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# *Compositiones Lucenses* and *Mappæ Clavicula*: two traditions or one? New evidence from empirical analysis and assessment of the literature

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**Abstract**

Information on materials and procedures of painters of the past can be gained from the latest examinations of a painting and its materials and from documentary sources, the change of meaning of which is of prior interest to historians of technical art. This paper is an empirical and theoretical examination of the relationships between the two main early medieval collections of craft recipes, the *Compositiones Lucenses* and the *Mappæ Clavicula*. The primary aim of this work is to criticise the current prevalent meaning of the concept of *Mappæ Clavicula*, and to show that its tradition does not include that of *Compositiones*: these two traditions, despite sharing two sets of manuscripts, result in two appreciably different texts. The first edition of the eighth to ninth centuries recipe book *Compositiones Lucenses* (Lucca, Biblioteca Capitolare, 490) occurred in 1739, and the twelfth century exemplar of *Mappæ Clavicula's* text about one century later (Corning, Museum of Glass, Phillipps 3715, or Corning manuscript). In the interwar period and particularly after WWII, the Lucca manuscript was predominantly considered to be a member of the *Mappae Clavicula* tradition, which was regarded as second only to Theophilus's *De diversis artibus*, as a written source for the study of medieval technology. '*Compositiones Lucenses*' and '*Mappæ Clavicula*' are taxonomic concepts for the classification of medieval manuscripts and texts, the meanings of which we redefine in this paper. In contrast to today's prevailing approach, we move the focus from two single manuscripts (Lucca 490 and Corning) to two different traditions of witnesses, and from single texts to collections of texts bound in the same codex. The critical section of the paper concerns the most important interpretations of the notion of *Mappæ Clavicula,* while the positive section draws on three works: the seminal paper by Halleux and Meyvaert (1980s), Baroni's first critical edition of *Mappæ*, and the inventory of the manuscripts of the *Compositiones* tradition by Brun (2010s). In the empirical section we contrast the two traditions and consider two sets of items: twelve manuscripts reveal the internal structure of the *Compositiones Lucenses* tradition, and nine codices, which transmit both traditions, shed light on how these traditions differ. As a result of the present research, we show that a significant segment of the *Compositiones Lucenses* tradition is composed of an aggregation of small recipe nuclei, and that this tradition developed regardless of that of the *Mappæ*. The *Mappæ Clavicula* and *Compositiones Lucenses* are two distinct textual traditions and not members of a super-corpus.

**Keywords:** *Compositiones Lucenses*, *Mappae Clavicula*, Medieval recipe books, Transmission mechanism, Medieval technical art

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## Background

From a general standpoint, *Mappæ Clavicula* and *Compositiones Lucenses* are the sole technological literary records, which come from the Late Antiquity to the Early Middle Ages. "The *Mappae Clavicula* is second only to Theophilus's *De diversis artibus* as a written source for the study of medieval technology" ([1], p. 14). The historical knowledge of painters' pigments and the interconnection between painting and other crafts have been greatly improved by current chemical analysis. Nevertheless, this forms only one part of the technical history of materials and techniques, because, according to Joyce Plesters "information about the techniques and materials of painters of the past is gained in two ways, firstly from documentary sources and secondly from the examination of the pictures themselves and the materials of which they are made" ([2], p. 101).

Plesters' work, credited with having laid the foundations of the field of 'technical art history', points out that this field requires the study of historical literary sources and physico-chemical investigations of 'art/craft' items [3].

Indeed, technical art history requires reliable literary sources; however, this is not the case for the *Mappæ* and *Compositiones Lucenses* traditions. In this paper we show how they have been interpreted differently since the first respective publications of their witnesses and how the prevailing interpretation of these records is far from being conceptually well-founded and coherently articulated. We propose a new interpretation of these dated literary records and provide new evidence for their systematic interpretation.

In the period between Ludovico Antonio Muratori's first publication of the *Compositiones Lucenses* from the Lucca 490 manuscript in 1739 [4] and Mary Philadelphia Merrifield's *Original treatises, dating from the XIIth to XVIIIth Centuries* in 1849[1] [7], some of the most notable Western recipe books of medieval technical 'art'/craft literature were edited: for example by Gotthold Ephraim Lessing [8], Giuseppe Tambroni [9],[2] and Sir Thomas Phillipps [10], who respectively published for the first time Theophilus' and Cennini's texts, and the anonymous text of *Mappæ Clavicula* of a manuscript, which is known as the Corning manuscript today.

The recipe book transmitted by the Lucca 490 manuscript has been given arbitrary and contrasting names, including *Compositiones ad tingenda musiva* [4], *Compositiones Variae* [11], and *Compositiones Lucenses* [12][3]; it is the oldest witness within the *Compositiones Lucenses* tradition. This manuscript has been transcribed many times since Muratori's first publication [4], and its various aspects have been studied by competent scholars [12–18]. Giulia Brun created the first inventory of witnesses within the *Compositiones Lucenses* tradition [19].

The twelfth century text recorded in the Corning manuscript [10] was formed of a series of aggregations around a fourth century A.D. Alexandrian alchemical text. The translation of this alchemical nucleus into Latin, which probably occurred around the fifth century, created the incongruous title *Mappæ Clavicula*.[4] After the first edition of the Corning manuscript [10], an English translation of its text was produced in the 1970s by Cyril Stanley Smith and John G. Hawthorne, who compared it with a few witnesses (Sélestat, Bibliothèque Humaniste 17; Lucca, Biblioteca Capitolare 490; and Klosterneuburg, Stiftsbibliothek W.8.293, see [1], pp. 3–9). The connection to alchemy within the *Mappæ Clavicula* text was first noted by Marcellin Berthelot ([21], pp. 29–30), and, significantly, by Robert Halleux and Paul Meyvaert [20].

Throughout its entire literature, the title '*Mappæ Clavicula*' was given three contrasting meanings. Since the date of Sir Thomas Phillipps publication in 1847, and for about 90 years, the phrase '*Mappæ Clavicula*' referred to the contents of the Corning manuscript, which has three *incipits*, the first of which reads as follows: "INCIPIT LIBELLUS DICTUS MAPPÆ CLAVICULA" ("Here begins the book called *Mappæ Clavicula*"). See [1], pp.

[1] On this author, see the *Oxford Dictionary of National Biography*. Merrifield was a late interpreter of the science of travelling [5], and belonged to a group of women who, "from the 'scientific descriptions' of Anna Miller in the 1770s to the 'unprejudiced inquiry' of Mary Philadelphia Merrifield in the 1850s, played an important role in demonstrating that aesthetic judgement was not simply a knack, dependent on noble birth, but an exact science based on the 'slowly gathered accumulation of facts' " [6], p. 248.

[2] These are, respectively, the twelfth century Wolfenbüttel, Herzog–August Bibliothek, Guelph Gudianus lat. 2°69 manuscript with Theophilus' text, and Biblioteca Apostolica Vaticana, Ottoboniano lat. 2974, copied in 1737 with Cennini's text.

[3] The entire codex was written in the *scriptorium* of Lucca under the guide of the archbishop Johannes I between the years 796 or 787–816 on the grounds of several chronological clues deductable from the text ([13], pp. 4–7, 11). The codex contains 33 works in its 355 folios of different format, among which the most important is *Liber pontificalis*. At least 40 different scribes cooperated in the whole copying of the volume. A thorough codicological and palaeographical description of the codex 490 was scrupulously written by Schiaparelli [13], whose work was updated by Pomaro [14].

[4] Halleux and Meyvaert pointed out that the Latin term *clavicula* (little key) had been often used in patristic and alchemical literature in a figurative sense for works of exegetical significance, while the term *mappa* (napkin, table-napkin, towel, map) makes the title nonsensical ([20], p. 11–13). Thus Halleux and Meyvaert advanced the hypothesis that the word *mappa* is the result of an erroneous translation, in which the word *cheirokmeton* (*χειρόκμητον*) was confused with *cheiromaktron* (*χειρόμακτρον*) (napkin or in Latin *mappa*). The adjective of *χειρόμαχτρον* means *handmade* or *artificial* and the neutral plural *τά χειρόκμητα* (*tacheirokmeta*, the tricks-of-the-trade) referred to an alchemical genre. Halleux's and Meyvaert's hypothesis is plausible, and has not been opposed by any other interpretations. Besides, it is coherently structured and is supported by some evidence; however, it is still conjectural.

5–9 for further information on Sir Thomas Phillipps, and the first and only publication of the manuscript.

The second meaning was inaugurated by the research of Rozelle Parker Johnson on the tradition of the Corning manuscript, which was published in 1935–1937. According to Johnson, the title '*Mappæ Clavicula*' denoted all the texts of the Corning manuscript, including the contents of Lucca 490, and referred to about 80 witnesses [22–24]. Johnson's concept of a unique collection including the Lucca 490 manuscript is shared by Bernhard Bischoff, an illustrious medieval historian and palaeographer. According to Bischoff, the five best-known medieval recipe books (Lucca 490, Sélestat 17, Corning, Madrid 19, and the Klosterneuburg fragment) have a common source that he refers to as *Mappæ Clavicula*, because they include similar contents ([25], pp. 277–80). This notion was still predominant in the early 2000s: Tosatti [26], pp. 27–36, Kroustallis [27], pp. 69–70, Clarke [28], pp. 23–26, Pomaro [14], p. 171.

In contrast to the authors mentioned above, the present paper sustains the hypothesis that *Mappæ* and *Compositiones* are two different traditions, originating from two different texts, whilst often being included within the same set of manuscripts. Meanwhile, a small but decisive number of manuscripts of the *Compositiones* are completely independent from the *Mappæ* tradition.

The third meaning, which was preceded by a growing awareness that the contents of the Corning manuscript were heterogeneous, was initiated by Halleux and Meyvaert's work [20]. Halleux and Meyvaert identified *Mappæ Clavicula* as only one part of the contents of the Corning manuscript; that is, solely the alchemical nucleus translated from Greek into Latin, which has also been copied in a few other codices (Sélestat, Bibliothèque Humaniste 17 and Glasgow, University Library, Hunterian 110). The critical edition by Baroni et al. [29] took for granted the new meaning ascribed to the title *Mappæ Clavicula*: the authors increased the number of witnesses of this tradition, without giving its inventory[5] (for an updated review of the studies on *Mappæ Clavicula*, see [30]).

Smith and Hawthorne deemed the contents of the Lucca 490 manuscript and that of Corning, which includes the text of the Lucca 490 too, to be two separate text traditions only on the basis of their geographic distributions, the first in the south of the Alps, and the latter in the north of the Alps ([1], p. 4). However, this theory is unsustainable on the basis of a larger inventory of the *Compositiones Lucenses* tradition.[6]

For other scholars, *Mappæ Clavicula* consists of two nuclei, called A and B, one of which includes the ancient alchemical core, and the other the *Compositiones Lucenses* tradition in its most ancient form as demonstrated by the Lucca 490 manuscript ([31], p. 200).

## The aims of the present research

From the 1930s until the 2010s, the notion of *Mappæ Clavicula,* or the analogous *Mappæ Clavicula text-family* ([28], pp. 25–26), continued to be heterogeneous, ad hoc definitions, without being grounded in any precise codicological and philological bases.

Conceptually, the notions of '*Compositiones Lucenses*' and '*Mappæ Clavicula*' relate to the roots of medieval technical literature: they are classifications of medieval texts and manuscripts, which are themselves the results of translations of Late Antiquity technical materials from Greek into Latin. We conceive of these taxonomic notions by redefining their meanings, whilst additionally highlighting the importance and relevance of the present research for the field of the medieval 'art'/craft recipe books. For the setting up of a better defined conceptual basis, we refer to the literary findings of Halleux and Meyvaert [20] for their identification of an alchemical nucleus in the *Mappæ Clavicula* tradition, Sandro Baroni et al. for their critical edition of this nucleus [29], and Brun for her research on the witnesses of the *Compositiones tradition* [19].

We argue that the *Compositiones Lucenses* and *Mappæ Clavicula* are two separate collections of texts, and for this purpose we criticise Johnson's notion of *Mappæ Clavicula* in both its dated and recent formulations. In order to reach our goals, the works on which we draw must be integrated with the inventories of the manuscripts of both traditions, and founded upon an operative procedure for identifying the text units of the *Compositiones Lucenses* tradition. The new interpretations of old data will reveal new pieces of evidence, from the examination of a set of manuscripts transmitting the *Compositiones Lucenses* tradition, and a second set of codices which include texts from the *Compositiones* and the *Mappæ* traditions. The material collected in the present research will be used to check the current hypothesis on the existence of a unique

[5] It is beyond the scope of the present paper to discuss the authority we accord to the first critical edition of *Mappæ*. We share its concept of *Mappæ Clavicula* as referring to the old alchemical nucleus, and a feature of the *stemma*, which shows that the α and β families are greatly different. The fact that the text units of the critical edition are arranged in order from precious to cheap metals is further evidence of an alchemical-astrological origin of *Mappæ*, which contrasts and separates the two traditions.

[6] The inventory of the witnesses of the *Compositiones Lucenses* tradition disproves Smith's and Hawthorne's provenance theory: only eight out of 26 witnesses of the *Compositiones* were copied in Italy (see [16]), i.e.: (i) London, British Library, Add. 41486. (ii) Paris, Bibliothèque National de France, Lat. 7418. (iii) Paris, Bibliothèque National de France, Lat. 6514. (iv) New York, Metropolitan Museum of Art, Dept. of Prints, Pl.1. (v) Lucca, Biblioteca Capitolare, 490. (vi) Firenze, Biblioteca Nazionale Centrale, Pal. 951. (vii) Firenze, Biblioteca Nazionale Centrale, Pal. 981. (viii) Siena, Biblioteca degli Intronati, C.V.24.

corpus containing both traditions. The scrutiny of the present state of the literature will bring further pieces of evidence as to the differences between the two traditions.

### A clear example of a change in *gestalt*: the case of the Klosterneuburg manuscript

An interpretation of Wilhelm Ganzenmüller's work can give us a good example of a change in *gestalt* in the notions of *Compositiones Lucenses* and *Mappæ Clavicula*. In 1941, the author collated the text of a newly discovered ninth century manuscript fragment (Klosterneuburg, Stiftsbibliothek, W.8.293) with three other witnesses (Lucca 490, Sélestat 17, and Corning). Because 13 Klosterneuburg text units[7] were discovered to be absent in Lucca 490 and present in the Corning manuscript, he concluded that the new fragment was an exemplar of the Corning tradition [32].

Ganzenmüller's procedure draws on a limited set of manuscripts and his conclusion is coherent with their contents. An effective procedure requires precise definitions of the witnesses in terms of manuscripts and texts they include, as well as well-defined procedures for assigning a given text unit to one of the two traditions (see below). However, the Corning manuscript is heterogeneous and includes both the texts from *Mappæ* and *Compositiones* (see below); for this reason it is not a reliable reference for separating and identifying the two textual traditions. In the present paper, we move the focus from manuscripts to texts and collections of the same text within different manuscripts. We interpret the Lucca 490 as belonging to a different tradition, on the basis of substantial evidence, and the Corning and Sélestat manuscripts as witnesses of both traditions (see the inventories below).

The 13 Klosterneuburg texts do not correlate with the critical edition of *Mappæ* [29], because the latter concerns the Latin translation of the old alchemical nucleus only. Moreover, unlike Ganzenmüller, we found concordances with the 13 text units absent in the Lucca 490 manuscript with the Sélestat and four other fundamental manuscripts that were unknown as possible witnesses at Ganzenmüller's time.[8] Finally, specific lexical terms used by these 13 recipes refer to the same lexicon of other sections of the Lucca 490 manuscript and of the *Compositiones Lucenses* tradition, as is exemplified by the terms *pandius, cianus, lulacin, ficarin, cinnabarin, iarin*, etc. These, on the contrary, are completely absent in the *Mappæ Clavicula* critical edition. Consequentially, one should consider these 13 recipes likely candidates for the *Compositiones Lucenses* tradition.

In summary, the attribution of this fragment to the *Mappæ* or the *Compositiones* traditions involves different meanings of the same terms or labels, different procedures of assignation of a given text unit to one of the two traditions, and different empirical bases.

### The inventory of the manuscripts of the *Compositiones Lucenses* and its text units

Texts within the *Mappæ Clavicula* and *Compositiones Lucenses* traditions are at first sight so intertwined that one is initially given to believe that they are simply different arrangements of the same fragments of text. However, *Mappae Clavicula* can be distinguished from *Compositiones Lucences* through more accurate and expansive inventories of the witnesses of both traditions and their text units.

In the Lucca 490 manuscript, the *Compositiones Lucenses*'s text is transcribed on f. 211v (T and U hands) and ff. 217r–231r (mostly N hand) ([14], p. 155). The f. 211v with the texts *De fabrica in aqua* and *De Malta* is included in the gathering No. $28^6$, and is thought to filling a blank space ([14], p. 170); the remaining part of the recipe book is included in the gatherings Nos. $30^8$–$31^{10}$ ([14], p. 195).

[7] The phrase 'text unit' has been chosen to refer to any single text, in place of the more common, yet misleading term, 'recipe.' In such a way, it becomes possible to include both prescriptive—i.e. true recipes—and descriptive text segments. A text unit refers to a meaningful text segment, which is often but not necessarily separated from the preceding and successive text segments with blank spaces or other palaeographical devices (title, rubrications, large initials, etc.). But this first step may be insufficient and, as a further step, one should compare a given text unit with its witnesses. This will permit one to verify whether the text at hand is the result of a fusion of two or more text units, or the splitting of a text unit into two or more segments, or to confirm the initial evaluation obtained in the first step.

[8] The Klosterneuburg fragment is composed of two folios of recipes (ff. 1r and 1v, with recipes nos. 1–18; ff. 2r and 2v with recipes nos. 19–30) that appear in other witnesses as contiguous sequences, locally ordered. The manuscripts which show the recipes from the first folio are not mixed with any from the second folio, and vice versa. The poor condition of the Klosterneuburg fragment makes it difficult to collate all its recipes: if we compare the 13 Klosterneuburg texts missing in the Lucca 490 manuscript with the text units of the critical edition of *Mappæ* and the text units that we think likely candidates of the *Compositiones Lucenses* tradition, we can reach the following conclusions:

i. None of the texts of the *Mappæ Clavicula*'s critical edition correspond to any of the thirteen Klosterneuburg text units.

ii. The sequence of thirteen recipes missing of the Lucca 490 manuscript is present, in a balanced order, in at least four witnesses of the two traditions and one exemplar of the *Compositiones* tradition. An initial comparison shows the following results: all 13 text units are present in London, British Library, Add. 41486 (ff. 96r–97r), Sélestat, Bibliothèque Humaniste, 17 (ff. 48r–49r), and Corning, Phillipps 3175 (ff. 37r–38v). Ten out of 13 text units are held in Oxford, Bodleian Library, Bodley 679 (ff. 29r–29v). The manuscript Città del Vaticano, Biblioteca Apostolica Vaticana, Reg. Lat. 2079, (ff. 78r–78v) of the *Compositiones* tradition includes at least 11 out of 13 text units.

Should the recipes of f. 211v on the foundations of buildings be excluded from the *Compositiones*' text? Do they belong to a separate collection?

The split in the textual body of the manuscript needs to be critically interpreted. Muratori [4] began the transcription from f. 217r, line 25 (i.e. from the recipe *'De tictio omnium Musivorum'*), and omitted f. 211v and the first 24 lines of f. 217r (in total 13 text units). This fact did not go unnoticed; the Archbishop Giovanni Domenico Mansi had already remarked in 1751 that Muratori had forgotten to transcribe this folio ([33], pp. 96–97). The succeeding literature, however, appears inconclusive, so that it was not transcribed by Pellizzari [15], nor by Hedfors [17], but by Burnam ([16], p. 14) and Svennung ([12], pp. 26–27). Johnson's observations that the two textual sections are contiguous in six manuscripts, seems decisive[9] ([18], pp. 222, 223; [11], p. 25).

The veneration of the Lucca 490, the most ancient exemplar of the medieval recipe books, likely impeded most scholars' understanding of its idiosyncratic nature. The Lucca 490 textual *consecutio*, or sequence of text units, is much more disorganised in comparison with other members of the *Compositiones* tradition, particularly to the Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 2079 [34]. The latter should be considered the reference witness of the tradition instead of the Lucca 490, because it is well structured, independent from the *Mappæ* tradition, and includes 188 texts—of which 149 are already present in Lucca 490.

The text of the *Compositiones*, originally written in ordinary Greek, was likely to have been translated into Latin in the sixth century A.D. ([35], p. 56). The Lucca 490 manuscript "stand[s] as a landmark in the history of sciences and the arts" ([18], p. 224). Currently, the *Compositiones Lucenses* tradition consists of 26 codices, spanning from the eighth up to the fifteenth centuries ([19], pp. 257–279). Within the codices of Table 1, we distinguish the following notable subsets:

i. The first 13 codices include texts from the *Compositiones* and the *Mappæ* traditions, but only nine of them are fundamental witnesses (Nos. 1–9); three (Nos. 10–12), having a small number of texts, are included in the sub-class of the *Compositiones* (*Mappæ*) *fragmentary tradition* and No. 13 is a *descriptus*, obtained by a direct copy from a recognised exemplar.
ii. Two other *descripti* (Nos. 14–15).
iii. Six codices transmit only a text that has been renamed *Editio Minor* (Nos. 16–21); a further seventh witness (No. 5) is fundamental and also includes the *Editio Minor*. The *Editio Minor* is composed of 26 text units, which are largely extracted from the *Compositiones Lucenses* tradition: this small recipe book is exclusively bound immediately after the *De Architectura* by Vitruvius [36].
iv. Three codices belong only to the *Compositiones* tradition (Nos. 22–24).
v. Two further witnesses contain a few text units of the *Compositiones* (Nos. 25–26). They represent, together with the above-mentioned manuscripts Nos. 10–12, the *fragmentary tradition* of the *Compositiones Lucenses*.[10]

Following systematic comparisons of all text units within the entire collection of the *Compositiones* tradition, we estimate that they number between 200 and 250 texts. Needing a more precise definition, we may state provisionally and operatively that the text units of *Compositiones Lucenses* tradition consist of three sets (α, β, γ), which have been categorised according to a progressively diminishing degree of probability (from α to γ) that they belong to a critical edition of text units of the *Compositiones*:

α. Let us first deal with the text units recorded in the Lucca 490 manuscript. We updated the latest edition edited by Caffaro of the Lucca 490 manuscript, which records 160 texts: four of these are evaluated as 'texts of uncertain origin' (on ff. 223r–223v, Nos. 77–80, [37]), because they are likely to have derived from a different, ancient translation of the same textual material that can be read in *Mappæ* ([38], p. 47; see [29], text units Nos. xxxvii, xliv, xlii, xlvii). We further divided three recipes,[11] and the final result consists of 160 texts belonging to the *Compositiones* tradition.
β. The α set is implemented by complementary text units of two manuscripts, i.e.: (i) Città del Vaticano, Biblioteca Apostolica Vaticana, Reg. lat. 2079 (ff. 74r–86r, with the exception of texts *De coloribus*; *De*

[9] We add two further manuscripts, the Vatican City, Biblioteca Apostolica Vaticana, Reg. lat. 2079, f. 74r (only *De malta*), and London, British Library, Add. 41486, ff. 75r–76r. Although Johnson supported the presence of the two recipes in the manuscript Florence, Palatine 951, we were never able to find them.

[10] The present inventory does not include the codices of Table 2 marked with an asterisk, which may transmit a few texts from the *Compositiones*, because they require further and deeper inspection.

[11] The recipes are: (i) No. 91 (f. 223v) with the creation of the texts 91A (*Pandius quanus*) and 91B (*Hec omnia exposuimus*). (ii) No. 148 which is split into texts 148A (*De confectio ficarim* f. 229v) and 148B (*Et dimitte alios*, f. 230r). (iii) No. 156 on f. 230v, with the formation of three texts 156A (*De terra qui vocatur Limnia*), 156B (*Alumen vero viridem*), and 156C (*Terra nigra nomisi*).

**Table 1 The manuscripts of the *Compositiones Lucenses* tradition**

| Prog. num. | Place | Library | Shelfmark | Century (c.) | Relevant folios and contents |
|---|---|---|---|---|---|
| 1 | London | British library | Add. 41486 | Thirteenth c. | *Mappæ* tradition: f. 60v; ff. 63v–75r<br>*Compositiones* tradition with excerpts from Palladius *De re rustica* and variorum: ff. 75r–104v |
| 2 | Oxford | Bodleian Library | Bodley 679 | Thirteenth c. | *Mappæ* tradition: ff. 21r–26v<br>*Compositiones* tradition ff. 27r–30v |
| 3 | Oxford | Bodleian Library | Digby 162 | Thirteenth c. | *Mappæ* tradition: ff. 11v–19r; ff. 21r–21v<br>*Compositiones* tradition: ff. 19r–21r |
| 4 | Oxford | Magdalen College | 173 | Fourteenth c. | *Mappæ* tradition ff. 192v–195r<br>*Compositiones* tradition: ff. 195r; 195v–196v |
| 5 | Sélestat | Bibliothèque Humaniste | 17 | Tenth c. | *Mappæ* tradition ff. 2r–13v<br>*Compositiones* tradition: ff. 14r–31v; ff. 41r–51v; *Editio Minor* ff. 212v–214r |
| 6 | Paris | Bibliothèque National de France (BNF) | lat. 7418 | Thirteenth to fourteenth c. | *Mappæ* tradition: ff. 269ra–269vb; ff. 271va–271vb; ff. 72vb–274rb; 277va–278rb; 278rb–278vb<br>*Compositiones* tradition: ff. 269vb–271rb; 271vb–272vb; 274va–277rb |
| 7 | Madrid | Biblioteca Nacional | 19 | Twelfth c. | *Mappæ* tradition: ff. 199ra–201ra; 201rb–202vb<br>*Compositiones* tradition ff. 203ra–203vb |
| 8 | Corning (N.Y.) | Museum of Glass | Phillpps 3175 | Twelfth c. | *Mappæ* tradition: ff. 4r–24v<br>*Compositiones* tradition with excerpts from *De re rustica* by Palladius:ff. 24v–67v |
| 9 | Firenze | Biblioteca Nazionale Centrale | Pal. 951 | Late fourteenth or fifteenth c. | *Compositiones* tradition:ff. 11r–17r; ff. 17r–17v<br>*Mappæ* tradition: ff. 18r–26r |
| 10 | Paris | BNF | lat. 6514 | Thirteenth to fourteenth c. | *Compositiones* tradition: 4 texts on ff. 46r, 48r, 52r<br>*Mappæ* tradition: thirteen texts on ff. 43r, 47v–49v |
| 11 | Paris | BNF | lat. 6830F | Thirteenth c. | *Mappæ* tradition: eight texts on ff. 78v, 79v–80v<br>*Compositiones* tradition: 7 texts on ff. 79r, 79v |
| 12 | Paris | BNF | lat. 11212 | Thirteenth c. | *Mappæ* tradition: eight texts on ff. 122r, 123v–124v<br>*Compositiones* tradition: seven texts on ff. 122r–123r |
| 13 | Glasgow | University Library | Hunterian 110 | Thirteenth to fourteenth c. | ff. 16r–23v, *descriptus* of the Corning manuscript |
| 14 | Leiden | Rijksuniversiteit Bibliothek | VFC 33 | Seventeenth c. | ff. 1–71, *descriptus* of the manuscript Vatican, Reg. lat. 2079 |
| 15 | Siena | Biblioteca degli Intronati | C.V.24 | Sixteenth to seventeenth c. | ff. 85r–86v, *descriptus* of the manuscript Vatican, Reg. lat. 2079 |
| 16 | London | British Library | Harley 2767 | Ninth to tenth c. | *Editio Minor*: f. 161v |
| 17 | Oxford | Bodleian Library | Rawlinson D893 | Tenth c. | *Editio Minor*: ff. 135r–136v |
| 18 | Leiden | Rijksuniversiteit Bibliothek | VFL 88 | Tenth c. | *Editio Minor*: ff. 106r–107r |
| 19 | Madrid | Real Biblioteca de Escorial | III.F.19 | Tenth c. | *Editio Minor*: ff. 84r–85r |
| 20 | New York | Metropolitan Museum of Art, Dept. of Prints | Pl.1 | 1400–1425 | *Editio Minor*: ff. 89r–91v |
| 21 | Firenze | Biblioteca Medicea Laurenziana | Pl. XXX.10 | Fourteenth c. | *Editio Minor*: ff. 60r–60v |
| 22 | Klosterneuburg | Stiftsbibliothek | W.8.293 | Ninth c. | *Compositiones* tradition: a two folios fragment |
| 23 | Città del Vaticano | Biblioteca Apostolica Vaticana (BAV) | Reg. lat. 2079 | Twelfth c. | *Compositiones* tradition: ff. 74r–86v |
| 24 | Lucca | Biblioteca Capitolare | 490 | Eighth to ninth c. | *Compositiones* tradition: 211v; 217r–231r |
| 25 | Città del Vaticano | BAV | Pal. lat. 1449 | Ninth c. | *Compositiones* tradition: 1 text on f. IVr |
| 26 | Firenze | Biblioteca Nazionale Centrale | Pal. 981 | Fifteenth c. | *Compositiones* tradition: about 5 autonomous texts on ff. 7r–9r on pigment making |

*emplastro*; *Ad cruas faciendas* on f. 77r as these are not found in any other manuscript), and (ii) Sélestat, Bibliothèque Humaniste, 17, with the exception of the text on f. 37r, the incipit of which reads: *Corpus hominis* (an excerpt from *Homo bene figuratus* by Vitruvius).

**Table 2 The manuscripts of the *Mappæ Clavicula* tradition**

| Prog. num. | Place | Library | Shelfmark | Century (c.) | Relevant folios and contents |
|---|---|---|---|---|---|
| 14 | Lucca | Biblioteca Capitolare | 490 | Eighth to ninth c. | *Mappæ* tradition: Nos. 77–80 of Caffaro's edition [35] |
| 15 | Torino | Biblioteca Nazionale Universitaria | 1195 | Sixteenth c. | *Mappæ* tradition 22 texts on ff.93r–94v, 104r–105v |
| 16 | Paris | BNF | lat. 7156 | Fourteenth c. | Nos. 15, 16, 2on f. 136v |
| 17 | Paris | BNF | lat. 7158 | Fourteenth c. | Nos. 15, 16, 2on f. 11r |
| 18 | Paris | BNF | lat. 7400A | Fourteenth c. | Nos. 35–40, 41, 42, 43, 44–47, 74–78, 80–82, 92 on ff. 28r–30r, 44v–46r (*) |
| 19 | Munich | Bayerische Staatsbibliothek | Clm lat. 7623 | Twelfth to thirteenth c. | Nos. 34–38, 52, 53, 81, 82, 91, 92, 93 on ff. 109v–110r |
| 20 | London | British Library | Cotton JuliusD viii | Fifteenth c. | Nos. 41, 82 on ff. 85v–87v (*) |
| 21 | London | British Library | Royal 7 D ii | Twelfth c. | Nos. 33, 35–37, 39–41 on ff. 20v–22v |
| 22 | London | British Library | Sloane 342 | Thirteenth c. | Nos. 38, 50, 51, 61, 82 on f. 132r (*) |
| 23 | London | British Library | Sloane 781 | 1699 | Nos. 5, 30, 33–35, 37–42, 45, 49, 50, 55, 56, 60, 65–71, 82, 89, 92, 95 on ff. 14r–19v (*) |
| 24 | Cambridge | University Library | 1781 (Ii.III.17) | Fifteenth c. | No. 52 on f. 36v (*) |
| 25 | Oxford | Bodleian Library | Bodley 177 | Fourteenth c. | No. 15 on f. 54r–v |

γ. Other textual candidates follow a three-step procedure, which is affected by a probability to reject 'good texts' (or type I error) and to accept 'bad texts' (or type II error).[12]

### The inventory of the manuscripts of the *Mappæ Clavicula* tradition and its text units

The alchemical textual nucleus of *Mappæ* originally consisted of a preface followed by 193 recipes for Halleux [39], or 182 for Baroni et al. [29]. However, a significant number of recipes of this core is not extant in any witness, with the exception of the titles (rubrications). The entire list (*recensio*) of the witnesses of the *Mappæ* tradition is not given explicitly by the authors of the critical edition who quote only 15 manuscripts, and use three papers by Johnson to confirm that the *recensio* consists within about 25 witnesses ([38], p. 38, n. 30). A more complete inventory is necessary in order to understand how the two traditions are intertwined. After a closer look at Johnson's papers [22–24], we detected information regarding a further ten potential manuscripts of the *Mappæ* tradition, making a total of 25 witnesses.

The first 13 manuscripts of the *Compositiones*' inventory of Table 1 also belong to the *Mappæ* tradition, and therefore they are not copied into Table 2 (see below). Two other manuscripts are quoted by the authors of the critical edition, but not used for setting up the *stemma codicum* (Nos. 14–15). Finally, ten further witnesses (Nos. 16–25) were already recorded by Johnson: some of these, marked by an asterisk, might also contain excerpts from the *Compositiones* tradition.

To summarise, the entire corpus of the manuscripts of *Mappæ Clavicula* may be divided into three subsets: the fundamental tradition (the first nine manuscripts of Table 1), one *descriptus* (No. 13 of Table 1), and the remaining 15 manuscripts named the *fragmentary tradition* of *Mappæ*.

### From touchstone to an alchemical text via a composite codex: a critical review of Rozelle Parker Johnson's work

Between the two World Wars, research into medieval 'art'/craft recipe books occurred not only through the discovery and publication of medieval manuscripts, but also through in-depth analysis that took place along two main lines. On one hand, Daniel Varney Thompson Jr. addressed the study of medieval craftsmanship in his seminal 1935 paper [40], by examining 158 manuscripts between the tenth and fifteenth centuries held in 18 libraries. The product of his work is a source-book of medieval 'arts'/crafts, which includes 202 subjects and sub-subjects ordered alphabetically from *absinthium* to

[12] A candidate text is examined according to the following procedure. It must:
1. Be present in more than one witness of the *Compositiones Lucenses* tradition. Examples of this rule are indicated above in the cases of the Vatican 2079 and Sélestat 17: in both cases we did not find a second witness in any manuscript of the *Compositiones*. The presence of a given text within many witnesses is not necessarily a good guarantee, because in some cases, the text can certainly be ascribed to known sources. For example, the texts *De calce et harena* and *De latericus parietibus* (Sélestat 17, ff. 33v–34r; London 41486, ff. 87v–88r; Corning, ff. 55r–56r) have been recognised as excerpts from *De re rustica* by Palladius ([19], p. 78).
2. Share one of the thematic nuclei now discovered in the *Compositiones* tradition. The thematic inventory is not complete, and a further research of other nuclei should be made.
3. Show a specific language, with a visible Greek or classical Latin substratum, thus excluding all texts that are clearly medieval additions.

yellow lead. On the other hand, and most relevant for the present paper, in the 1930s Johnson explored the witnesses of the Corning manuscript scattered over 25 European libraries. He used all the text units of its 1847 first transcription as a reference [10], and compared them with the alleged witnesses. In so doing, he discovered 81 witnesses of the Corning, some of which contain large sections, and others just short excerpts [22–24].

Johnson's method has at least three drawbacks: (i) it is mainly an exploratory research, which needs to be reinterpreted; (ii) the use of the Corning Phillips as a reference generates discrepancies due to the highly heterogeneous nature of the manuscript, produced by the overlap of chronologically different texts, and (iii) the one and only transcription of the Corning manuscript is considered obsolete.

Firstly, Johnson's papers are the result of an 'exploratory work', because the author "did not attempt to find more than one recipe on each folio" ([23], p. 77; [24], p. 84), and annotated the recipe and folio in concern, which he photographed with his micro-camera. Unfortunately, Johnson was neither able to collate his materials with the Corning manuscript nor to photograph it because Sir Thomas' heir refused permission ([22], p. 73).

Two manuscripts quoted by Johnson are not useful[13] and the remaining 79 do not relate to a single text, but rather to the following combinations of three main texts (the number of references is reported in round brackets):

*De Coloribus et Mixtionibus*[14] (42).
*Mappæ Clavicula* tradition (4), where the term *Mappæ* corresponds to the notion introduced by Halleux and Meyvaert [17].
*Compositiones Lucenses* tradition, where the title *'Compositiones Lucenses'* is defined as above (7).
*De Coloribus et Mixtionibus* + *Mappæ Clavicula* tradition (1).
*Mappæ Clavicula* tradition + *Compositiones Lucenses* tradition (6).
*De Coloribus et Mixtionibus* + *Compositiones Lucenses* tradition (9).
*De Coloribus et Mixtionibus* + *Compositiones Lucenses* tradition + *Mappæ Clavicula* tradition (9).
Lucca manuscript 490 (1).

Secondly, the Corning manuscript is very heterogeneous, being a compilation of compilations and the result of many different chronological contributions ([1], pp. 7, 15, 17; [39]). It includes the following items quoted in accordance with the enumeration (between brackets) of Smith and Hawthorne's edition [1].

i. The recipe book named *De Coloribus et Mixtionibus* (Nos. i–xi), ff. 1r–4r.
ii. What is today known as the alchemical core of the Corning manuscript or *Mappæ Clavicula* (0–95), ff. 4r–24r.
iii. Texts belonging to the *Compositiones Lucenses* tradition (Nos. 96–278), ff. 24r–62r. Notable text units of English and Arabic origin are Nos. 190–191 on f. 40r and Nos. 195–203 on ff. 43r–44v. Texts addressing military subjects and incendiary bombs are Nos. 264–278 on ff. 57v–62r.[15]
iv. Table of runes (Nos. 288 B-P on f. 64r).
v. Some enigmatic notes interpreted as the legend of automata, the pictures of which are missing on f. 65r (see [35], p. 58).

Thirdly, the transcription of the Corning manuscript used by Johnson [10] is not especially reliable because Smith and Hawthorne [1] only split around 92 text units out of 293 of the text units.

Johnson's last work [11] is a revision of his expanded PhD dissertation on the Lucca 490 manuscript. His tragic death due to a car accident in 1941 interrupted his seminal scientific research (see Johnson's obituary 1899–1941, [44]). Johnson, and a great majority of authors after WWII, shared the conviction that there was a high level of continuity in the literary technical materials between the Late Antiquity up to the fourteenth to fifteenth centuries ([11], pp. 88, 89; [21], pp. 16–17; [22], pp. 72–73), and for that reason Johnson considered the Lucca 490 manuscript as a witness of the textual tradition of the Corning's text ([24], p. 84). Thompson had similar ideas when he published the transcription of the fourteenth century manuscript *De Coloribus Illuminatorum Siue Pictorum*. Thompson was convinced that this manuscript stood in a long line of recipe books beginning with the Lucca 490,

[13] Two of Johnson's references are useless for the present work; that is: (i) The Lincoln, Cathedral, B.6.4 codex has never been checked as a possible witness of the Corning manuscript by Johnson, who affirmed: "Since all the other MSS of this work [*Secretum Philosophorum*] contain M[appæ] C[lavicula] recipes, I feel certain that this manuscript does also, although I have not yet examined it."([23], p. 78). (ii) The London, BL, Royal 15 C iv is quoted, because it "contains [only] as its last item the entry 'Liber magistri Adelardi Bathoniensis qui diciture mappe clavicula'" [23], p. 79.

[14] The title *De Coloribus et Mixtionibus* was coined by Thompson in a short note on a paper devoted to the vermillion ([41], p. 66, n. 14), a fact which may have escaped Johnson's attention. Today, the taxonomic concept of *De Coloribus et Mixtionibus* is largely accepted by literature. This small tract consists of an introductory passage in verses followed by 11 recipes, part of which is for preparing pigments and the remaining rules for shading [42], pp. 488–90; [43], p. 539. Whether the verses are an integral part of the *De Coloribus et Mixtionibus* is contested by some authors.

[15] Evidence of the textual nucleus on military machines are in the ninth century Lucca 490 (f. 224r), and in the tenth century Sélestat 17 (ff. 41r–45r), although Halleux and Bernès ascribed them to twelfth century additions ([35], p. 58). These text units are likely candidates for being part of the *Compositiones Lucenses* tradition.

and continuing through to the *Schedula* of Theophilus and the Corning's text ([45], pp. 280–1). Much later, Inès Villela-Petit formulated an opposing opinion on *De Coloribus Illuminatorum* ([46], pp. 172,174).

Mark Clarke's approach to the early medieval recipe books is likely to have been determined by the same idea of continuity, and does not consider the hypothesis that a further independent tradition from that of *Mappæ* could exist. His definition of the *Mappæ Clavicula text-family* ([28], p. 25), as the union of four manuscripts (Lucca 490, Madrid 19, Corning, and Sélestat 17), is in terms of manuscripts and not of texts as in the present work. In fact, the four items are witnesses of both traditions, and all four are of fundamental importance to the reconstruction of *Mappæ* and *Compositiones* texts. Clarke's list lacks five other fundamental manuscripts (see below): he follows the paths of Bischoff and Johnson, and his method is affected by the similar and even greater flaws. In fact the four reference manuscripts contain different texts, a great part of which is irrelevant to either of the respective traditions.

## The textual arrangement of the *Compositiones Lucenses* tradition

The contents of 12 manuscripts of the *Compositiones Lucenses* tradition show the presence of at least ten thematic nuclei of text units.[16] Table 3 illustrates the presence of six nuclei, which are included in four notable manuscripts dated between the ninth and the twelfth centuries. Usually, every manuscript includes a part of the nuclei presenting a peculiar overall arrangement.[17]

In order to obtain Table 3, we firstly indexed every text unit of each manuscript with a progressive number, so that it became possible to obtain the *consecutio* (the sequence or ordinal structure)[18] of the text units within each of the four manuscripts examined here and their respective corresponding folios. The first column of Table 3 refers to the name of the textual nucleus, and the second to the title of the text units, while columns 3–6 indicate the relevant folio and the position of each text-unity within its own manuscript.

The nuclei are internally ordered in an even fashion. Table 3 provides examples of the change mechanisms which occurred in the four manuscripts: the most common of which is the loss of one or more than one text within a nucleus. Other mechanisms include the lack of an entire nucleus (see the case of lapidary 'b') and the loss of the ordinal structure, due to inversions. In a few cases, these nuclei are discontinuous, which is probably due to the conditions of their exemplar or to a confusion between the folios during the copying process.

## Some codicological information on the main manuscripts of the *Mappæ Clavicula* tradition

In the current section, we outline the main pieces of codicological information on the nine fundamental codices, which were used for the critical edition of *Mappæ*'s text (ninth to fifteenth centuries; see [47]). The *stemma codicum* of *Mappæ* (Fig. 1) is composed of two branches, both descending from the same lost manuscript. To sum up, the α family is characterised by the transmission of title,

[16] Besides the four manuscripts indicated in the key of Table 3, the remaining eight are the following: (i) London, British Library, Add. 41486. (ii) Oxford, Bodleian Library, Bodley 679. (iii) Oxford, Bodleian Library, Digby 162. (iv) Oxford, Magdalen College, 173. (v) Paris, Bibliothèque National de France, lat. 7418. (vi) Klosterneuburg, Stiftsbibliothek, W.8.293. (vii) Madrid, Biblioteca Nacional, 19. (viii) Firenze, Biblioteca Nazionale Centrale, Pal. 951.
At the current stage of our research, ten nuclei have been recognised. The labels and functions of the first six are the following: (1) *De fabrica* for building foundations. (2) *Conchylium* for parchment purple dyeing and metallic inks. (3) *Tinctio omnium musivorum* for glass mosaic-making. (4) *De tinctione vitri* for colouring glass. (5) Lapidary 'a', and (6) Lapidary 'b'. The text units of the two lapidaries are not contiguous in any witnesses of the *Compositiones* tradition; nevertheless, they may be found within the same manuscript.
In the following paragraphs, we record the titles, the progressive number of the text units, and the relevant folios from the Vatican Reg. lat. 2079 of the remaining four nuclei (Nos 7–10), which are not represented in Table 3:
(7) *De coloribus* (pigment making). 40 texts from Nos. 51 to 90 on ff. 77r–79v: *Compositio lulaci, Flores neulacis, Lazurin diforon qui dictum bifaces, Lazurin melini zonta, Lazurin arinon, Lazurin carnei coloris, Lazurin hunici zonta, Lazurin ethizonta, Luseum vero, Compositio alithini, Alia, Alia compositio, Alia compositio vermiculi, Item alia compositio vermiculi, De pandio lulacin, Aliud pandium, Alia compositio, Item alia compositio, Alius pandius, Item alius pandius, Primus pandius cinnabarin coloris, Pandius cinnabarin, Pandius cinnabarin, Pandia vocantur omnes colores, Pandius viridis, Item pandius viridis, Item pandius viridis, Pandius ocrei coloris, Pandius purpurei coloris, Pandius porfyrius, Pandius porphyrus, Pandius porphyrus, Pandius sub porphyrus, Pandius cynnabarin, Pandius, Quianus nascitur, Quianus nascitur, Pandius, Pandius, Hec omnia exposuimus.*
(8) *De tinctione pellis* (skin dying). 15 texts from Nos. 158 to 172 on ff. 83v–84v: *Qualiter debeant pelles tingui alithine, Alia tinctio, Tinctio pellis prasini, Alia tinctio, Quarta tinctio, Prima pandii tinctio, Secunda pandii tinctio, Tercia pandii tinctio, Porfiro melino, Tercius pandius, Tinctio ossuum et cornuorum, Secundam tinctionem, Tinctio melina, Colore similiter cinnabarin, Quomodo fiant bovina pargamena.*
(9) *Militaria* (military machines and incendiary mixtures). 17 text units from Nos. 2 to 18 on ff. 74r–75v: *De sagitta plumbea, De alio coxico, De alia sagitta, De sagitta vitoxicata, Drapidos, De compositione arietis, Quomodo debeat celum arietis incedere, Compositio declamias, Compositio napte, Compositio autem olei therebinthini, Hec compositio napthe, Compositio picis, Scyre, De compositione stupii, De anthimyrronia, De extiontione ignis.*
(10) *Memoria* (a recapitulating mnemonic chapter). Three text units from Nos. 185 to 187 on ff. 85v–86r: *Natura herbarum lignorum lapidum et metallorum, Memoria, Herbarum autem terra et lignorum.*

[17] One of the authors of the present work thoroughly analysed all 26 manuscripts of the tradition, by looking at the presence and structure of the nucleus named *De coloribus* for preparing pigments and dyes. The nucleus was found in only thirteen manuscripts [34]. Much work is still to be done on discovering new nuclei, to study the diffusion of each single nucleus and its quantitative weight over the total number of text units of each single manuscript of the tradition.

[18] The position of each text unit inside the manuscript is indicated by a progressive integer, which starts from the first text. For the Corning and Lucca 490 manuscripts we used the published indexes [1, 37], the latter being updated (see note 11).

**Table 3 The arrangement of six thematic nuclei in four witnesses of the *Compositiones Lucenses* tradition**

| Nuclei | Text-units | Lu | | S | | C | | V | |
|---|---|---|---|---|---|---|---|---|---|
| 1. De fabrica | Dispositio fabricae | – | – | f.14r | 1 | f.24v | 101 | – | – |
| | De fabrica in aqua | f.211v | 1 | \| | 2 | f.25r | 102 | – | – |
| | De malta | \| | 2 | f.14v | 3 | \| | 103 | f.74r | 1 |
| 2. Conchylium | De conchylio | f.226r | 106 | f.19r | 33 | f.29v | 127 | f.80v | 110 |
| | De tinctione porphyri | f.226r; 230r | 107; 148B | f.19v | 34 | \| | 128 | \| | 111 |
| | De oxiporfiron to apo rodinis | \| | 149 | \| | 35 | f.30r | 129 | \| | 112 |
| | De porphyro citrino | \| | 150 | f.20r | 36 | \| | 130 | f.81r | 113 |
| | De crysorantista | \| | 151 | \| | 37 | – | – | \| | 114 |
| | De auri sparsione | \| | 152 | \| | 38 | \| | 131 | \| | 115 |
| | De argyrosantista | \| | 153 | \| | 39 | \| | 132A | \| | 116 |
| | De alia argenti sparsione | \| | 154 | \| | 40 | \| | 132B | \| | 117 |
| 3. Lapidary (a) | Petra que dicitur smyra | f.230v | 155 | f.20v | 41 | f.30v | 133 | f.81r | 118 |
| | Terra que vocant limnia | \| | 156A | \| | 42 | \| | 134A | \| | 119 |
| | Alumen | \| | 156B | \| | 43 | \| | 134B | \| | 120 |
| | Terra nigra | \| | 156C | \| | 44 | \| | 134C | \| | 121 |
| | Lapis qui dicitur focaria | \| | 157 | \| | 45 | \| | 135 | \| | 122 |
| | Lapis fissus | \| | 158 | f.21r | 46 | f.31r | 136 | \| | 123 |
| | Lapis gagatis | f.231r | 159 | \| | 47 | \| | 137 | f.81v | 124 |
| | Lapis trachias | \| | 160 | \| | 48 | f.31v | 138 | \| | 125 |
| | Lapis orebus | f.227r | 124 | \| | 49 | f.46r | 214 | \| | 126 |
| | Lapis atriens | \| | 125 | \| | 50 | \| | 215 | \| | 127 |
| | Lapis fumice | f.227v | 126 | f.21v | 51 | f.46v | 216 | \| | 128 |
| 4. Lapidary (b) | Lapis olimpus | – | – | f.46r | 176 | f.35r | 163 | f.76r | 39 |
| | Lapis flebiti | – | – | \| | 177 | \| | 164 | \| | 40 |
| | Lapis rubeus | – | – | \| | 178 | \| | 165 | \| | 41 |
| 5. Tinctio omnium musivorum | Tinctio omnium musivorum | f.217r | 14 | f.25r | 71 | f.49r | 224 | f.83r | 148; 149 |
| | Inauratio musivi | \| | 15 | \| | 72 | f.32r | 144 | \| | 150 |
| | De musivum de argento | f.217v | 16 | \| | 72 | – | – | \| | 151 |
| | De smirutas tabula | \| | 17 | \| | 73 | f.32v | 145 | \| | 151 |
| | De coloratione | \| | 18 | \| | 74 | \| | 146A | \| | 152 |
| 6. De tinctione vitri | Tinctio vitri prasini | f.217r | 5 | f.45v | 167 | f.34v | 154 | f.76r | 30 |
| | Alia tinctio | \| | 6 | \| | 168 | \| | 155 | \| | 31 |
| | Alia lactei coloris | \| | 7 | \| | 169 | \| | 156 | \| | 32 |
| | Tinctio sanguinea | \| | 8 | \| | 170 | \| | 157 | \| | 33 |
| | Tinctio rubea | \| | 9 | \| | 171 | \| | 158 | \| | 34 |
| | Tinctio alithini | \| | 10 | \| | 172 | \| | 159 | \| | 35 |
| | Quo modo tincta melini coloris | \| | 11 | \| | 173 | \| | 160 | \| | 36 |
| | Tinctio rubea | \| | 12 | \| | 174 | \| | 161 | \| | 37 |

*Lu* Lucca, Biblioteca Capitolare, 490, ninth century

*S* Sélestat, Bibliothèque Humaniste, 17, tenth century

*C* Corning, Museum of Glass, Phillipps 3175, twelfth century

*V* Città del Vaticano, Biblioteca Apostolica Vaticana, Reg. lat. 2079, twelfth century

No. 1 *De fabrica*: the ordinal structure is preserved. The manuscripts *Lu*, *S*, and *C* have one text unit missing, and *V* two texts missing

No. 2. *Conchylium*: the *Lu* manuscript shows a break after text No. 108, which continues with text 148B on f. 230r. The ordinal structure is preserved in all other manuscripts. The *C* manuscript lacks one text unit

No. 3. Lapidary (a): *Lu* and *C* manuscripts show a similar order inversion, as their three initial texts are located at the bottom of the set of texts. The manuscripts *V* and *S* conserve their *consecutio*

No. 4. Lapidary (b): this nucleus is absent in *Lu*; the ordinal structure is present in the remaining manuscripts

No. 5. *Tinctio omnium musivorum*: the *C* manuscript includes two ordinal inversions and lacks one text. The *V* manuscript shows a duplication of one text and a fusion of two texts. The other two manuscripts keep their *consecutio*

No. 6. *De tinctione vitri*: all four manuscripts conserve their ordinal structure

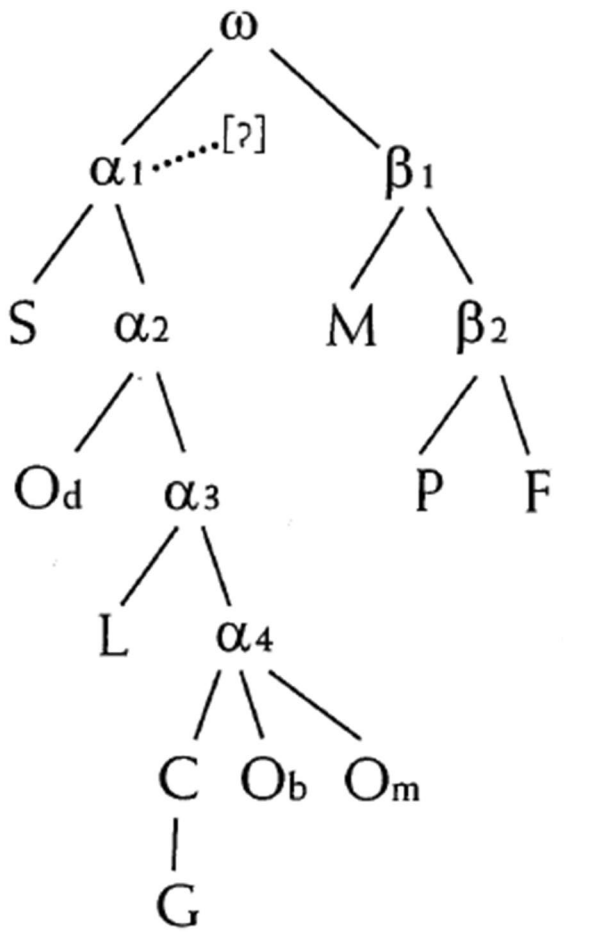


**Fig. 1** *Stemma codicum* of the *Mappæ Clavicula* tradition (Source: Courtesy of Sandro Baroni and Paola Travaglio ([36], p. 39))

prologue, and index, whereas the β family lacks the prologue, index, and the first four texts of *Mappæ Clavicula*.

Two different selective forces operated on the two branches of the stemma. The first is represented by the selective action of the various copyists, who introduced a set of sharp changes to the *Mappæ*'s texts of the α family along the chain from ω to $\alpha_4$. The active selection operated on the β family was that of the copyist who compiled the *florilegium*.

The structure of the texts within the codices may be described with the mechanism pair *ordinatio*/*compilatio*.[19]

[19] *Ordinatio* and *compilatio* are two scholastic mechanisms that innovated reading practices at the beginning of the twelfth century [48]. These are likely to be connected to the development of scholastic *lectiones*, a structured production of books, its commerce, and the birth of new religious orders. The practice of *ordinatio* is the result of an original *mise-en-page* based on a sophisticated arrangement of written works using functional features such as marginal numbers, running titles, and tables of contents. This process was most likely a response to the growing scholastic need for an analytical and efficient study of texts, which required accessibility for readers. This innovative practice more efficiently organised texts and excerpts from a variety of sources into new arrangements and collections.

A palaeographical examination of the nine codices reveals that the various scribes did not use any particular visual devices to organise the material in any specific way. *Ordinatio*'s indexes, numeral or in alphabetical order, marginal numbers or glosses are all features of an efficient textual *mise-en-page*. Nevertheless, these elements are missing in our codices, with the exception of the London, British Library, Add. 41486 manuscript (see [38], p. 43). The texts of the eight remaining codices are provided in a continuous progression, in which recipes are marked by their title only, sometimes with differently coloured ink, and without any comments in the pages' margins. A discontinuous alpha-numerical thematic order is rarely present.

### The statistical description of the textual blocks of the nine fundamental manuscripts

Figure 2 illustrates how the codices have been compiled with sets of text units of various magnitudes, indicated by blocks of different colours. The relevant folios and quantity of texts are specified inside each block. In addition, the greenish blocks include an integer within round brackets, which denotes the quantity of the text units already present in the Lucca 490 manuscript. The block of texts of the *Mappæ* and *Compositiones* traditions, which are distinguished in the α and β families, are considered the material source for a statistical treatment: the unit of analysis are the blocks of texts belonging to the two traditions.

The four columns on Table 4 present four univariate, discrete sets of data, small in size: they refer to the number of text units indicated by the blocks of *Mappæ* (*Compositiones*) of the α and β families.

It seems hard to consider the four data sets as samples extracted from one large population of codices; therefore, we may consider each one of the four as individual populations themselves. The average number of texts of the *Compositiones* of the α family (98.5.) is 1.72 times that of *Mappæ* (57.2), unlike the figures of the β family which are very close in number (26.7 texts for the *Compositiones* and 24.6 for *Mappæ* respectively).

The coefficient of variation (CV, the ratio of the standard deviation to the mean value) of the four distributions is large and has similar magnitudes. It ranges from a maximum CV of 0.85 (*Mappæ* blocks of the α family) to a minimum CV of 0.67 (*Compositiones* blocks of the β family). The high values of the standard deviation and the coefficient of variation of the four distributions are due to the contemporaneous presence of both big and small blocks of recipes.

The indices of kurtosis and skewness are used to describe the shape of the distribution of our empirical populations. Karl Pearson operatively introduced the concept of kurtosis in terms of the fourth moment

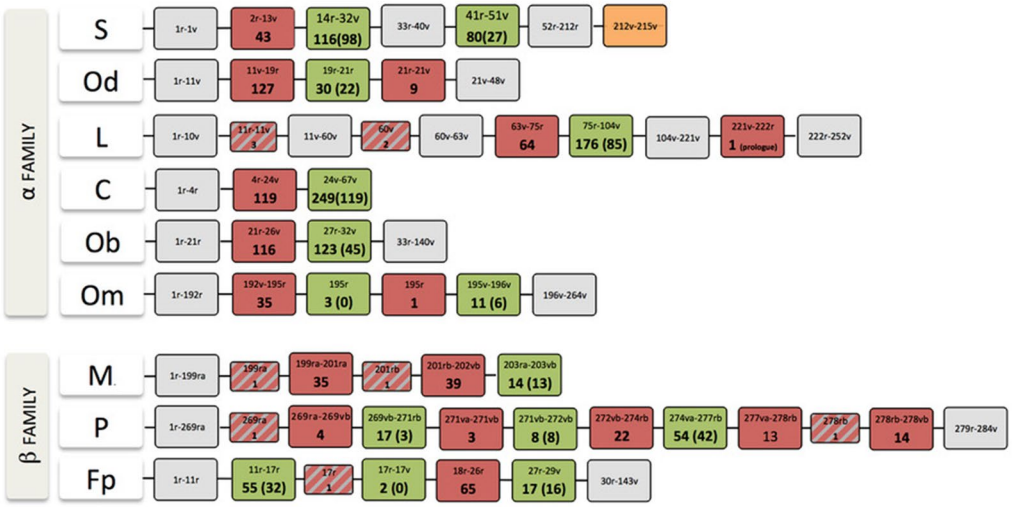


**Fig. 2** Contents and structure of the nine codices transmitting *Mappæ Clavicula* and the *Compositiones lucenses* traditions. *α Family*—*S* Sélestat, Bibliothèque Humaniste, 17, tenth century. *Od* Oxford, Bodleian Library, Digby 162, thirteenth century. *L* London, British Library, Add. 41486, thirteenth century. *C* Corning, Museum of Glass, Phillipps 3715, twelfth century. *Ob* Oxford, Bodleian Library, Bodley 679, thirteenth century. *Om* Oxford, Magdalen College, 173, fourteenth century; *β Family*—*M* Madrid, Biblioteca Nacional, 19, twelfth century. *P* Paris, Bibliothèque National de France, lat. 7418, fourteenth century. *Fp* Firenze, Biblioteca Nazionale Centrale, Pal. 951, fifteenth century. *Green* Compositiones Lucenses tradition. *Red Mappæ Clavicula*. *Red* and *grey* fragmentary tradition of the *Mappæ Clavicula*. *Grey* other unrelated texts

**Table 4 The statistical description of the blocks of texts of the α and β families**

| | 1<br>α CLT | 2<br>α MCT | 3<br>β CLT | 4<br>β MCT |
|---|---|---|---|---|
| | 3 | 1 | 8 | 4 |
| | 11 | 1 | 14 | 5 |
| | 30 | 9 | 17 | 13 |
| | 80 | 35 | 17 | 14 |
| | 116 | 43 | 22 | 22 |
| | 123 | 64 | 54 | 35 |
| | 176 | 116 | 55 | 39 |
| | 249 | 119 | | 65 |
| | | 127 | | |
| Mean | 98.5000 | 57.2222 | 26.7143 | 24.625 |
| Stand. Dev. | 80.1358 | 48.9098 | 17.9977 | 19.3968 |
| CV = st.dev./mean | 0.8136 | 0.8547 | 0.6737 | 0.7877 |
| Eccess of kurtosis (K) | −0.8373 | 0.1324 | −1.1462 | −0.2872 |
| Skewness | 0.4921 | 0.2825 | 0.7939 | 0.8699 |
| Shapiro–Wilk index (W) | 0.9366 | 0.8641 | 0.7821 | 0.8972 |
| P value (α = 0.05) | 0.8229 | 0.8344 | 0.8088 | 0.8229 |

*CLT Compositiones Lucenses* tradition, *MCT Mappæ Clavicula* tradition

around the mean, and coined the terms leptokurtic, mesokurtic, and platykurtic to indicate cases in which (excess) kurtosis is > 0, = 0 (K value of column 2 is near to zero), and < 0 (columns 1, 3 and 4), respectively. This index is related to the tails of the distribution: high values of kurtosis mean that the distribution is affected by infrequent extreme deviations, that determine a great part of the variance, This is the case of the *Compositiones* distributions of both α and β families (see columns 1 and 3).

The skewness index has been calculated in terms of the third moment around the mean (Fisher–Pearson standardised third moment): in symmetrical distributions, the mean is equal to the median, and the distribution has zero skewness. Positive skewness indicates that the tail on the right side of the distribution is longer or fatter than that of the left side, and the mass of the distribution is concentrated on the left of the figure. Distributions nos. 3 and 4 are moderately skewed to the right (+½ < skewness < +1), while nos. 1 and 2 are approximately symmetrical (0 < skewness < +½). According to the Shapiro–Wilk index, three distributions over four are normal at the confidence level of 0.05, and only data set no. 3 is non-normal.

The mean values of the two sets of data including all the blocks of *Compositiones* (columns 1 plus 3) and of *Mappæ* (columns 2 plus 4) are 65.00 texts (*Compositiones*) and 41.66 texts (*Mappæ*). Their corresponding coefficients of variation increase in comparison to the values of the four initial data sets [CV (CLT) = 1.07; CV (MCT) = 0.99]. The high values of the CV may be easily interpreted as the result of an active selection of text units by the copyists. The Shapiro–Wilk index shows that both new distributions are normal at 0.05 level of confidence.

### *The codices of the α family*

In the α family, *Mappæ Clavicula*'s text always precedes that of the *Compositiones Lucenses*. No specific devices—such as title, spaces, transcription from a new folio or fascicule, etc.—separate the texts of the two traditions, with the exception of the Sélestat 17. All manuscripts which succeeded the lost manuscript $\alpha_2$ lacked the last section of *Mappæ* (recipes Nos. CXLVII–CLXXXII, [38], p. 41; see Fig. 1).

[*S*] Sélestat, Bibliothèque Humaniste, 17, tenth century, Saint Amand of Tours in Northern France, parchment, 215 ff., 20–22 lines in a single column. The codex is a collection of texts on craft techniques and architecture, and is likely to be the result of a subject-based reassembly of different writings. Texts from *Mappæ* and *Compositiones* traditions are bound with *De architectura* by Vitruvius, *De diversis fabricis architectonicae* by Faventinus, excerpts from *De re rustica* by Palladius, and other fragments from ancient collections on the same subject.

[*Od*] Oxford, Bodleian Library, Digby 162, thirteenth century, England, parchment, 48 folios, 46 lines in two columns. It is the most extensive *Mappæ* witness within the α family. Likely, *Od* is a late copy of an ancient version of the text, as it represents the only witness of the α family, which includes five texts on ff. 21r–21v (Nos. CXXVII, CXLII, CXLIII, CXLC, CXLVI of the critical edition, see [38], p. 42).

[*L*] London, British Library, Add. 41486, thirteenth century, Italy, parchment, 252 folios, 25 lines in a single column, 14 folios and two entire quires missing. This manuscript consists mainly of alchemical texts and recipe books. A single, competent compiler, who composed glosses and word lists, seems to have efficiently gathered and organised texts (*De diversis artibus* by Theophilus, *De coloribus et artibus Romanorum* by Heraclius, *De Coloribus et Mixtionibus*, *Mappæ Clavicula* and *Compositiones Lucenses.* See [38], p. 43). The prologue of *Mappæ* is placed at the end of the codex (ff. 221v–222r), together with those of Heraclius and an incomplete version of *De Coloribus et Mixtionibus*.

Three texts on ff. 11r–11v, indicated here as 'text of uncertain origin', could be ascribed to *Mappæ Clavicula*; however, they seem likely to be part of autonomous traditions, excerpted from *Mappæ* or from other similar alchemical collections. Two *Mappæ* texts on f. 74r have been duplicated on f. 60v. The manuscript is dismembered after f. 100v. This is indicated by an interruption in the transcription of the text *De speciebus metallorum herbarum lapidum lignorum et fusi salnitri afronitri* at the end of the quire. Folio 101r begins with a text on *nigellum.*

[*C*] Corning, Museum of Glass, Phillipps 3175, twelfth century, England, parchment, 67 folios, 21 lines in a single column: its texts (see above) are not separated by particular visual devices.

[*Ob*] Oxford, Bodleian Library, Bodley 679, thirteenth century, monastery of Saint Augustine in Canterbury, parchment, 140 folios, 50 lines in a single column. The manuscript is mostly devoted to alchemy and recipe books such as *De Coloribus et Mixtionibus*, *Mappæ Clavicula*, and *Compositiones Lucenses*. The compiler carried out an extensive and recognisable reworking of the text. The section on ff. 23r–32v contains several textual segments from the *Compositiones* tradition: some of them could have been missing, due to the loss of two folios (ff. 33–34).

[*Om*] Oxford, Magdalen College, 173, fourteenth century, England, parchment, 264 folios, 27–33 lines in a single column, ff. 79r–95v in two columns. It is an alchemical and medical codex that includes texts from the *De Coloribus et Mixtionibus*, *Mappæ Clavicula*, *Compositiones Lucenses* tradition, with excerpts from the first book of *De diversis artibus* by Theophilus. One text unit from *Mappæ* is inserted within the transcription of the *Compositiones* tradition.

### *The codices of the β family*

Madrid 19 still maintains a division between the blocks of texts of the two traditions (see Fig. 2); the other two codices are characterised by an alternation between large and small segments of text units of the *Compositiones* and *Mappæ* traditions. It is plausible that all manuscripts of this family come from the same *florilegium*, even though this has only been demonstrated for Madrid 19 and Paris, lat. 7418 [49]. The β family is characterised by the presence of two typical recipes.[20]

[*M*] Madrid, Biblioteca Nacional, 19, twelfth century, Catalonia or Montecassino, parchment, 203 folios, 47 lines in two columns. This codex originates from a *florilegium*, compiled in Southern Italy around the year 1000. Some texts on ff. 199r–202v are named in the library's catalogue '*Excerpta ex tractatibus alchimiae*': they belong to *Mappæ* and *Compositiones* traditions. The manuscript includes the most extensive copy of the alchemical nucleus of *Mappæ* within the β family ([38], p. 45), which is preceded by the recipe *Item de chrisographia* on f. 199ra; the other typical recipe *Aurum crescere* is on f. 201rb.

[*P*] Paris, Bibliothèque National de France, lat. 7418, thirteenth to fourteenth centuries, Italy, parchment, 284 folios, 42 lines in a single column. This manuscript

[20] They are recipes on making gold: *Item de chrisographia* (Madrid 19)/*Item de grisografia* (Paris 7418)/*De grisographia* (Firenze 951), and *Aurum crescere* (Madrid 19)/*Amplificatio auri* (Paris 7418). The origin of these recipes are uncertain, but they show similarity in style and subject with other prescriptions of the *Mappæ* and *Compositiones* traditions ([38], p. 31).

belongs to the same *florilegium* of Madrid 19, with which it shares most features, although the Parisian manuscript appears more extensive than the Madrid codex in the section of the *Compositiones* tradition. The texts *Item de grisografia* and *Amplificatio auriis* are on f. 269ra, and f. 278rb respectively.

[*Fp*] Firenze, Biblioteca Nazionale Centrale, Palatino 951, fourteenth to fifteenth centuries, Southern Italy, paper, 25–26 lines in a single column, ‹dragon› and ‹M› watermarks alternated in the volume. This manuscript is most likely to be an excerpt from the same *florilegium*, although here *Mappæ Clavicula and Compositiones* traditions are bound up with *De diversis artibus* by Theophilus, and other treatises related to pigments and glass colourings. It shares with the *P* manuscript the presence of the recipe *De grisographia* on f. 17r.

### Some codicological information on three witnesses of the *Compositiones Lucenses* tradition

The following three manuscripts belong only to the *Compositiones Lucenses* tradition: they are fundamental witnesses of the tradition, two of these include large amounts of text units, and two are very old. All three are independent from the *Mappæ* tradition.

[*Lu*] Lucca, Biblioteca Capitolare, 490, eighth to ninth centuries, Lucca (Italy), parchment, 32–34 lines in a single column, except 18 lines on f. 211 (see above).

[*V*] Città del Vaticano, Biblioteca Apostolica Vaticana, Reg. lat. 2079, twelfth century, France (Rouen?), parchment, 39 lines in a single column. The text of the *Compositiones Lucenses* tradition was copied just after the transcription of *De architectura* by Vitruvius. It begins with a series of directions on incendiary mixtures and military machines, and this fits in well with the Book X of the *De architectura* devoted to the use and construction of machines.

[*K*] Klosterneuburg, Stiftsbibliothek, W.8.293, ninth century, France, Belgium or Germany, parchment, 27 lines in a single column, 30 texts. This fragmentary manuscript was probably formed from at least 119 text units.

## Results

The catalogue of the library of the Reichenau's monastery (821–2), and the title transmitted by the Sélestat 17 manuscript (tenth century), indicate that the phrase '*Mappæ Clavicula*' has been around since the Carolingian times ([20], p. 11). Various pieces of evidence show that *Mappæ* and *Compositiones* are two different textual traditions, arising from new interpretations of old evidence, an assessment of the literature, and from new codicological data.

The text of *Mappæ* can be retraced throughout the indexes of four manuscripts.[21] The *Compositiones Lucenses*' text, instead, cannot be restored on the basis of current knowledge, since none of its manuscripts identified to date can give us the precise number of text units and their sequence.

The topics dealt with by the two traditions diverge significantly. *Mappæ Clavicula* has a distinctly alchemical character and only briefly touches upon craft applications, as highlighted by both its enigmatic prologue and the sequence of its texts. In fact *Mappæ Clavicula* was originally a coherent work, its subjects arranged in reasoned order: according to its critical edition ([38], p. 41), the text units of *Mappæ* are organised, with some exception, in order of metal from precious to cheap. The progressive number of the text units (in brackets) are the following: gold (Nos. 1–70); silver (Nos. 71–113), copper (Nos. 114–136); iron (Nos. 142–146); lead (Nos. 147–151), tin (Nos. 153–155); and glass (Nos. 158–172). Glass was considered a metal by Late Antiquity astrologers and alchemists, because it melts like other metals (see [50], pp. 136, 149–160, 162).

In stark contrast, the contents of the *Compositiones* tradition are specifically devoted to craft techniques, without any substantial mention of alchemical or hermetic themes, as has been noted by Berthelot ([21], pp. 10, 22).

Besides, there are some lexical divergences about pigments and dyes between the Corning and the Lucca 490 manuscripts, which are likely to be mirrored in other witnesses to the two traditions. What the first manuscript calls *aerugo* (copper(II) acetate), *indicum* (indigo), *caeruleum* (Egyptian blue), *alcusa* (alkanet), *aes ustum* (copper (I) oxide), *chalcanthum* (iron and copper sulphates), the second manuscript calls *iarin*, *lulacium, quianium, lacca, cecucecaumenon*, and *bitriolum* respectively ([39], pp. 179–180).

### Pieces of codicological evidence

Two pieces of evidence show the separation between the two traditions. Firstly, a significant part of the *Compositiones Lucenses* tradition was likely to result in the aggregation of small internally ordered nuclei; each manuscript presents its own particular order of these nuclei that form the *Compositiones Lucenses* text (see also [39], p. 178). This feature sharply distinguishes this tradition from that of *Mappæ* (see [27] for an opposing opinion).

Secondly, three witnesses of the *Compositiones* tradition had their autonomous literary circulation from the *Mappæ* tradition, from at least the ninth century until

[21] Sélestat, Bibliothèque Humaniste, 17, tenth century.; Oxford, Bodleian Library, Digby 162, thirteenth century; Oxford, Bodleian Library, Bodley 679, thirteenth century, and Corning Museum of Glass manuscript, Phillipps 3175, twelfth century; see [38], pp. 28–29.

the twelfth century (the eighth to ninth centuries Lucca 490, the ninth century Klosterneuburg W.8.293, and the tewlth century Vatican, Reg. lat. 2079).

Three other notable pieces of evidence concern the *Mappæ Clavicula* tradition; i.e.:

i. The Corning manuscript is a poor candidate to reconstruct the contents of *Ur-Mappæ*. Its position in the *stemma codicum* of Fig. 1 is low. It is extremely heterogeneous, and its first and unique transcription [10] is not reliable (see above)].
ii. Unlike the *Compositiones*, the *Mappæ* tradition is not characterised by witnesses having both greatly sized blocks of texts and an independent life from other textual traditions. Based on what we currently know, only a small number of manuscripts of the *Mappæ*'s *fragmentary tradition* might be independent from the *Compositiones Lucenses*.
iii. Any theory on *Mappæ* should consider that the texts of the fundamental tradition of *Mappæ* have been subjected to sharp changes. The first and greatest change is the separation of the α and β families of the *Mappæ*'s text, which have different philological ([38], pp. 38–40) and statistical features. Moreover, they are transmitted with different mechanisms: the three codices of the β family are more conservative, being members of a *florilegium* ([38], pp. 45–46), whereas the α family is strongly affected by a set of abrupt consecutive changes from $\alpha_1$ to $\alpha_4$. Twenty-nine texts are missing from the text change $\alpha_1$ to $\alpha_2$ ([38], p. 40). Similarly 36 texts are missing in the transition from text $\alpha_2$ to $\alpha_3$ ([38], p. 41). In the transition from $\alpha_3$ to $\alpha_4$, texts numbered with Nos. 121 onwards are missing ([38], pp. 42–43).

The analysis of the manuscripts which include both traditions reveals two further pieces of evidence. Firstly, the codices' structures (see Fig. 2) indicate a variety of different arrangements. We focus primarily on large blocks of text units: the biggest number of texts of the blocks of the *Compositiones* (*Mappæ*) tradition varies from 249 (127) texts in the α family to 55 (65) in the β family. Four codices out of six of the α family (*S*, *L*, *C*, and *Ob*, see Fig. 2) include big blocks of text units from the *Compositiones*' tradition (116, 176, 249, 123 texts), and in three cases out of four (*L*, *C*, and *Ob*) the texts of the *Compositiones*' blocks overlap those of *Mappæ Clavicula,* without the two traditions becoming mixed in any way. It seems safe to conclude that the two traditions overlap in many cases of the α tradition. Moreover, it must be noted that the two *Compositiones* blocks of the Sélestat codex are practically complementary (see Fig. 2). These features may be rationalised with the deliberate copying of a selection from larger blocks operated by copyists. Nevertheless, the origin of big blocks of texts may also be explained by means of a first stage of aggregation, followed by a successive segregation from a unique source in a quasi-homogeneous state from a source named *Mappæ Clavicula* text family. However, the latter hypothesis is not statistically plausible.

Secondly, with the exception of the Lucca 490 manuscript and sparse information on some of the nine fundamental codices, our knowledge of their codicological units (quires or booklets) is still approximate. Nevertheless, further evidence of separation of the two traditions emerges: in the Sélestat 17 manuscript, the *Mappæ Clavicula* text is found in the first two quires, the second of which (ff. 10–13) is incomplete, as four folios are missing, and the last page is largely blank (f. 13v). *Compositiones Lucenses* tradition starts from a new quire on f. 14r, which is different in both format and parchment. The two traditions are contiguous and are copied in subsequent gatherings. This same fact may be interpreted as a process in which two different texts or booklets are bound together, and not as the result of the deliberate work of the copyist. However, this latter interpretation cannot rule out the magnitude of the two *Compositiones*' blocks, neither their complementarity.

## Conclusions

It is doubtful that a critical edition of the *Compositiones Lucenses* tradition will be possible. However, a comparative and perhaps critical edition of the text-units of the latter seems plausible. This will contribute to a more clear-cut distinction between the two traditions.

In summary, there are new pieces of evidence supporting the theory of two separate collections of recipe books. First of all, any theory on *Mappæ* must consider its critical edition, which heavily narrows the number of possible witnesses and the fact that the *Compositiones Lucenses* tradition has had an autonomous existence from *Mappæ* for a long time. The contents of the two traditions are significantly diverse and *Compositiones*' structure includes various nuclei of texts, the contents of which are not similar to those of *Mappæ*.

Secondly, other pieces of evidence emerge from an analysis of the structure of the witnesses with texts of the two traditions: we refer to the large sized blocks of texts of *Compositiones* in the α family of *Mappæ*, the statistical differences between the two traditions as well as the differences between the α and β families. Moreover, the copying process of the nine fundamental codices occurred in various manuscripts through a simple superposition of segments of different, but significant sizes. In the Sélestat 17 and other manuscripts of Fig. 2 there is a clear-cut separation between the two traditions. Further

evidence could come from assessment of the lexical differences on pigments and dyes throughout a significant number of witnesses from the two presumed traditions.

All these facts are difficult to account for with any theory of a unique *Mappæ Clavicula text family*; rather, they can be rather easily explained by imagining the existence of two separate traditions.

**Authors' contributions**
GB provided the codicological data, drafted the codicological description of the manuscripts, and the section concerning the structure of the *Compositiones lucenses* tradition. GF drafted the remaining sections and revised the entire paper. Both authors read and approved the final manuscript.

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**References**

1. Smith CS, Hawthorne JG. Mappae Clavicula: a little key to the world of medieval techniques. Transac Am Philos Soc. 1974;64(4):1–128.
2. Plesters J. Painting methods and materials. A brief survey of published works from 1961–1972. In: Anon, Editor. Conservation of paintings and the graphic arts: preprints of contributions to the Lisbon Congress, 1972. Preprints of Contributions to the Lisbon Congress 1972, 9–14 October 1972. London: International Institute for Conservation of Historic and Artistic Works; 1972. p. 101–5.
3. Bomford D. Introduction. In: Hermens E, Ouwerkerk A, Costaras N, editors. Looking through paintings: the study of painting techniques and materials in support of art historical research. London: Archetype, Prom Baarn; 1998. p. 9–12.
4. Muratori LA. Antiquitates Italicae Medii Aevi, sive Dissertationes de moribus, ritibus, religione, regimine, magistratibus, legibus, studiis literarum, artibus […]. Mediolani: ex typographia Societatis Palatinae in regia curia, . vol. II; 1739. Dissertatio XXIV. cols. 365–88.
5. Stagl J. A history of curiosity. London: Routlege; 2004.
6. Palmer C. 'I will tell nothing that I did not see': British women's travel writing, art and the science of connoisseurship, 1776–1860. Forum Mod Lang Stud. 2015;51(3):248–68.
7. Merrifield MP. Original treatises, dating from the XIIth to XVIIIth centuries, on the arts of painting, in oil, miniature, and on glass; of gilding, dyeing, and the preparation of colours and artificial gems, vol. 2. London: J. Murray; 1849.
8. Lessing GE. Theophili Presbyteri Diversarum artium schedula. In: Leiste C, editor. Zur Geschichte und Literatur aus den Schätzen der herzoglichen Bibliothek zu Wolfenbüttel. Braunschweig: Fürstl. Waisenhaus Buchhandlung; 1781. p. 291–424.
9. Tambroni G. Cennino cennini. Trattato della Pittura. Roma: Paolo Salviucci; 1821.
10. Phillipps T. Letter from Sir Thomas Phillipps… addressed to Albert way communicating a transcript of a MS. Treatise on the preparation of Pigments, and on various processes of the decorative arts practised during the middle ages, written in the twelfth century, and entitled *Mappæ Clavicula*. Archaeologia. 1847;32:183–244.
11. Johnson PR. Compositiones variae from codex 490, Biblioteca Capitolare, Lucca, Italy. An introductory study. Illinois studies in language and literature. Urbana: University of Illinois; 1939.
12. Svennung JA. Compositiones Lucenses, Studien zum Inhalt, zur Textkritik und Sprache, Uppsala-Leipzig: A.-b. Lundequistska bokhandeln, O. Harrassowitz; 1941.
13. Schiaparelli L. Il codice 490 della Biblioteca Capitolare di Lucca e la scuola scrittoria lucchese (sec. VIII–IX). Contributi allo studio della minuscola carolina in Italia. Roma: Biblioteca Vaticana; 1924.
14. Pomaro G. Materiali per il manoscritto Lucca, Biblioteca Capitolare Feliniana 490. In: Pomaro G, editor. In margine al Progetto Codex. Aspetti di produzione e conservazione del patrimonio manoscritto in Toscana. Pisa: Pacini; 2014. p. 139–99.
15. Pellizzari A. I Trattati attorno le arti figurative in Italia e nella Penisola Iberica dall'antichità classica al rinascimento e al secolo XVIII. Ricerche e studi storici e letterari. Dall'antichità classica al secolo XIII, vol. I. Napoli: F. Perrella; 1915. p. 453–502.
16. Burnam MJ. A classical technology edited from Codex Lucensis 490. Boston: Richard G. Badger The Gorham Press; 1920.
17. Hedfors H. Compositiones ad tingenda musiva. Uppsala: Almqvist & Wicksells Boktryckeri-A.-B; 1932.
18. Johnson PR. The 'compositiones ad tingenda'. Tech Stud Field Fine Arts. 1935;3(4):220–36.
19. Brun G. The transmission and circulation of practical knowledge on art and architecture in the Middle Ages. The case of *Compositiones Lucenses* tradition and its connection to Vitruvius' De architectura. Ph.D. diss, Politecnico Milano; 2015. Sistema Archivistico e Bibliotecario. Archivio digitale delle tesi di laurea e di dottorato. http://hdl.handle.net/10589/102810. Accessed 12 Aug 2017.
20. Halleux R, Meyvaert P. Les origines de la Mappae Clavicula. Archives d'histoire doctrinale et littéraire du Moyen Age. 1987;LXI:7–58.
21. Berthelot M. Histoire des sciences. La chimie au Moyen Âge. Book I. Paris: Imprimerie Nationale; 1893.
22. Johnson PR. Note on some manuscripts of the Mappae Clavicula. Speculum. 1935;10(1):72–6.
23. Johnson PR. Additional notes on some manuscripts of the Mappae Clavicula. Speculum. 1935;10(1):76–81.
24. Johnson PR. Some continental manuscripts of the 'Mappae Clavicula'. Speculum. 1937;12(1):84–103.
25. Bischoff B. Die Überlieferung der technischen Literatur. In: Centro italiano di studi sull'alto Medioevo. Artigianato e tecnica nella società dell'alto medioevo occidentale, Settimana di studio del Centro Italiano di Studi sull'Alto Medioevo, 18. Spoleto: CISAM; 1971. (I.). p. 267–296.
26. Tosatti SB. Trattati medievali di tecniche artistiche. Milano: Jaca book; 2007.
27. Kroustallis S. The Mappae Clavicula treatise of the Codex Matritensis 19 and the transmission of art technology in the middle ages. In: Córdoba R, editor. Craft treatises and handbook. The dissemination of technical knowledge in the middle ages. Turnhout: Brepols; 2013. p. 69–84.

28. Clarke M. The earliest technical recipes: assyrian recipes, Greek chemical treatises and the Mappae Clavicula text family. In: Córdoba R, editor. Craft treatises and handbook. The dissemination of technical knowledge in the middle ages. Turnhout: Brepols; 2013. p. 9–31.
29. Baroni S, Travaglio P, Pizzigoni G. Mappae Clavicula. Edizione e commento tecnico, In: Baroni S, Pizzigoni G, Travaglio P, editors. Mappae Clavicula. Alle origini dell'alchimia in Occidente. Testo—traduzione—note. Saonara (Padova): Il Prato; 2013. p. 57–185.
30. Caprotti G. Mappae Clavicula nella storiografia. In: Baroni S, Pizzigoni G, Travaglio P, editors. Mappae Clavicula. Alle origini dell'alchimia in Occidente. Testo—traduzione—note. Saonara (Padova): Il Prato; 2013. p. 17–26.
31. Tolaini F. 'De tinctio omnium musivorum'. Technical recipes on glass in the so-called « Mappae Clavicula ». In: Beretta M, editor. When glass matters. Firenze: Olschki; 2004. p. 195–214.
32. Ganzenmüller W. Ein unbekanntes Bruchstück der Mappae Clavicula aus dem Anfang des 9. Jahrhunderts. Mitteilungen der Medizin, der Naturwissenschaften und der Technik. 1941;40:1–15. Now in Ganzenmüller W. Beiträge zur Geschichte der Technologie und der Alchemie. Weinheim: Verlag Chemie. 1956; p. 336–348.
33. Mansi JD. De insigni codice Caroli Magni aetate scripto et in bibliotheca RR. Canonicorum Majoris Ecclesiae Lucensis servato. In: Calogierà A, editor. Raccolta di opuscoli scientifici e filologici Venezia: Simone Occhi; 1751. p. 71–123.
34. Brun G. De Coloribus: new perspectives on a series of recipes for making pigments within the *Compositiones Lucenses* tradition. Color Cult Sci (Rivista dell'Associazione Italiana Colore). 2015;3:51–5.
35. Halleux R, Bernès AC. Formule d'Architecte, dans le réceptaires et manuscrits d'arpentage de l'Antiquité et du Haut Moyen Age. In: Radelet-de Grave P, Benvenuto E, editors. Between mechanics and architecture. Basel: Birkhaüser; 1995. p. 47–66.
36. Brun G. Transmission and circulation of written knowledge on art in the middle ages. The case of the *Compositiones Lucenses* tradition and the connection with vitruvius' De architectura". Medioevo Europeo. 2017;1(1):18–31.
37. Caffaro A. Scrivere in oro. Ricettari medievali di arte e artigianato (secoli IX-XI). Codici di Lucca e Ivrea. Napoli: Liguori; 2003.
38. Baroni S, Travaglio P. Storia del testo e criteri di edizione. In: Baroni S, Pizzigoni G, Travaglio P, editors. Mappae Clavicula. Alle origini dell'alchimia in Occidente. Testo—traduzione—note. Saonara (Padova): Il Prato; 2013. p. 27–53.
39. Halleux R. Pigments et colorants dans la Mappae Clavicula. In: Guineau B, editor. Pigments et colorants de l'antiquité au Moyen-Age. Paris: CNRS Editions; 2002[1990]; p. 173–180.
40. Thompson DV Jr. Trial index to some unpublished sources for the history of Medieval craftsmanship. Speculum. 1935;10(4):410–431.
41. Thompson DV Jr. Artificial vermilion in the middle ages. Tech Stud Field Fine Arts. 1933;2:62–70.
42. Bulatkin EW. The Spanish word 'MATIZ': its origin and semantic evolution in the technical vocabulary of medieval painters. Traditio. 1954;10:459–527.
43. Thompson DV Jr. Review of the work Farbgebung und Technik frühmittelalterliche Buchmalerei: studien zu den Traktäten "Mappae Clavicula" und "Heraclius," by Heinz Roosen-Runge. Art Bull. 1972;54(4):539–40.
44. Oldfather WA. Current events. Class J. 1942;37(5):313–6.
45. Thompson DV Jr. Liber de Coloribus Illuminatorum Siue Pictorum from Sloane Ms. No. 1754. Speculum. 1926;1(3):280–307.
46. Villela-Petit I. Copies, reworkings and renewals in late medieval recipe books. In: Nadolny J, editor. Medieval painting in Northern Europe: techniques, analysis, art history, studies in commemoration of the 78th birthday of Unn Plahter. London: Archetype; 2006. p. 167–81.
47. Brun G. I codici testimoni di Mappae Clavicula. In: Baroni S, Pizzigoni G, Travaglio P, editors. Mappae Clavicula. Alle origini dell'alchimia in Occidente. Testo—traduzione—note. Saonara (Padova): Il Prato; 2013. p. 201–17.
48. Parkes MB. The influence of the concepts of ordinatio and compilatio on the development of the book. In: Alexander JJ, Gibson MT, editors. Medieval learning and literature: essays presented to Richard William hunt. Oxford: Clarendon Press; 1976. p. 115–41.
49. Lott ES. The Florilegium of Cava 3, Madrid 19, and Paris 7418. Harv Stud Class Philol. 1981;85:305–7.
50. Halleux R. Problème des métaux dans la science antique. Paris: Les Belles Lettres; 1974.