages from the Umayyad caliphs.

2 Inks as Instruments of Writing

The material dimension and technical skills necessary to practice the art of penmanship are an important motif of this text. The first speculation states that the three material 'pillars' upon which the quality of writing rests are a smooth and brilliant ink, a clean parchment, and a sharp pen.

2.1 *MS Berlin Sprenger 1918, fol. 1v*

First speculation **النظر الاول**

One must prepare a compound substance of a medium fluidity made with soot of olive oil, then it will have the thinnest body and the finest consistency, and it will achieve its brilliance.	ان يتخذ مركبا متوسط الجرى مصنوعا من دخان زيت الزيتون فانه ارق جسما والطف جرما وسياتي بيانه
Then one must prepare some parchment (*raqq*) cleaned with a mixture of gypsum and lime,[17] so that his hand can smoothly proceed in writing without any obstruction.	ويتخذ رقا مجلوا بالطباشير لتمريده في الكتابة من غير تاخير
Then one must prepare an excellent pen of medium hardness, so that its movement ensures that the writing turns out well.	ويتخذ قلما بالغا متوسط الصلابة لتجود بحركته الكتابة
These are the three [elements] of the first [speculation] upon which the result of the work depends.	فهذه الثلاثة من الاول التي عليها المعمول

17 بالتباشير [بالطباشير] The expression *bi-tabāšīr*, with the *tā'*, means 'at the beginning, at the dawn' of something. In this context, however, I think it is more likely to be an orthographic oddity in the name of a kind of chalk paste. See Fabian Käs, *Die Mineralien in der arabischen Pharmakognosie. Eine Konkordanz zur mineralischen Materia Medica der klassischen arabischen Heilmittelkunde nebst überlieferungsgeschichtlichen Studien*, 2 Bände. Wiesbaden: Harrassowitz, 2010, vol. II pp. 765–769, s.v. *ṭabāšīr*; Alfred Siggel, *Arabisch-deutsches Wörterbuch der Stoffe aus drei Naturreichen*. Berlin: Akademie Verlag, 1950, p. 83. For the practice of rubbing parchment with chalk before its use in order to smoothen the surface, see Gacek, *Vademecum*, p. 197 (s.v. 'parchment').

The sixth and last speculation deals with the innate causes and the material tools connected to writing and is articulated in two separate sections. In the first, the act of writing is equated to all the other crafts that are transmitted from master to pupil, as is appropriate for this kind of knowledge. The author admits that this chain of transmission from the past is very fragile and can easily be broken. In such an unfortunate case, the next best solution is to follow contemporary masters. The result, however, will always be bound to a skill—or the lack thereof—that is innate in the one who performs the act of writing and which God decreed to place in the fingertips. The distribution of this skill is unequal, as is often the case with intelligence and other talents. The anecdotes included in this section stress the crucial importance of using appropriate tools for writing. There is also an interesting remark about the best ink, chosen by professionals, for ensuring smooth writing: due to its consistency, scribes seem to prefer *līqa* over *ḥibr*. If the latter usually indicates iron-gall inks, in this context *līqa* seems to refer to inks based on metallic components.[18]

2.2 *MS Berlin Sprenger 1918, fols. 11v–12v*

Sixth speculation on the causes of writing and its instruments, in two sections.

[11v] **النظر السادس في اسباب الكتابة وآلاتها وفيه فصلان**

The first [section] is about its causes.

الاول في اسبابها

Know that writing is like all other handicrafts, and relies rests upon the guidance of a master.

اعلم ان الكتابة كسائر الصناعات تتوقف على ارشاد استاذ

If you do not find [a master], then write according to the handwriting of a master of our time, whose handwriting must be correct, yet in conformity with his personal inclination.

فان لم تجد فليكتب على خط استاذ زماننا فانه يستقيم خطه لكن على قدر استعداده

18 For *līqa*, see Sara Fani, *Le arti del libro secondo le fonti arabe originali. I ricettari arabi per la fabbricazione degli inchiostri* (*sec. ix–xiii*)*: loro importanza per una corretta valutazione e conservazione del patrimonio manoscritto*. PhD dissertation, Napoli: Università 'L'Orientale', 2013, p. 27; see also Gacek, *Vademecum*, p. 76 (s.v. 'Coloured inks and paints'). For *ḥibr*, see Gacek, *Vademecum*, pp. 132–134 (s.v. 'Ink').

فان الله تعالى قد خلق في الانامل قوة تتفاوت الناس
في تلك القوة فترى بعض الناس في خطه لطافة
وحسن وحلاوة تلتذ العين بالنظر اليه ولا تجد ذلك
في خط الغير

In fact, God—may He be exalted—created in the fingertips a faculty, people are different concerning this quality; and so you see that some people have a fine, beautiful, and pleasant handwriting at which the eye can rejoice when looking at it, but you will not find this in the handwritings of others.

فانها منحة من الله تعالى خصص انامل [12r] هذا
بها دون غيره كما خصص بعض الاذهان بمزيد زكاء
وفطانة

In fact, this is a gift from God—may He be exalted—Who assigned this to the fingertips and to nothing else; as He assigned a greater level of justness and smartness to only some intellects.

وكما ترى من اللاعب بالشطرنج فان فيهم من يلعب
بالطبقة العالية حتى يطرح اللاعبون المجود الرخ وغيره
لايقدر على ذلك

As you can see from chess players, in fact, among them one plays at a high level, until he wins over [lit., throws away] the players with a strong rook, or something else, with [the adversary] being unable to do anything against this.

وان كان اعلم منه واذكي وما ذاك الا لخاصية جعلها
الله تعالى في قوة المفكرة ولم يجعلها في مفكرة غيره

In fact, [the gifted player] is wiser than him and cleverer, and what is this if not the peculiarity with which God—may He be exalted—endowed the faculty of thinking.

حكى ان ابراهيم بن حيلة مر به عبد الحميد الكاتب
المشهور فراى الكتب خطا رديا
فقال اتريد ان يجود خطك
فقلت من ادي ذلك
فقال اطل جلفة قلمك وحرف قطعتك وايمنها
ففعلت ذلك فحسن خطي

It is told that the famous scribe ʿAbd al-Ḥamīd came across Ibrahim ibn Ḥīla and saw that the books were badly written.
He said: 'Do you want to improve your handwriting?'
I: 'How do I achieve this?'
He replied: 'Hold the nib of your pen (*ǧalfa/ǧilfa/ǧulfa*)[19] and the edge of your piece [of paper] with the right hand'.
'I did this and my handwriting became beautiful'.

19 See Gacek, *Vademecum*, p. 41. In his lexicon, Lane says that the *ǧilfa* is the central part of the pen, see Edward W. Lane, *Arabic-English Lexicon*. Beirut: Librairie du Liban, 1968, vol. 1 p. 448. Rosenthal, in the annotations to al-Tawḥīdī's translation, say that *ǧilfa* "refers to the

وحكي ايضا ان بعض الناس تنكي الى⟨ابن⟩ ابي طاهر الكاتب من ردأة خطه فقال له ابن ابي طاهر الق دواتك واطل سن قلمك وفرج بين السطور وقرمط بين الحروف. ففعل ذلك فاستوي خطه

It is also told that a man was complaining to the scribe Ibn Abī Ṭāhir about the poor quality of his own handwriting, and Ibn Abū Ṭāhir said to him: 'Use appropriate instruments, hold the nib (*sinn*)[20] of your pen, leave a space between the lines and make the letters minute'. He did so and his handwriting became regular.

وانما قال الق دواتك لان القوم كانوا يكتبون بالحبر من غير ليقة والحبر رقيق لا تجرى كما يريد الكاتب بخلاف الليقة فان قوامها [12v] غليظ يجري كما يريد الكاتب والله الموفق

He only said 'Use appropriate instruments' because people used to write with an ink (*ḥibr*) that is not a *līqa*—as the ink (*ḥibr*) is thin and does not flow as the scribe wants, unlike the *līqa*. In fact, [the *līqa's*] consistency is thick, and it flows as the scribe wants, and God is the One who provides.

The second section of the same speculation has an inclusive title that refers to the instruments and tools of writing, though its contents are actually limited to different kinds of ink (iron-gall, carbon and compound black inks, coloured metallic inks, dissolved gold and silver, and inks prepared with the seven metals), neglecting other writing implements. A final entry announces a section on invisible ink, referring to procedures that are not actually described in the text. This selection of recipes represents an inclusive compendium of ink typologies, with a preference for metallic ingredients and metallic-based preparations.[21]

(a) Iron-gall black ink (*ḥibr*)

The first four recipes describe preparations of black iron-gall inks. The basic ingredients are gallnuts, gum arabic, and vitriol, only in recipe no. 4 is gum arabic substituted with wheat starch. Recipes no. 2 and no. 3 add a different ingredient, egg white and meerschaum, respectively, as thickening agent.

1. Green gallnuts, water, gum Arabic, Kirmani green vitriol.
2. Nuts, gum arabic, Kirmani green vitriol, egg white.

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whole part of the calamus which is cut away in order to make the calamus fit for writing", see Rosenthal, *Abū Ḥayān al-Tawḥīdī*, p. 4.

20 For Gacek, *sinn* is the name for the two halves of the nib, see Gacek, *Vademecum*, p. 41.

21 The progressive numbers associated in this study to the recipes included in the *Kitāb al-iṣāba fī lawāzim al-kitāba* will be used, henceforth, to refer to them.

3. For Qur'ans: gall nuts, water, gum arabic, vitriol, meerschaum.
4. Starch ink: wheat starch, gallnuts water, Kirmani vitriol.

(b) Carbon-gall and compound inks (*midād*).

The second typology of inks is represented by recipes that list soot or another burnt substance as characterizing ingredient. Recipe nos. 5 and 6 include vitriol as metallic component. This kind of ink could correspond to what al-Marrākušī defined as 'compound' (*murakkab*) inks.[22]

5. Seed soot, gum arabic water, gallnuts water, vitriol.
6. Soot, honey water, gum arabic, cow gall, Kirmani vitriol.
7. *Al-afqāš* ink: burnt squash, cooked wine, egg yolk, gum arabic, gallnuts water.
8. Egyptian ink: ground *afqāš*, gum arabic, gallnuts, burnt paper, egg yolk.
9. Chinese ink: burnt gourd, cooked starch, gum arabic.

(c) Coloured metallic inks (*līqa*).

The metallic inks mentioned in this cluster of recipes describe procedures to imitate the colour of precious substances, either metals or gems. The range of colours is limited to gold, silver, red, and green. The focus on metallic substances has an alchemical echo.[23] The most striking case, however, is recipe no. 10, in which some alchemical instruments—the alembic, the gourd, and a long-necked flask—are mentioned in connection with the process of distillation recommended for obtaining an artificial golden ink. The precipitate that results from this operation must be

22 The mixture of soot with the iron-gall element prevents the black ink from deteriorating. See Muḥammad ibn Maymūn ibn 'Imrān al-Marrākušī, "Kitāb al-azhār fī 'amal al-aḥbār li-Muḥammad ibn Maymūn ibn 'Imrān al-Marrākušī", *Zeitschrift für die Geschichte der arabischislamischen Wissenschaften* 14 (2001), pp. 103–106; and Sara Fani, *Le arti del libro*, pp. 112–114; François Déroche & Valentina Sagaria Rossi, *I manoscritti in caratteri arabi*. Roma: Viella, 2012, pp. 84–85.

23 The preparation of metallic inks was one of the applications of alchemical practice already attested in the Graeco-Roman period, see Robert Halleux, *Papyrus de Leyde. Papyrus de Stockholm. Fragments de recettes. Texte établi et traduit par Robert Halleux*. Paris: Les Belles Lettres, 1981; and Lucia Raggetti, "*Cum Grano Salis*. Some Arabic Ink Recipes in Their Historical and Literary Context", *Journal of Islamic Manuscripts* 7 (2016), pp. 294–338, p. 310; and Miriam Blanco Cesteros, "Written in Blood? Decoding Some Red Inks of the Greek Magical Papyri", in L. Raggetti (ed.) *Traces of Ink. Experiences of Philology and Replication*. Leiden: Brill (Nuncius Series, forthcoming). We know that al-Marrākušī combined an interest in inks with his active practice of alchemy, unfortunately the section of his treatise dealing with the dissolution and the calcification of metals has never been written. See al-Marrākušī, *Kitāb al-azhār*, pp. 130–133; Fani, *Le arti del libro*, pp. 80–82 and 132.

stored in a sealed receptacle where it will change its colour several times in the course of twenty days, until it reaches the desired nuance of red gold. The mention of carp gall and black sheep gall as ingredients in such preparations (recipe nos. 11 and no. 12) can be interpreted as code names (*Decknamen*), used to refer to other substances. Recipe no. 13 mentions 'killed' mercury as sole ingredient to be diluted in fish glue in order to obtain an ink that looks like silver. The expression 'to kill mercury' usually refers to its fixation, a process that renders this volatile substance into a more stable state.

10. Golden ink: *ṭalq*, honey, red vitriol (distillation).
11. Another: cinnabar, vinegar, gum arabic, carp bile.
12. Golden ink: orpiment, sheep black gall (polish with hematite).
13. Silver ink: 'killed' mercury, fish glue (polish with onyx).
14. Ruby ink: cinnabar, salt water, yellow gallnuts water.
15. Emerald ink: verdigris, vinegar, saffron mixed with gum arabic and vinegar.
16. Cinnabar ink: cinnabar, pomegranate water, vinegar.

(d) Dissolved gold and silver.

The recipes of this group deal with dissolving the two noble metals—gold and silver—in order to write with them. Recipe nos. 17 and no. 18 are based on the antipathies between metallic substances, exploited to ease the filing or grinding of these metals, especially problematic in the case of gold. The antagonist of gold is lead, whereas potash causes the crumbling of silver. The precious metals do not even have to come into direct contact with their antipathetic counterpart: melted gold just has to be poured into the same water in which lead has been quenched; while silver breaks better if melted in a crucible in which potash has been smelted.

17. Gold: water in which lead has been quenched fifty times to soften the gold filing, gum arabic (polish with onyx)
18. Silver: silver smelt in a crucible previously used for potash, gum arabic.
19. Gold: golden leaves macerated in honey, gum arabic (polish with onyx).
20. Any of the seven metals filed and precipitated in water, mixed with gum arabic.

(e) Writing with the seven metals [lit., 'the seven bodies'].

This last group includes a single procedure, good for writing with any of the seven metals. The idea is to prepare an abrasive base by first writing with a mixture of ground lapis lazuli and fish glue. Then, a metallic probe

must be rubbed and scraped against this abrasive base several times, so that the colour of the metal can adhere to it. The formulation used in the heading with reference to the seven metals (*al-aǧsād al-sabʿa*, 'the seven bodies') recalls an alchemical classification.[24]

21. Abrasive base of ground lapis lazuli and fish glue—probe of any metal to be scraped over it.

2.3 *MS Berlin Sprenger 1918, ff. 12v–17v*

الفصل الثاني في آلات الكتابة وادواتها

Second section on the instruments of writing and its tools.

من اراد خطا حسنا فعليه بتحسين آلات الكتابة وادواتها قلم جيد وسكين حاد ومداد اسود براق وقرطاس نقي

The one who wants a nice handwriting must then take care of refining the instruments of the writing; his tools should be a good pen, a sharp knife, a shiny black ink, and a clean sheet of paper.[25]

قيل لبعض الكتّاب اي تلاميذك يكتب احسن

It was once said to some scribe: 'Which one of your pupils writes better?'

قال من سكينه احد

He replied: 'The one whose knife is sharper.'

24 Sometimes, the number of metals can be five, when gold and silver are considered separately. See Paul Kraus, *Jābir ibn Ḥayyān. Contribution à l'histoire des idées scientifiques dans l'Islam*. Cairo: Imprimerie de l'Institut Français d'archéologie orientale, 2 vols, 1943; in particular vol. I pp. 111–116 and vol. II p. 18 and p. 26. The Ps. Aristotle *Kitāb al-aḥǧār* ('Book of stones'), as transmitted in MS Istanbul Aya Sofya 3610, witnesses a different classification of the metals in three categories. The first includes the mineral substances that melt (ff. 97v–109r): gold (*ḏahab*), silver (*fiḍḍa*), copper (*nuḥās*), a kind of copper or brass (*ṭālīqūn*), lead (*raṣāṣ*), tin (*qaṣdīr*), mercury (*zaybaq*). These are followed by the minerals derived from the seven metals that melt (ff. 109r–118r), and by the minerals in form of powder (ff. 118r–129r).

25 In the first speculation, the author announced that there are three fundamentals of writing: ink, parchment, and pen. The knife is added to the second series. Al-Qalqašandī—in the section about *midād* and *ḥibr*, and how their kinds of blackness differ—quotes a couplet in which the pillars of writing are said to be four: "You should know that ink is one of the pillars of writing, is one quarter of its pivot, and about this it is said: '*A quarter of writing is in the blackness of the ink, a quarter in the refinement of the scribe's art | a quarter is from the of the pen cut even, upon the paper rests the fourth cause*'. See al-Qalqašandī, *Subḥ al-aʿšā fī ṣināʿat al-inšā*, Cairo, al-Qāhira: al-Maṭbaʿa al-Amīrīya, 1914, vol. II p. 463. See also Gacek, *Vademecum*, p. 240 (s.v. 'Scribes and copyists').

اما المداد والقرطاس فبمثابة الحادة للخط ومن المعلوم ان الصورة تزداد حسنا بحسن المادة

As for the ink and the paper, they are the equivalent of the sharpness [of the knife] for the handwriting; and it is known that the form (*ṣūra*) [produced] becomes ever more beautiful as the quality of the material improves.

الا ترى ان الصانع الواحد اذا اتخذ خاتما من ذهب وخاتما من فضة على شكل واحد وصنعة واحدة فان الخاتم الذهبي يكون احسن صورة من الخاتم الفضي مع اتخاذ الصانع والصنعة

Just consider that a single craftsman, when he makes a golden seal and a silver seal with the same shape and prepares them with the same manufacture, then the golden seal will be of a better form (*ṣūra*) than the silver seal, despite having been made by the same craftsman and manufacture.

وكذلك اذا كتب الكاتب بدواة وقلم رديين على كاغد ردي لا تكون كتابته مثل كتابته بالادات الجيدة

In the same way, when the scribe writes with a bad inkwell and a bad pen on bad paper, then his writing will not be like that achieved with good tools.

والمداد الجيد ما يكون ذا سواد وبرق وجريان منعقد لا يتغير مكتوبه عند اصابة النداوة

The best ink is black and glossy, with the consistency of a thick liquid, and what has been written with it does not change when it is affected by moisture.

فصل في اعمال الحبر

[1] Section on the making of ink (*ḥibr*).

يؤخذ عفص اخضر ويكسر ويصب عليه من الماء [13r] خمسة امثاله وتجعل في قدر نحاس ويوقد تحته نار لينة حتى يذهب نصف الماء

Take some green gallnuts, crush them, pour on them five times their quantity of water, put this in a copper recipient, and light under it a gentle fire until half of the water has gone.

ثم يصفي بخرقة صفيقة ويطرح عليه من الصمغ العربي على كل رطل

Then purify it using a thick cloth, pour over it five *asātīr*[26] of gum arabic for

26 A measure that may correspond to four *miṯqāl* or a bit more. See Albert Kazimirky, *Dictionnaire Arabe-Français*. Paris: Maisonneuve, 1860, vol. 1 p. 1050; and Edward W. Lane, *An Arabic–English Lexicon*. 8 vols. London: Williams & Norgate, 1863, see vol. 4 p. 1305.

every *raṭl* of purified gallnuts water, and half an ounce of Kirmani green vitriol.[27]

من ماء العفص المصفي خمسة اساتير[28] ونصف اوقية من الزاج الاخضر الكرماني

Then this will be the apogee of good quality.

فانه يكون في غاية الجودة

If you add some sal ammoniac, then it will not decay.

ولو القي عليه شيئا من النوشاذر لا يتكرج اليته

And if there is some salt in it, then it will not congeal in the countries where the cold is intense, and God is the One who provides.

ولو كان شيئا من الملح فانه لا يجمد في البلاد الشديدة البرد والله الموفق

[2] Another one[29]

اخر

To make 'pastilles' [of ink] for travel: crush the gallnuts well until they become [a fine powder] similar to kohl, crush the gum arabic in the same way as well, and half that quantity of Kirmani green vitriol, until the solution becomes like kohl. Then add egg white [made into] a paste, give it the shape of pastilles, and put it in a sealed vessel that cannot be penetrated by either air, or dust, and it will last for a long time.

يتخذ بنادق لاجل السفر يسحق العفص سحقا ناعما حتى يصير كالكحل وسحق الصمغ ايضا مثله ونصف مثله زاج اخضر الكرماني حتى يصير الحل مثل الكحل

ثم يجمعه ببياض البيض كالعجين ويتخذ منه بنادق وتجعلها في ظرف مسدود الرأس لا يدخلها الريح والغبار يبقي دهرا طويلا

When you want to write with it, soak it in water and use it.

فاذا اردت ان تكتب به فانقعه في ماء واستعمله

27 For *zāǧ aḥḍar*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. II pp. 616–618 and 623–627, green vitriol was also called *zāǧ al-ḥibr* (ink vitriol). The fact that some recipes specify using green vitriol from Kirman is not necessarily connected to Ibn al-Ǧazarī's life experience (though it is known that he spent several years in Iran).

28 A note in the margin suggests different quantities: four *miṯqāl* and half a *qāmūs*, اربعة مثاقيل ونصف قاموس.

29 Ibn Bādīs, in his *ʿUmdat al-kuttāb*, mentions this recipe, which is later taken up by the Rasulid ruler al-Malik al-Muẓaffar Yūsūf al-Ġassānī, see al-Muʿizz ibn Bādīs al-Tamīmī al-Ṣanhāǧī, *ʿUmdat al-kuttāb wa-ʿuddat ḏawī al-albāb. Fīhi ṣifat al-ḥaṭṭ wa-l-aqlām wa-l-midād wa-llīyaq wa-l-ḥibr wa-l-asbāġ wa-ālat al-taǧlīd*; eds Naǧīb Mā'il al-Harawī and ʿIṣām Makkīya. Mašhad: Maǧmaʿ al-Buḥūṯ al-Islāmīya, 1409 / 1988 H., p. 41 and Fani, *Le arti del libro*, p. 60. Also, al-Marrākušī mentions the same recipe, see al-Marrākušī, *Kitāb al-azhār*, p. 88. All the different technical handbooks refer to this recipe as a dry ink that is suitable for travelling.

[3] Another one on the ink for Qur'ans (*ḥibr al-maṣāḥif*)[30]

Place the gall nuts in a chickpea pan, pour on them ten times their quantity of water, light under it a gentle fire until it reduces to its original quantity, add the gum arabic and the vitriol in the way we mentioned, add a bit of ground meerschaum to it, and this will make it thicker and black and it is not 'cut' by the pen when the scribe takes it from the inkwell—then grind it and pour it into the gallnuts water, close it tight so that it will not decay.

اخر في حبر المصاحف

يرض العفص على قدر الحمص ويصب عليه من الماء عشرة امثاله ويوقد تحته نار لينة [13v] حتى يرجع الى مثليه ويطرح عليه من الصمغ والزاج كما ذكرنا ويلقي عليه قليل من زبد البحر مسحوقا فانه يمسكه ويسوده فلا ينقد من القلم اذا استمده الكتاب وسحقته والقيته في ماء العفص امسكه ولا يتكرج

[4] Another one, on starch ink (*ḥibr al-našā'*)

Take wheat starch, put it in a casserole, light a fire under it until it burns.

Then put it close to the flame until it flares up and becomes like ash.

Then grind it until it becomes like a fine dust, pour the gallnuts water onto it, and place it on the fire until its water has gone.

Mix with it a quantity of Kirmani vitriol that serves to make it black, and then it will be good, and God is the One who provides.

اخر في حبر النشاء

يؤخذ نشاء الحنطة وتجعل في طنجير ويوقد تحته حتى يحترق

ثم يقرب منه شعلة حتى يلتهب ويصير كالرماد

ثم يسحق حتى يصير كالهباء ويصب عليه ماء العفص ويعرض على النار حتى تذهب مائته

ثم تخلط به ماء الزاج الكرماني مقدار ما يسوده فانه يكون جيدا والله الموفق

30 For this translation of *maṣāḥif*, see Raggetti, *Cum Grano Salis*, p. 301. Al-Marrākušī mentions the use of meerschaum for the same purpose in connection with the preparation of black inks, specifying that the function of meerschaum is to prevent the formation of mould. See Fani, *Le arti del libro*, pp. 94 and 99; and al-Marrākušī, *Kitāb al-azhār*, pp. 81 and 86.

[5] Another one, on the preparation of ink (*midād*)

Take ten dirhams of seed soot,[31] put this in a casserole, place it on the fire until its greasy part has gone.

Then place it in a mortar, pour gum arabic water onto it, little by little, and mix it with this.

Then pour over it the gallnuts water and the vitriol in the way that we have already described, leave it in the sun for the time required to make its water evaporate.

Then store it, and this will be a good kind [of ink], and God is the One who provides.

اخر في صنعة المداد

يؤخذ دخان البزر عشرة دراهم وتجعل في طنجير
ويعرض على النار حتى تذهب منه دهنيته
ثم تجعل في الهاون ويصب عليه ماء الصمغ العربي
قليلا قليلا وتخلط به
ثم يصب عليه ماء العفص والزاج على [14r] النسبة
التي ذكرناها ويترك في الشمس مقدار ما تذهب مائته

ثم يرفع فانه نوع حسن والله الموفق

[6] Another one, ink (*midād*) **at the apogee of beauty**

Take ten dirham of soot, one dirham of honey water, the same quantity of gum arabic and cow gall, ten dirhams of gallnuts, and one dirham of Kirmani vitriol.

Crack the gallnuts, soak them in water for one night and add vitriol to this; then mix it with gum arabic and honey, light a fire under it until its water has gone, dissolve the soot with gum arabic water, after that its greasy component has been removed, and add it to the rest of the ingredients. Make it into compresses, let it dry, and use it when needed, and this will be the apogee of beauty.

اخر مداد في غاية الحسن

يؤخذ من الدخان عشرة دراهم ومن العسلماية
درهم ومن الصمغ مثله ومرارة بقر وعشرة دراهم
عفص ودرهم زاج كرماني
يرض العفص وينقع في الماء ليلة ويجعل فيه الزاج
ثم يخلطه بالصمغ والعسل ويوقد تحته حتى تذهب
مائته ويحلل الدخان بماء الصمغ بعد ان اخذ دهنيته
ويضمه الى بقية الادوية

ويتخذ منه اقراصا ويجففها ويستعملها عند الحاجة
فانه في غاية الحسن

31 Sprenger annotated this passage in the manuscript, specifying that the expression refers to linseed. Al-Marrākušī mentions the use of linseed soot in several recipes for black ink, see Fani, *Le arti del libro*, pp. 114, 116 and 120; and al-Marrākušī, *Kitāb al-azhār*, pp. 104, 109 and 115.

[7] **Another one, on *afqāš* ink** (*midād al-afqāš*)[32]

Burn the squash called *yaqṭīn*, take its coal, crush it, mix it with cooked wine[33] and egg yolk.

Then, leave it in the shade until it dries; then mix it with all ten dirhams of gum arabic, moisten it with gallnut water and write with it, then it will be good, and God is the One who provides.

اخر في مداد الافقاش

تحرق اليقطين ويؤخذ فحمه ويسحق ويخلط
بالميبختج وصفرة البيض
ثم يترك في الظل حتى يجف ثم يخلط مع كل عشرة
دراهم من الصمغ العربي ويبل بماء العفص ويكتب
به فانه يكون جيدا والله الموفق

[8] **Another one, Egyptian ink** (*al-midād al-miṣrī*)[34]

Take the *afqāš*, grind it finely, pour on it ten full dirhams of gum arabic and the same quantity of gallnuts, five dirhams of burnt paper; put everything in a mortar, mix it with egg yolk, make it into compresses, and use it when needed: it will be good.

اخر [14v] **في المداد المصري**

يؤخذ الافقاش ويسحق ناعما ويلقي على كل منّ
منه عشرة دراهم من الصمغ العربي ومن العفص
مثله ومن الكاغد المحرق خمسة دراهم ويجعل الجميع
في الهاون ويجمعها بصفرة البيض ويتخذ منها اقراصا
وتستعمل عند الحاجة فانه جيدا

32 A marginal note in the manuscript explains *afqāš* as the peel of the Arak fruit and palm twigs [Fig. 2]. This uncommon name for an ingredient may have generated problems in the transmission, also because several variants may refer to other possible ingredients. Both the roots *f-q-š* and *f-q-ṣ*, in fact, refer to the act of crushing, in particular eggshells. The word *faqīš* points to a small, hard kind of almond or nut. *Faqqūṣ* or *faqqūš* is a kind of melon or cucumber, attested as an ingredient in other recipes in Ibn al-Ǧazarī's compilation (see recipe no. 8). No dictionary that I have consulted includes the lemma *afqāš*, its meaning in this context, however, is likely to refer to some kind of cucurbit or hard fruit or its peel. Al-Marrākušī—who uses the word *qar'* for gourd and indicates flour as characterizing ingredient, labelling it *midād daqīqī*, 'flour ink'—includes two versions of a similar recipe in his treatise, a longer and a shorter one. The latter is closer to the text of Ibn al-Ǧazarī, with the difference that al-Marrākušī adds starch to the compound. See al-Marrākušī, *Kitāb al-azhār*, pp. 118–119; and Fani, *Le arti del libro*, pp. 122–123.

33 Cooked wine or must, either liquid or with the consistency of a syrup or jam, see Reinhart Dozy, *Supplément aux dictionnaires arabes*. Leiden: Brill, 1981, vol. II p. 634.

34 Recipes for an Egyptian and a Chinese ink are mentioned by al-Marrākušī in the section of his treatise devoted to dry inks suitable for travelling. Only the titles, however, match with the text of the *Kitāb al-iṣāba*. In al Marrākušī, in fact, the Egyptian and the Chinese inks are prepared with, respectively, sesame oil soot and pine resin soot, whereas the inks prepared with burnt gourds are mentioned under different rubrics. This shift in titles and contents might be traced back to the transmission of one of the sources consulted for this

[9] Another one, on Chinese ink (*al-midād al-ṣīnī*)

Burn the gourd, crush it with cooked starch that is smeared onto the paper, in the quantity that serves to soak it. Then grind it with dissolved gum arabic, let it dry until one third has gone.

Then grind it with milk, moisten it with gum arabic water, make it smooth, and then a nicely brilliant black ink will emerge.

اخر في المداد الصيني

يحرق القرع ويسحق بالنشاء المطبوخ الذي يطلي به الكاغد مقدار ما يعجنه

ثم يسحق بماء الصمغ المحلول ويجففه حتى يذهب ثلثاه

ثم يسحق باللبن الحليب و يبلل بماء الصمغ ويرقق به فانه يخرج مدادا براقا اسودا جيدا

[10] Another one: on a golden coloured ink (*ḥibr ḏahabī al-lawn*)[35]

Take one part of dissolved talc,[36] two parts of honey, one part of *qalqant*—and this is red vitriol[37]—put everything in a vessel and whip it with the hand.

اخر في حبر ذهبي اللون

يأخذ من الطلق المحلول جزؤا ومن العسل جزؤين ومن القلقنت جزؤا وهو زاج احمر واجعل الكل في ظرف واضربه باليد

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compilation. For the recipes in al-Marrākušī, see Fani, *Le arti del libro*, pp. 123 and 125; and Marrākušī, *Kitāb al-azhār*, pp. 119 and 121.

35 Ibn Bādīs dedicated the fourth chapter of his treatise to the preparation of coloured inks (*al-aḥbār al-mulawwana*) in which he included a similar recipe that prescribes distilling the same set of substances: "One part of bee honey, one part of *ṭalq*, and one part of *qalqant* have to be taken, the *qalqant*, the *ṭalq* and the honey have to be ground, put in a 'gourd' or an alembic, and let them evaporate. Then take what has evaporated and put it in a long-necked flask, place it in the sun for twenty days; one dirham of gum arabic has to be ground every day for it and then added to it. Agitate it well until the gum arabic has melted, write with it and it will be beautiful". The label of the recipe (*ḥibr adham*, 'black or dark ink') is curious, especially considering the section in which the recipe is included and the fact that the previous recipe described how to obtain an artificial golden ink. It is not impossible to think to *adham* as paleographically originated from *al-ḏahab*. See Ibn Bādīs, *ʿUmdat al-kuttāb*, p. 50. Martin Levey translates the adjective as 'blackish' without giving it a second thought, see Martin Levey, "Medieval Arabic Bookmaking and Its Relation to Early Chemistry and Pharmacology", *Transactions of the American Philosophical Society*, New Series, lii/4 (1962), pp. 1–79, p. 24. The MS Beirut AUB, Ḥūrī 248 contains a parallel recipe for a golden ink, in which the same set of ingredients is not distilled but buried in manure for some days. After this, it must be mixed with gum arabic and used to write; at the end, the writing has to be burnished with hematite stone. See Raggetti, *Cum Grano Salis*, pp. 316–317 no. 10.

36 For *talq*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. II pp. 769–779.

37 القلقنة [القلقنت] The orthographical choice of the *tāʾ marbūṭā* might lead those who are

ثم اجعله في قرع وانبيق وقطره

Then put it into a 'gourd' or an alembic, and let it precipitate.[38]

ثم اجعل قطارته في قارورة وختمه عشرين يوما فانه يتلون [15r] بالوان فاصبر حتى يثبت على لون الذهب الاحمر واكتب به فانه جيدا

Then put its precipitate into a long-necked flask,[39] seal it for twenty days; then it will take on different colours, but be patient until it steadily takes on the colour of red gold, write with it and it will be beautiful.

اخر

[11] Another one

يؤخذ الزنجفر في خل خمر سبعة ايام واخلط به بعد ذلك الصمغ العربي المحلول واطرح عليه مرارة شبوط واكتب به فانه يبقي بلون الذهب

Put the cinnabar in wine vinegar for seven days, after this mix with it dissolved gum arabic, add carp (*šabbūṭ*) bile, write with it, and then it will remain the colour of gold.

اخر في اعمال الليق ان اردت ليقة بلون الذهب

[12] Another one on the preparations of inks (*liyaq*): if you want an ink with the colour of gold

يؤخذ من الزرنيخ الاصفر ويسحق بمرارة الشاة السوداء ويكتب به

Take some yellow arsenic (orpiment),[40] crush it with sheep black gall, and write with it.

ثم يصقل بحجر الشاذنج فانه يخرج على لون الذهب

Then polish it with hematite stone, and then it will come out the colour of gold.

اخر ليقة فضية

[13] Another one: silver ink (*līqa fiḍḍīya*)

يأخذ الزيبق المقتول ويجعله في غراء السمك ويكتب به ويترك حتى يجف

Take 'killed' mercury, put it in fish glue, write with it, and leave until it dries.

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unfamiliar with the name to a different vocalization. *Qalqant* is one of the many denominations used for different kinds of vitriols. In this case, the recipe itself states the correspondence with red vitriol. For a general discussion of the different vitriols in the Arabic tradition, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, II pp. 604–623.

38 See Siggel, *Wörterbuch der Stoffe*, pp. 95 and 99.

39 See Siggel, *Wörterbuch der Stoffe*, p. 99.

40 For *zirnīḫ aṣfar* (orpiment), see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. II pp. 658–660.

ثم يصقل بالجزع فانه يخرج على لون الفضة

Then polish it with onyx, and it will come out the colour of silver.

اخر ليقة ياقوتية

[14] Another one: ruby ink (*līqa yāqūtīya*)[41]

يأخذ زنجفرا مسحوقا ويغسله بماء الملح ويتركه حتى يجف وتحله بماء العفص الاصفر ويتخذ منه ليقة ويكتب به فانه يخرج ياقوتي اللون

Take some ground cinnabar, wash it with salt water, leave it until it dries, dissolve it with yellow gallnuts water, make it into an ink, write with it, and then a ruby red ink will emerge.

اخر ليقة زمردية اللون

[15] Another one: an ink with the colour of emerald (*līqa zumurrudīya*)[42]

يأخذ شيئا من الزنجار ويسحقه في الخل العتيق سحقا جيدا ويجففه

Take some verdigris, crush it well in old vinegar, and let it dry.

ثم يلقي على عشرة دراهم درهما من الزعفران ويحل بالصمغ العربي بالخل [15v] ويخلطه ويتخذ منه ليقة فانه يخرج على لون الزمرد

Then pour ten dirhams of saffron dissolved in gum arabic with vinegar on it, mix it, make it into an ink, and then it will come out the colour of an emerald.

41 The refined name of 'ruby ink' is a different way to brand a cinnabar-based metallic ink. Very similar preparations under simpler names can be found in al-Marrākušī and al-Qalalūsī, who called this ink, respectively, *ḥibr* and *midād*. See Fani, *Le arti del libro*, pp. 105 and 146; al-Marrākušī, *Kitāb al-azhār*, p. 95; Abū Bakr Muḥammad ibn Muḥammad al-Qalalūsī al-Andalusī, *Tuḥaf Al-Jawāṣṣ Fī Turaf Al-Jawāṣṣ* (*Las galanduras de la nobleza en lo tocante a los conocimientos más delicados*), ed. Hossam Ahmed Mokhtar El-Abbady. Alexandria: Maktabat al-Iskandarīya, 2007, p. 28. Ibn Bādīs also mentions two different ruby inks in his fourth chapter on coloured inks. The second one is close to the one in this treatise, although several technical details are different: the cinnabar has to be of the colour of pomegranates (*rummānī*), the washing with salt water is not mentioned, the gallnuts mentioned are white. See Ibn Bādīs, *ʿUmdat al-kuttāb*, pp. 47 and 49.

42 The mixture of verdigris, vinegar, and gum arabic is quite common for the preparation of green inks, the addition of saffron is a variant attested in al-Marrākušī and al-Qalalūsī, see Fani, *Le arti del libro*, pp. 130–131 and 146; al-Marrākušī, *Kitāb al-azhār*, p. 129; al-Qalalūsī, *Tuḥaf Al-Jawāṣṣ*, p. 28.

[16] Another one, cinnabar ink (*līqat al-zunǧufr*)

اخر ليقة الزنجفر

Take the cinnabar, crush it finely on a slab, then wash it with pomegranate water and vinegar several times and the way of washing it is by mixing it either with the vinegar or with the pomegranate water, stir it well until it has mixed properly [with both].

يؤخذ الزنجفر ويسحق على الصلابة ناعما ثم يغسل بماء الرمان والخل مرارا وصفة غسله ان يخلطه بالخل او بماء الرمان ويحرك فيه حتى يمتزج به شديدا

Then leave it, let it precipitate, and pour out the liquid.

ثم يترك حتى يرسب ويريق المائع عنه

Then moisten it once again with vinegar or fresh pomegranate water until you have done it three times.

ثم يصب عليه مرة اخرى خلا او ماء رمان جديدا حتى يفعل ذلك ثلاثا

Then let it dry, take its grounds separately, protect this from the dust, strengthen it with gum arabic, then, when you make an ink from it, it will remain of the utmost beauty.

ثم يجفف ويعيد سحقه ويحفظه من الغبار ويقويه بالصمغ فانه اذا اتخذ منه ليقة يبقي احسن ما يكون

[17] Section on writing with the metals [lit., *al-aǧsād*, 'the bodies']

فصل في الكتابة بالاجساد

If you want to write with gold, take fifty dirhams of lead (*ānuk*), smelt it, pour it into a bowl of water for fifty times, until this water has taken on the smell of lead (*usrub*).[43]

اذا اردت ان تكتب بالذهب فخذ من الآنك خمسين درهما واذبه وافرغه في قدح ماء خمسين مرة حتى يكتسب ذلك الماء رايحة الاسرب

Then take as much pure gold as you want, smelt it, pour it into this water for five times, and this will become soft inasmuch as its filing can be.

ثم خذ ما شئت من الذهب الخالص واذبه وافرغه في ذلك الماء خمسة مرات فانها تلين بحيث يمكن سحقها

43 For *ānuk*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. I pp. 293–296; for *usrub*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. I pp. 223–226. Both terms were used to translate the Greek μόλυβδος (lead).

فاسحق في هاون زجاج او اسفيذرويه سحقا ناعما
واخلط بها الصمغ العربي واكتب بها [16r] بعد ما
مرستها بالصمغ شديدا

ثم يتركها اذا كتب بها حتى تجف ثم تصقلها بالجزع
فانه يخرج في غاية الحسن

Then grind it well into a crystal[44] or white copper[45] mortar, mix some gum arabic with it, and write with it after that you have macerated it well with the gum arabic.
When you write with this, leave it until it dries; then burnish it with onyx, and then it will emerge as the apogee of beauty.

اخر في حل الفضة

اذا اردت ان تكتب بالفضة خذ بوتقه وتذوب فيها
القلعي مرارا
ثم تنظفها وتذوب فيها الفضة مرارا كما قلنا في الذهب
فانها يتيبس وتتفتت لان الرصاص عدو الفضة كما ان
الآنك عدو الذهب وتفعل بها ما قلنا في حل الذهب
وتكتب بها

[18] Another one, on dissolving silver (*ḥall al-fiḍḍa*)
If you want to write with silver, take a crucible, smelt in it some potash[46] a few times.
Then clean it, smelt in it the silver a number of times—as we said about gold—and then it will dry and crumble because lead (*raṣāṣ*) is an enemy of silver, as lead (*ānuq*)[47] is for gold; then do what we said and write with it.

اخر في حل الذهب

اذا اردت ان تكتب بالذهب خذ من الاوراق التي
تستعملها المزوقون وتخلطها بالعسل الصافي وتمرسها

[19] Another one, on dissolving gold (*ḥall al-ḏahab*)[48]
If you want to write with gold, take some of the leaves that the illuminators (*muza-*

44 For *zuǧāǧ*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. II pp. 649–652.

45 For *isfīḏrūyah*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. I pp. 249–250 (listed under the variant spelling *isfīdrūyah*); and Siggel, *Wörterbuch der Stoffe*, p. 76.

46 For *qily*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. II pp. 905–908.

47 For *raṣāṣ*, see Käs, *Die Mineralien in der arabischen Pharmakognosie*, vol. I pp. 582–586. Both *ānuk* and *raṣāṣ* were used to translate the Greek names μόλυβδος (lead) and κασσίτερος (tin). The same lexical ambiguity is shared by the term *usrub*.

48 A similar procedure is described in greater detail by al-Malik al-Muẓaffar, see Fani, *Le arti del libro*, pp. 71–72. It is also included in the chapter on metallic inks in al-ʿIrāqī's *ʿUyūn al-ḥaqāʾiq*, see Lucia Raggetti, "Ordinary Inks and Incredible Tricks in al-ʿIrāqī's *ʿUyūn al-ḥaqāʾiq*", in L. Raggetti (ed.) *Traces of Ink. Experiences of Philology and Replication*. Leiden: Brill (Nuncius Series, forthcoming), recipe No. 29.

wwiqūn) use, mix it with pure honey and let it macerate for a long time in a Chinese bowl [of porcelain] or glass until it melts in such a manner that you cannot see the particles of gold in it.

كثيرا في قدح صيني او زجاج حتى يخل بحيث لا ترى فيها اجزاء الذهب

Then pour some water onto it, whip it with your hand until it sinks to the bottom; then pour out the water and mix the rest with dissolved gum arabic using a quantity that allows [the substances] to mix.

ثم صب عليها الماء واضربها باليد ويترك حتى يرسب ثم يصب الماء عنها ويخلط بالصمغ المحلول مقدار ما يجمعها

Then, whether one wants to write with its liquid part, or whether one wants to make an ink from it in order to write with it, it must be left until it dries, and burnished with onyx, and then it will remain like the sun that shines, beautiful and bright.

ثم ان شاء يكتب بمائها وان شاء اتخذ منه ليقة ويكتب بها ويترك حتى يجف ويصقل بالجزع فانه يبقي كالشمس يتلالاء [16v] حسنا وضياء

[20] **Section on dissolving the seven metals** (*ḥall al-aǧsād al-sab'a*)[49]

فصل في حل الاجساد السبعة

If you want to write with one of the seven metals, take a piece of any metal you want to write with, scrape it on a whetstone with water until the water in a bowl takes on the colour of this metal.

اذا اردت ان تكتب بشيء من الاجسام السبعة خذ قطعة من اي جسد اردت ان تكتب به وحكه على مسن بالماء الى ان يصير الماء بلون ذلك الجسد في جام

When it reaches the desired quantity, leave it to precipitate in the water, and pour out the water until it dries.

فاذا حصل المقدار الذي تريده فاتركه ليرسب في الماء وصب عنه الماء واتركه حتى يجف

Once the dissolved gum arabic has been mixed with this, write with it and it will be good.

فاذا اخلط به الصمغ العربي المحلول فاكتب به فانه جيدا

49 For a similar recipe, see Raggetti, *Cum Grano Salis*, p. 330 no. 117; see also recipe No. 30 in Raggetti, *Ordinary Inks*.

[21] Another one about writing with the seven metals[50]

If you want to write with any of the seven metals, take the lapis lazuli stone, grind it, mix it with water of fish glue, write with it whatever you want, and leave it until it dries.

Than take a probe made of any metal you want to write with and write over the previous writing with it several times, and then the colour of this metal will appear on top of it in the most beautiful way.

اخر في الكتابة بالاجساد السبعة

اذا اردت ان تكتب بشيء من الاجساد فاعمد الى حجر اللازورد واسحقه وامزجه بماء غراء السمك واكتب به ما شئت واترك حتى يجف

ثم خذ ميلا من اي جسد اردت ان تكتب به واكتب فوق تلك الكتابة بالميل مرارا فانه يظهر عليها لون ذلك الجسد احسن ما يكون

[22] Section on secret messages

If you do not want people to know what you have written, apart from the one for whom it was written, then write in some of the ways we have mentioned.

فصل في اعمال الملاطفات

اذا اردت ان لا يعلم احد ما كتبته من الناس غير المكتوب اليه فاكتب بشيء من الطرق التي نذكرها

3 Artificial Golden Ink: An Experience of Replication

Recipe no. 10 and its mention of distillation is a case deserving special attention. Ink recipes have been circulating together with alchemical ones since the late antique Graeco-Egyptian papyri,[51] and it is known that some Arabic authors (like al-Marrākušī) interested in the technical aspects of ink making were also well-trained alchemists. It is rare to find a recipe that mentions the application of a specifically alchemical technique, like distillation, involved in the preparation of an ink.[52] For this reason, recipe no. 10 was selected for replication within the frame of the ERC Project *AlchemEast*.[53]

50 For another procedure that implies an abrasive base for writing with metals, see Raggetti, *Cum grano salis*, p. 330 (No. 117); and Raggetti, *Ordinary Inks*, recipe No. 27.

51 See Halleux, *Papyrus de Leyde*; and Raggetti, *Cum Grano Salis*, p. 310.

52 For the parallel attestation of this recipe in Ibn Bādīs, see footnote 33.

53 The replication of alchemical recipes, together with the philological study of primary sources, is a pivotal component of the ERC Project *AlchemEast—Alchemy in the Making: From ancient Babylonia via Graeco-Roman Egypt into the Byzantine, Syriac and Arabic traditions* (*1500 BCE–1000 AD*). Special thanks to the P.I. of the project, Prof. Matteo Martelli, for the attention and the space given to ink recipes.

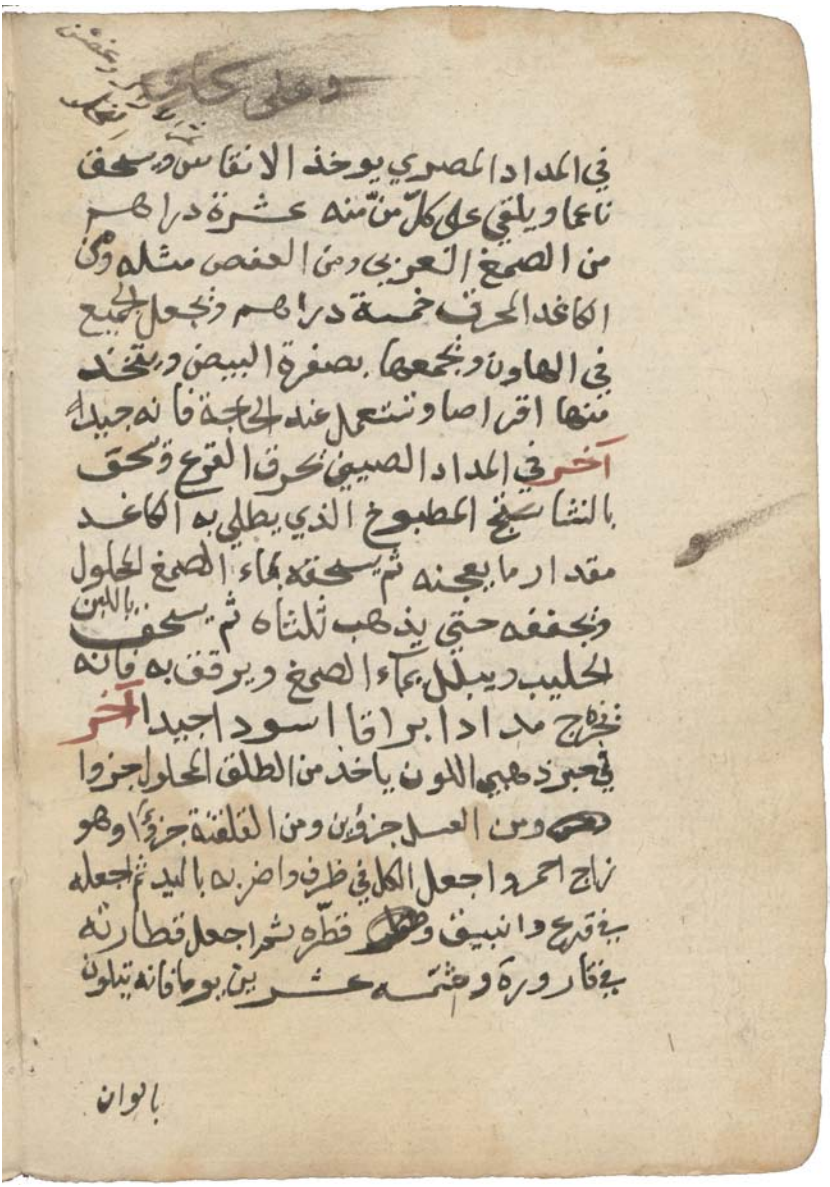

FIGURE 2 MS Berlin Sprenger 1918 f. 14v. Page with the text of recipes nos. 8–10. On the upper margin, an annotation with the explanation of the name for a problematic ingredient listed in the recipe for Egyptian ink (*midād miṣrī*, no. 8)
PHOTO: STAATSBIBLIOTHEK ZU BERLIN

The aim of replicating a recipe in the laboratory is to reproduce the chemical reality that would have been observed by those who performed that procedure, in order to better understand the relation between this and the way in which it is recorded in the written sources.[54] The first step of replication is a philological assessment of the text with its problematic or even obscure aspects, taking into account all the cultural components that might have influenced its transmission and present form. The information derived from the text can then be used to discuss with the chemists the different technical questions raised by the procedure, in order to design an experiment that may shed light on what remains opaque in a purely textual dimension. For the chemists and historians of science, this approach may reveal much about material culture and technical knowledge. The philologist may use the results of a replication to, for instance, refine a translation, or to decide between variants that are on an equal footing from a purely textual point of view (especially in the context of a fluid tradition) and, in general, to understand more about the text, its formation, and the vicissitudes of its transmission.

The analysis of the recipe is the first step in its replication.

> **10. Another one: on a golden coloured ink** (*ḥibr ḏahabī al-lawn*)
> Take one part of dissolved talc, two parts of honey, one part of *qalqant*—and this is red vitriol—put everything in a vessel and whip it with the hand.
> Then put it into a 'gourd' or an alembic, and let it precipitate.
> Then put its precipitate into a long-necked flask, seal it for twenty days; then it will take on different colours, but be patient until it steadily takes on the colour of red gold, write with it and it will be beautiful.
> This recipe contains a number of ambiguous points, and the research questions concern different technical aspects of the procedure.

– The first question concerns the identification of the ingredients. The Arabic *ṭalq* may refer to a wide range of substances that look like a white powder. Reflecting on the material reality behind the lexicographical complexity, one may isolate two main groups of substances to which the term could refer. On

54 "The way substances behave and react have remained the same, even as human observers explain and conceptualize them have changed", see Lawrence M. Principe, *The Secrets of Alchemy*. Chicago, London: The University of Chicago Press, 2013, p. 138; see also, Lawrence M. Principe, "Texts and Practices: The Promises and Problems of Laboratory Replication and the Chemical Explanation of Alchemical Procedures", in E. Nicolaidis (ed.) *Greek Alchemy from Late Antiquity to Early Modernity*. Turnhout: Brepols, 2018, pp. 159–170.

the one hand, it can be interpreted as an inert mineral material, on the other as slaked lime, which has an alkaline property.

– The identification of *qalqant* is also problematic. The recipe itself has a specification about it—'that is red vitriol'—which appears to be an addition to the recipe in the course of its transmission to explain an ambiguous or even obscure term. *Qalqant* is very likely to be a vitriol, but the semantic field of vitriols is quite chaotic, and their classification by colour is far from having an unambiguous identification. Even though a specific author may provide some coherence, the different traditions of technical texts and recipe handbooks reveal a great fluidity and variety of ideas about these substances. Red vitriol has been interpreted here as the result of the calcination of green and blue vitriol, i.e. copper and iron sulphate [Fig. 3], in which the oxidation of this second component produces the red colour that emerges once the product of calcination is ground [Fig. 4]. Since the component proportions are not given, for the sake of this experiment the red vitriol is conventionally prepared with equal parts of green and blue vitriol.
– Another research question concerns the distillation and the role it plays in the production of the ink. Having checked whether the process is possible at all,[55] there are other aspects to consider. Chrysography using real gold is an expensive procedure and the availability of the primary ingredient is not to be taken for granted. Metallic inks based on gold are a suspension of golden particles in gum arabic.[56] Gold is very malleable, reducing it to particles is difficult and, in fact, it is not uncommon to find supplementary indications to achieve this result.[57] As minute as these particles can be, they influence the consistency of the ink. If we move to the procedure for obtaining artificial golden inks—with the advantage of employing less precious and usually more readily available ingredients—these can be based on vegetal or mineral components. Artificial golden inks prepared with vegetal ingredients are usually based on substances that produce an intense yellow dye, like curcuma, saffron and safflower. The metallic substances used to produce artificial golden inks are various, with orpiment and vitriols among the most common. In theory, if the distillation prescribed by recipe no. 10 were successful, it would produce a liquid substance with no sensible par-

55 The different experiments showed that it is possible to distil different compounds that include honey, and that this does not burn or caramelize immediately when exposed to the high temperatures of the heating mantle (250–300 °C). The residue of the distillation slightly resembles burnt caramel and it is not easy to remove it from the gourd.

56 See recipe nos. 17–19.

57 See recipe nos. 17–18, which contain the indication to use the 'antagonist' substance of gold and silver (that is lead and potash) in order to ease their treatment.

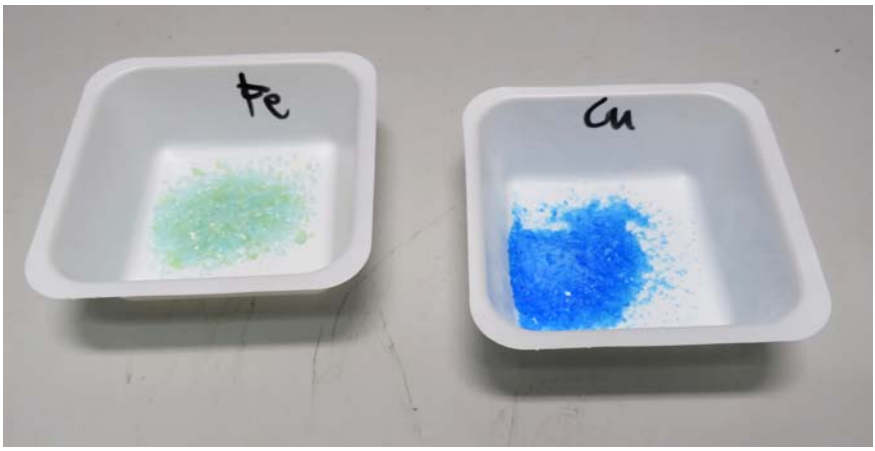

FIGURE 3 Green and blue vitriol (copper and iron sulphate) before the calcination. Bologna, Dipartimento di Chimica 'Giacomo Ciamician', 6 February 2019
PHOTO: LUCIA RAGGETTI

ticulate (being a distillation of the separation of the moist component of a fluid by condensation) without using any extravagant ingredient: quite a technical step in artificial chrysography.

The replication of this recipe consisted of the distillation of two different sets of ingredients [Fig. 4]: in one, honey and red vitriol were mixed with silica (silicon dioxide, SiO_2) to represent an inert mineral substance [Fig. 5]; in the other, honey and red vitriol were mixed with slaked lime (calcium hydroxide, $Ca(OH)_2$) [Fig. 6]. It was possible to obtain a distillate from both mixtures, both of which had the same colour, i.e. a pale yellow [Fig. 7 and 8]. During the prescribed twenty days of ageing, both distillates progressively turned into a more intense shade of yellow-orange, settling at an almost brownish-orange after twenty days, more intensely in the case of the mixture containing the silica. No further colour change could be observed after this period [Fig. 9 and 10].

A writing test was the last stage of the replication. Although it is not explicitly stated in the recipe, the preparation of the ink required adding gum arabic to the distillate as an adhesive component.[58] Powdered gum arabic was directly mixed with the distillates, since it was observed that dissolving it first

58 In the chapter on metallic inks in al-'Iraqī's *'Uyūn al-ḥaqā'iq*, for instance, the recipes for several coloured inks are introduced by the procedure to dissolve gum arabic, meant to be diluted with all the coloured preparations. See Lucia Raggetti, *Ordinary Inks*, recipe no. 1. The parallel attestations of this recipe confirm that it is necessary to mix the distillate with gum arabic in order to write with it, see footnote 35.

FIGURE 4 Red vitriol obtained after the calcination of green and blue vitriol. Bologna, Dipartimento di Chimica 'Giacomo Ciamician', 6 February 2019
PHOTO: LUCIA RAGGETTI

with water produced an excessively watery and rather transparent compound, not suitable for writing. The difference in colour between the two distillates remained unaltered when mixed with gum arabic [Fig. 11]. The ink prepared with the mixture containing slaked lime resulted in a brownish-yellow colour, still rather light, with a very faint metallic glance [Fig. 13]. By contrast, the ink prepared from the other mixture containing silica resulted in an intense orange with a shiny metallic glance that, once dried, looked indeed like gold and its resemblance to writings actually containing the precious metal was striking [Fig. 12].[59]

59 Further chemical analysis will be carried out on the samples in order to better assess the differences between the two compounds and their properties. NMR (Nuclear Magnetic Resonance) spectroscopy yielded no meaningful results due to the disturbance produced by the relatively large amount of water contained in the honey.

FIGURE 5 Distillation of the golden ink mentioned in recipe No. 10, interpreting *ṭalq* as silica. Baltimore, Johns Hopkins University, Department of History of Science and Technology, 14 September 2018
PHOTO: LUCIA RAGGETTI

FIGURE 6 Distillation of the golden ink mentioned in recipe No. 10, interpreting *ṭalq* as slaked lime. Bologna, Dipartimento di Chimica 'Giacomo Ciamician', 6 February 2019
PHOTO: LUCIA RAGGETTI

FIGURE 7 Freshly distilled golden ink from recipe No. 10, the variant with silica. Baltimore, Johns Hopkins University, Department of History of Science and Technology, 14 September 2018
PHOTO: LUCIA RAGGETTI

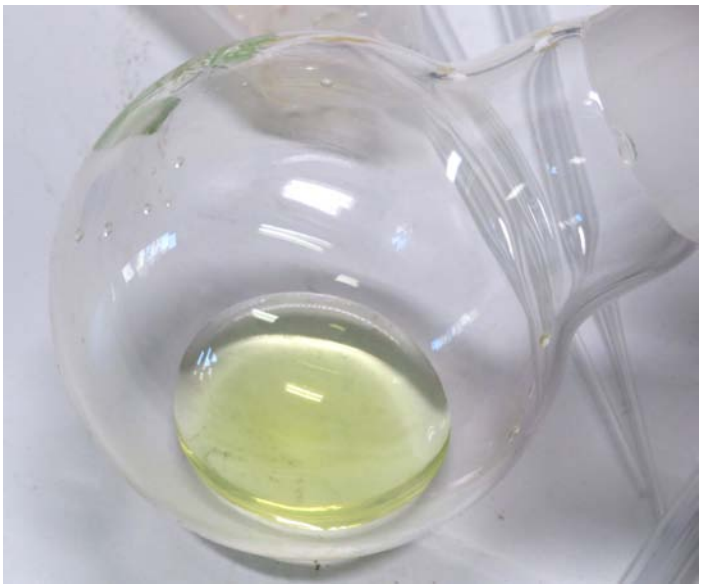

FIGURE 8 Freshly distilled golden ink from recipe No. 10, the variant with slaked lime. Bologna, Dipartimento di Chimica 'Giacomo Ciamician', 6 February 2019
PHOTO: LUCIA RAGGETTI

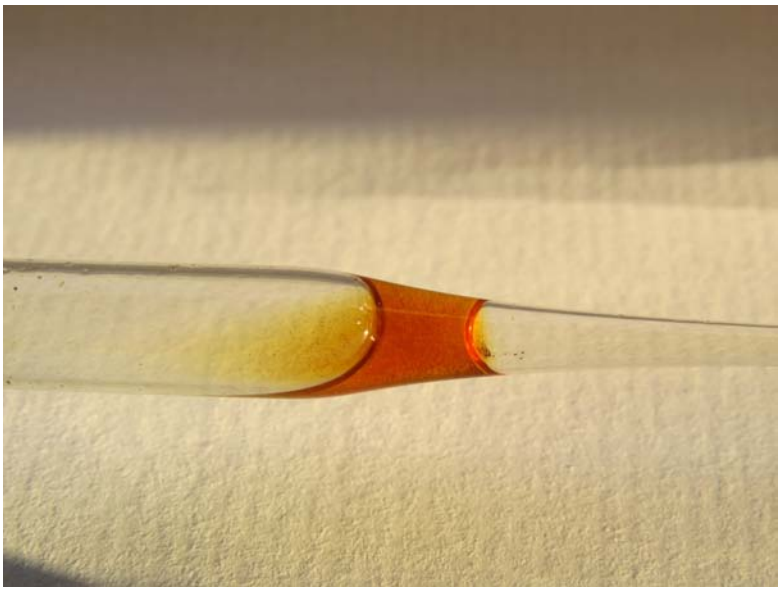

FIGURE 9 The distilled ink prepared with silica after the twenty days prescribed by the recipe for its maturation. Bologna, 28 September 2018.
PHOTO: LUCIA RAGGETTI

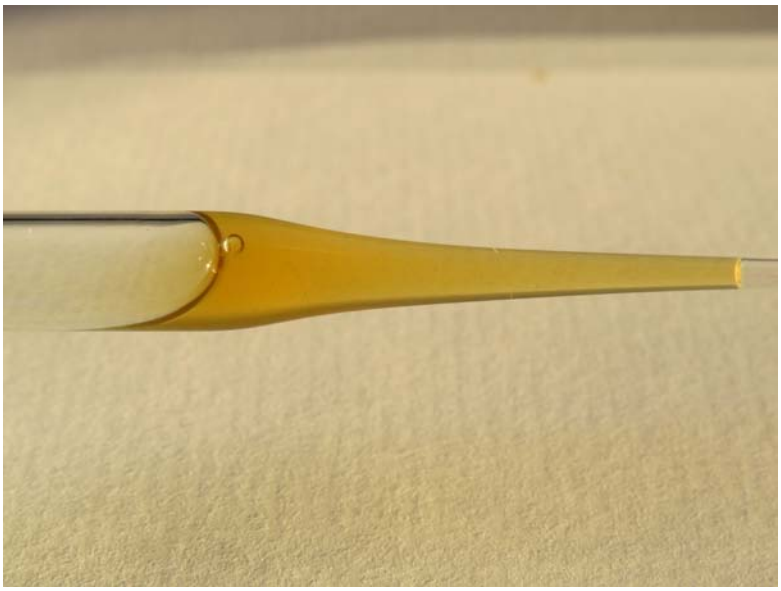

FIGURE 10 The distilled ink prepared with slaked lime after the twenty days prescribed by the recipe for its maturation. Bologna, 4 March 2019
PHOTO: LUCIA RAGGETTI

FIGURE 11 The products of the two different distillations directly mixed with gum arabic; on the right, the version containing slaked lime; on the left, the version containing silica—along with the chicken feathers used for the writing test. Bologna, 4 April 2019
PHOTO: LUCIA RAGGETTI

FIGURE 12 Writing test, result of the distilled ink containing silica. Bologna, 4 April 2019
PHOTO: LUCIA RAGGETTI

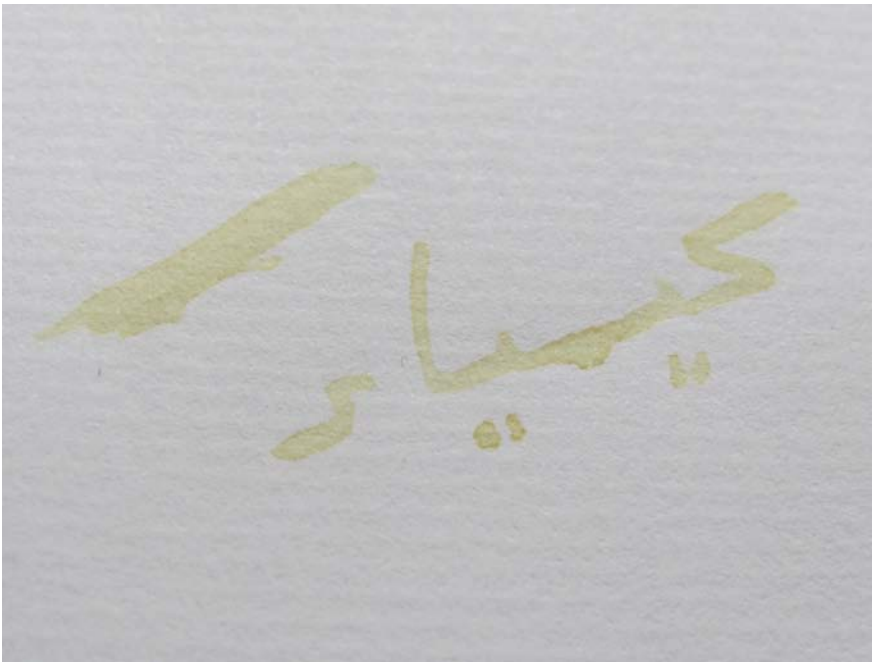

FIGURE 13 Writing test, result of the distilled ink containing slaked lime. Bologna, 4 April 2019
PHOTO: LUCIA RAGGETTI

4 Concluding Remarks

The *Book on the Art of Penmanship* attributed to Ibn al-Ǧazarī is an erudite compilation of technical reflections and historical anecdotes about writing. The section on ink recipes covers all the main typologies of black inks (iron-gall, carbon, and compound inks), coloured metallic inks, preparations for chrysography, and argyrography. In general, the author appears to revel an inclination for metallic preparations. The range of coloured inks, if compared to the great number of nuances mentioned in technical treatises on ink making, is quite limited, and only includes black, red, and green, along with gold and silver. The text seems to be addressed to scholars, rather than to technical experts such as decorators, illuminators, or professional copyists.

As for the contents of the section on inks, on the one hand, it is possible to point out some parallel attestations for a number of recipes; on the other, it remains impossible to state direct relations with the sources. Some of the recipes have an alchemical flavour, and it is not far-fetched to propose that

some alchemical technical notions emerge here because they were part of a widely shared intellectual and technical background. This shows, moreover, that alchemy scored some major technological successes and that its practices entered and influenced other crafts.

Replication—meant as the interaction between the philological study of the primary sources and the experimental attempt to reconstruct the chemical reality behind them—opens a new perspective on the study of premodern technology and a deeper understanding of its textual transmission. In the case of recipe no. 10, the experience of replication helped the interpretation of the text, in particular relating to the identification of the ingredients. Moreover, replication has the potential to enhance the understanding of many different technical details in the procedure that might, at first sight, seem irrelevant from a purely textual point of view.

Acknowledgments

In 2016, I published a number of Arabic sources on ink recipes. This research was the occasion to start collecting other materials on ink making. I would like to thank Claudia Colini, who brought this manuscript to my attention. Special thanks go to Prof. Lawrence M. Principe, who discussed the replication of one of the recipes and brilliantly executed it in his laboratory, during a research stay at the Johns Hopkins University in September 2018. I also wish to acknowledge the support of Prof. Lucia Maini, who patiently assisted me in refining different aspects of the replication in her laboratory in Bologna.