

# The ‘Book on How to Make Colours’ (‘O livro de como se fazem as cores’) and the ‘*Schedula diversarum artium*’

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## I. Introduction

Research on the sources of medieval art materials and techniques, complemented with the analytical examination of the works themselves, has been decisive to the knowledge of the state of medieval technology. Within the written sources of medieval art material and techniques, the ‘*Schedula diversarum artium*’ holds a pivotal place as one of the best-known technical treatises in Europe, with several extant copies spread throughout European libraries. The ‘*Schedula diversarum artium*’, also known as ‘*De diversis artibus*’, is a logically structured work, the result of a practising artist whose devoted work was intended to “the increase of the honour and glory” of God and to the “advancement” of men<sup>1</sup>. Its three books comprise a significant amount of subjects such as miniature and mural painting (Book I), glass techniques and painting on glass (Book II), and metal, gems and ivory techniques (Book III). Although there are no surviving copies of the ‘*Schedula*’ in any Portuguese libraries, its influence on Portuguese medieval art, specifically concerning the treatment of miniature figures from the Alcobaça monastery, as well as in metalwork, has already been established.<sup>2</sup>

The ‘Book on how to make colours of all the paints’, in Portuguese ‘O livro de como se fazem as cores das tintas todas’ (henceforth: ‘Livro das cores’), is an anonymous medieval compilation of recipes for the preparation of pigments and paints, mostly for book illumination. It is the only medieval Portuguese written

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<sup>1</sup> Theophilus, *De diversis artibus*, I, prol., ed. Ch. R. Dodwell, in: Theophilus, *De diversis artibus – The Various Arts*, London 1961 [Reprint Oxford 1986, 1998], 4: “[...] *sed in augmentum honoris et gloriae nominis eius multorum necessitatibus succurrisse et profectibus consuluisse.*” English translation: Theophilus, *On Divers Arts. The Foremost Medieval Treatise on Painting, Glassmaking and Metalwork*, trans. by J.-G. Hawthorne and C.-S. Smith, New York 1979, 13.

<sup>2</sup> A. Miranda, *A construção de uma imagem de poder: a figura do rei na arbor consanguinitatis*, in: E. Fernández González (ed.), *Imágenes del poder en la Edad Media*, vol. 2: *Estudios in memoriam del Prof. Dr. Fernando Galván Freile*, León 2011, 341–355. The author has determined that the treatment of the human figures in a manuscript of the Alcobaça monastery is in accordance with the instructions given in the first book of the ‘*Schedula*’. Also, there are some other evidences of such influence in the work with gold.

source of materials and techniques for book illumination and painting<sup>3</sup>. The analysis of its recipes and textual structure allowed us to conclude that it is not a coherent treatise but rather a compilation of recipes that may have one or more sources. In this paper we evaluate the influence of the ‘*Schedula diversarum artium*’ on the ‘*Livro das cores*’. This will allow further determination of the context and the degree of originality of the Portuguese text.

The remainder of this paper is structured as follows: we begin by defining the background of the ‘*Livro das cores*’, followed by the analysis of the text. We then proceed to establish the context of the ‘*Livro das cores*’ within medieval colour treatises, followed by its comparison with the ‘*Schedula diversarum artium*’.

## II. Preliminary observations

Even though there was a significant manuscript production in Portugal throughout the Middle Ages, there are barely any textual sources on the materials and techniques employed in Portuguese scriptoria. This historical silence is equally felt in the rest of the Iberian Peninsula, as there are no extant original technical treatises on pigment and colour preparation. Known recipes are generally included in texts of a different nature, and in most cases they are found by chance<sup>4</sup>. In Portugal, apart from a few ink recipes, the only surviving medieval source regarding the preparation of pigments and paints for book illumination is a small text entitled ‘*Livro das Cores*’. Its only known copy is included in a collection of texts concerning the copy and decoration of Hebrew sacred texts such as Bibles and liturgical books, as well as Torah scrolls, tefillin and mezuzot (Parma, Biblioteca Palatina, Ms. 1959). Some units are copies of known texts, whereas others seem to be original. Despite the textual diversity most units share the same format, justification and number of lines.

Ms. Parma 1959 was initially thought to be an assorted compilation of texts written by different hands. However, recent research has established that the palaeographic differences are in fact the result of different modes of writing (regular and current semi-cursive, square and cursive) by the same hand<sup>5</sup>. According to the only colophon in the volume (fol. 184v), the copyist was Abraham ben Yehudah ibn Hayyim, who copied it in Loulé (south of Portugal) in the “Jewish year of 22”. This date was initially interpreted as 1262<sup>6</sup>, yet the watermarks in the

<sup>3</sup> So far, there are only two known original Portuguese technical texts for colour preparation, the medieval ‘*Livro das cores*’ and the seventeenth century ‘*Breve tratado de Iluminação*’ (anonymous).

<sup>4</sup> Cf. R. de la Llave, *Un recetario técnico castellano del siglo XV: el manuscrito H490 de la Facultad de Medicina de Montpellier*, in: *En la España Medieval* 28 (2005), 7–48.

<sup>5</sup> Each mode of writing is directly related to a specific theme; cf. D. Matos, *The Ms. Parma 1959 in the context of Hebrew illumination* (Master thesis), Lisbon University 2011.

<sup>6</sup> Cf. G. B. de Rossi, *Manuscripti codices hebraici bibliothecae*, vol. 3, Parma 1803, 21 sq., who mistakenly identifies the Jewish year of 22’ as 1262.

volume suggest a later moment, more specifically 1462. Ibn Hayyim's name also appears in an ornamented signature included at the end of the 'Livro das cores'. This, nevertheless, should not be interpreted as a sign of authorship but rather as the name of its copyist and owner.

The majority of texts included in Ms. Parma 1959 are written in Hebrew with two exceptions: the 'Livro das cores' (foll. 1r–20r) and a group of additional recipes (fol. 28v and fol. 79r), which are similar in terms of contents<sup>7</sup>. In both cases they are written in the vernacular using Hebrew script, a unique combination that is frequently described as Judeo-Portuguese<sup>8</sup>. However, there is a complete absence of a Jewish lexical component that is so characteristic of other Judeo-Portuguese texts, and the existence of treatises originally in the vernacular (scientific texts in particular) that have been transliterated with Hebrew characters seems to suggest that the 'Livro das cores' may be a transliteration of a Portuguese text (or texts). This combination should therefore be interpreted as a sign of acculturation of the copyist and at the same time raises the question of what was the source (or sources) of the current version of the 'Livro das cores'.

The use of Hebrew script and the type of the texts included in Ms. Parma 1959 undoubtedly associate it with the Portuguese medieval Jewish community. The revised date of 1462 coincides precisely with the beginning of the intensive production of illuminated manuscripts in Lisbon<sup>9</sup>. Evidence points towards the existence of an organised centre where books were copied and systematically decorated. Yet there is still no research on the pigments used in Portuguese Hebrew manuscripts and therefore no comparison with the pigments and procedures described in the 'Livro das cores' has been established, even though at a first glance it is possible to ascertain some degree of connection particularly in terms of chrysography and the range of colours used. Interestingly enough, a few studies suggest that there are examples of Portuguese illumination where the materials employed are closely related to the text in the 'Livro das cores', as is the

<sup>7</sup> These recipes were initially described as medical recipes, however our analysis allowed us to determine that they are related to the preparation of stag's glue and size (fol. 28v), as well as pigments and mordants (fol. 79r).

<sup>8</sup> The language of the 'Livro das cores' was studied by Devon Strolovich, firstly in the context of other Judeo-Portuguese texts (PhD Dissertation) and then integrated in the multidisciplinary research project entitled "The materials of the image: pigments on Portuguese treatises from the Middle Ages to 1850", reference POCI/EAT/58065/2004 of the Portuguese Foundation for Science and Technology.

<sup>9</sup> For more information on the Portuguese Hebrew manuscripts cf. T. Metzger, *Les manuscrits hébreux copiés et décorés à Lisbonne dans les dernières décennies du XV<sup>e</sup> siècle* (Cultura medieval e moderna 6), Paris 1977; G. Sed-Rajna, *Manuscrits hébreux de Lisbonne: Un atelier de copistes et d'enlumineurs au XV<sup>e</sup> siècle* (Institut de recherche et d'histoire des textes. Documents, études et répertoires 16), Paris 1970.

case of the 'Livro das Aves' ('Book of Birds') of Lorrvão, one of the most important Portuguese scriptoria<sup>10</sup>, as well as the Charter of Vila Flor<sup>11</sup>, of 1512.

### III. The text of the 'Livro das cores'

The language in the 'Livro das cores' is clearly from the fifteenth century with frequent references to materials and procedures that were common in the previous century. For example, the inclusion of typical fifteenth century procedures for *aurum musivum* (mosaic gold) and turnsole, as well as recipes for brazilwood and Arabic gum, both common in the fourteenth century. Thus, the question that poses is to what extent is the 'Livro das cores' an original compilation or reworking of pre-existing material? If it is a reworking, then the sources for this text and the extent of their influence is still to be determined. The structure of the text points towards a division in several parts<sup>12</sup>. This is corroborated with the existence of two incipits: one in the initial chapter and another in chapter 25. The duplication of some procedures seen in the repetition of recipes for the same pigments, the analysis of contents (materials, procedures, purposes, and so on), as well as some linguistic differences in terms of syntax and terminology, all suggest the division of the text into three main parts.

Part One (chapters 1–15) is the most extensive, dealing with techniques and materials for illumination. Each chapter deals with a specific procedure to obtain pigments that are mainly inorganic. It includes a few alchemic references such as the use of the planets to represent specific metals (gold being represented by the Sun, silver by the Moon and tin by Jupiter), and the expression "take your work" which might be connected with the alchemic Great Work, as well as the reference to a glass dome and the process of indirect heating mentioned in some recipes that are more typical of a laboratory than of a painter's workshop<sup>13</sup>. Recipe four (for gold grinding) is particularly important, as it establishes the date of the recipe and therefore of Part One. The reference to gold coins (dobras, florins and escudos) puts its in early fourteenth century to early fifteenth. The joint circulation of these coins cannot be previous to the end of the thirteenth century, given that only in 1266 this last coin began to be minted. Furthermore, both the escudo and the florim are foreign coins, French and Italian, respectively, which means that it must have taken some time until they became frequent in the Portuguese

<sup>10</sup> Cf. A. Miranda/A. Lemos/C. Miguel/M. J. Melo, On Wings of Blue: the history, materials and techniques of the Book of Birds in Portuguese scriptoria, in: L. U. Afonso (ed.), *The Materials of the Image – As Matérias da Imagem* (Série monográfica Alberto Benveniste 3), Lisbon 2010, 171–184.

<sup>11</sup> Cf. M. J. Melo, A study on Portuguese manuscript illumination: The Charter of Vila Flor (Flower town), in: *Journal of Cultural Heritage* 8 (2007), 299–306.

<sup>12</sup> Cf. L. U. Afonso, New Developments in the study of O Livro de Como se Fazem as Cores, in: id. (ed.), *The Materials of the Image* (nt. 10), 3–27.

<sup>13</sup> Cf. op. cit., 8.

monetary circuit. In the thirteenth century, the Peninsular morabetin were still the most important golden coin in Portugal, therefore it would not make sense to ignore them if the text of the Cores had been written in the thirteenth century. Moreover, it is precisely in the period between ca. 1300 and ca. 1400 that the three mentioned coins in chapter four were, simultaneously, more frequent in Portugal<sup>14</sup>.

Part Two (chapters 16–24) is essentially focused on the techniques of dyeing objects made of wood and bone. Recipes twenty-two and twenty-three are missing. This part denotes a stronger Arabic influence, more specifically in the technical language (for example, “azarnefe” instead of orpiment, “alfadida” instead of cuprous oxide, and so on). However, this is not exclusive of Part Two and it also seen, to some extent, in Part One. In both cases, the Arabic vocabulary is mostly used for technical terms<sup>15</sup>, some of them more frequent in other texts than others. Although this may point to an original source and a desire to keep the original terms unchanged, the use of such words can simply be the result of their importation into both Portuguese and Spanish (Castilian) languages, although (especially in the case of the Portuguese language) they do not apply anymore<sup>16</sup>.

Part Three (chapters 25–45) is composed of recipes mainly for the mixture of pigments and dyes. Each chapter presents several recipes related to an initial pigment. Most pigments in this part are of organic origin, and the language denotes some Castilian influence. Chapter 27 is particularly interesting: according to the writer, there are ten main colours (blue, orpiment and vermilion, green, carmine, “sufi”, turnsole, saffron, red lead and brazil), yet this list seems to include eleven colours instead. Two possibilities have been pointed: either the author considers orpiment and vermilion a single colour, perhaps red orpiment (realgar) or purpurinus, in this case, mosaic gold; or, as some authors suggest, carmine and “sufi” relate to a single colour. This intriguing word, “sufi”, has also several possible meanings: Espinosa Villegas, who translated the ‘Livro das cores’ into Spanish, suggests that “sufi” must be an archaic form of the Galician and Castilian word, originally Arabic “zupia” (“sopie”, “sapa”). It designates the sort of turbid wine still containing sediment<sup>17</sup>. This way, “sufi” would mean a colour within the range of carmine. Another possibility, pointed out by David Blondheim<sup>18</sup> and

<sup>14</sup> For more information of the dating of the ‘Livro das cores’ cf. op. cit., 5; A. J. Cruz/L. U. Afonso, On the Date and Contents of a Portuguese Medieval Technical Book of Illumination, in: *The Medieval History Journal* 11,1 (2008), 1–28, 3.

<sup>15</sup> Alcrevite (sulphur), anoxatar (sal ammoniac), azinhavre (verdigris), azarcon (minium), alfer (tin), alvaialde (white lead), among others.

<sup>16</sup> One should notice that the preservation of the Arab knowledge is equally seen in the ‘Mappae Clavicula’, and the ‘Schedula diversarum artium’ equally preserved some Byzantine knowledge.

<sup>17</sup> Cf. M. Espinosa Villegas, O livro de como se fazem as cores de Abraham bar Yehudah Ibn Hayyim, in: *Cuadernos de Arte de la Universidad de Granada* 27 (1996), 7–22.

<sup>18</sup> Cf. D. Blondheim, An Old Portuguese Work on Manuscript Illumination, in: *Jewish Quarterly Review* 19,2 (1928), 97–135.

Devon Strolovich<sup>19</sup>, is that “sufi” may be referring to a reddish wool wore by members of the Sufi sect of Islam. Despite the terminological affinity between the first two parts, the vocabulary employed in the third part is significantly different. For instance, instead of *alvaialde* (white lead), the term “branchete” is used. In fact, another aspect that contributes to the independence of the third part is the repetition of some recipes of the first part, although the procedures are different. However, this overlap of recipes is only partial.

More recently, our analysis of Ms. Parma 1959 and the ‘*Livro das cores*’ raised an important issue: the existence of a specific mark in several parts of the text of the ‘*Livro das cores*’ suggests an alternate division. This mark, which also signals the end of the first recipe on fol. 28v, appears in the ‘*Livro das cores*’ at the end of chapter 16; together with the catchword on fol. 12v, which corresponds to the missing folio with chapters 22 and 23; at the end of chapter 40; and in the catchword on fol. 18v. Hence, following the placement of these marks, the ‘*Livro das cores*’ can alternatively be divided in four parts: Part One includes the first 16 chapters, and it includes some alchemic language; Part Two includes chapters 17 to 22 or 23 (both in the missing folio), and it is the most coherent one, dealing with the dyeing of wood and bone, with a strong Arabic influence; Part Three corresponds to chapters 24 to 40, and it mostly deals with colour tempering, shades and variations, as well as mixtures and mordants; and finally Part Four includes chapters 41 to 45 which are assorted recipes with no predominant theme<sup>20</sup>.

#### IV. The ‘*Livro das cores*’ within the context of medieval colour texts

The question remains: does the division of the ‘*Livro das cores*’ correspond to several sources? The comparison with the ‘*Mappae Clavicula*’ has already been made, although there is no clear connection between the two texts. There are some similarities with Jean le Bègue’s ‘*Experimenta de coloribus*’ (1431) and with the manuscript H 490 of the Medical Faculty of Montpellier (1460–1480<sup>21</sup>, and to a lesser extent with the Bolognese manuscript (first half of the fifteenth century)<sup>22</sup>. Indeed, the presence of several sources is not an exclusive feature of the ‘*Livro das cores*’, but rather the prevailing pattern of medieval texts concerning the preparation of pigments and inks. From the fourteenth century onwards, long and coherent texts such as the ‘*Schedula diversarum artium*’ give way to collec-

<sup>19</sup> Cf. Espinosa Villegas, *O livro* (nt. 17), 21.

<sup>20</sup> Cf. D. Matos, *The Ms. Parma 1959* (nt. 5), 148–157.

<sup>21</sup> Montpellier, Bibliothèque interuniversitaire, Section médecine, Fonds anciens, Ms. H 490.

<sup>22</sup> This study was conducted by A. J. Cruz, *Em busca da origem das cores de ‘O Livro de Como se Fazem as Cores’: sobre as fontes de um receituário português medieval de materiais e técnicas de pintura*, in: Afonso (ed.), *The Materials of the Image* (nt. 10), 75–85.

tions and compilations of recipes and independent treatises, which increasingly replaced the earlier Latin texts. Collections and compilations were randomly assembled or organised by theme, and frequently include extracts of older known texts in the form of translations or paraphrases which, consequently, can be presented as reworked material. The very nature of recipes, in the sense that they are short texts, enables the process of selection, interpolation and reworking according to the specific interest or interests of the compiler, or of his audience.

These features, together with the increase of the use of the vernacular (and consequent translation of older sources), contribute to the difficulty of determining the process of textual transmission<sup>23</sup>. Mark Clarke, in his analysis of the 'Livro das cores', suggests a few examples of individual words that may be translated from earlier Latin texts: "vegera boli" and "azarcoanboli" (chapter 16), which most likely are boles (coloured clays used for etching resist). Clarke further suggests that the word "katasol" can be a calque from the Latin "*torna-ad-solem*", which should not be translated as "sunflower" but rather as "turnsole", a dye product producing red-purple-blue, according to the alkalinity<sup>24</sup>. Another interesting expression is "garassa di nobra", perhaps a corruption of the Latin word "*glassa*" or "*grassa*", an ingredient commonly found in varnish recipes, possibly some sort of resin. This word, as we shall see, may be related to the "*glassa*" mentioned in the 'Schedula'<sup>25</sup>. There are other intriguing words that may be better understood in this context of translations, such as the previously mentioned "sufi". The same happens in the 'Schedula', where some terms, such as "*prasinus*", or "*folium*" raise new possibilities of interpretation.

Finally, to what extent does the 'Livro das cores' reflect workshop practices in which new materials and processes are introduced? In the case of the 'Livro das cores', several codicological evidences support the idea of it being linked to a workshop environment: the fact that it is written in paper<sup>26</sup>, its format, the use of vernacular<sup>27</sup>, or the fact that it is part of a general compilation of texts related to a specific subject. Yet, it may be more accurately associated with the whole

<sup>23</sup> Also, the subsequent copy of such compilations by a single hand and the elimination of transpositions will give a uniform look to the new manuscript.

<sup>24</sup> In fact, and despite the confusion in English, the word "sunflower" is translated in Portuguese as "girassol", which is different from "katasol", a word that still is used for the dye.

<sup>25</sup> Cf. Theophilus, *De diversis artibus*, I, c. 21, ed. Dodwell (nt. 1), 19: "[...] *quod Romane glassa dicitur.*"

<sup>26</sup> Cf. M. Clarke, *The context of the Livro de como se fazem as cores: late mediaeval artists' recipe books (14<sup>th</sup>–15<sup>th</sup> centuries)*, in: Afonso (ed.), *The Materials of the Image* (nt. 10), 45–73, 56: "Paper, rather than print, may be the key to the shift from reproducing old texts to producing new ones. In addition to making fair copies of manuscripts on parchment for preservation of a text for posterity, paper 'rough copy' manuscripts are written for one's own use, especially those in one's own personal vernacular consisting of translations of extracts and new personal observations."

<sup>27</sup> With the increase of literacy in the fourteenth and fifteenth centuries, vernacular texts appealed to apprentices and new segments of the audience who often commissioned vernacular translations; cf. op. cit., 54.

environment of learning, that may include the workshop and classroom theory, especially if one considers Ms. Parma 1959 as a single unit.

Concerning the introduction of new materials and techniques in fourteenth and fifteenth century technical texts, there is a visible increase of the number of used pigments, especially organic pigments for scribes and illuminators, although a large portion was previously known. As an example, ultramarine blue (chapter 5 in the 'Livro das cores') began to be used in Northern Europe around the eleventh century, but the earliest records are from 100 to 150 years later. Thus, it seems that late technical manuscripts, among them the 'Livro das cores', are a combination of compilation and adaptation of old material, which sometimes preserve the errors of the previous texts, and newly composed material that reflects personal knowledge.

#### V. The 'Livro das cores' and the 'Schedula diversarum artium'

So far, we have described the main features and specificities of the 'Livro das cores' and established the necessary background to better understand any possible relationship with the 'Schedula diversarum artium'. One of the most disconcerting evidences is the fact that there are neither surviving copies nor records of the existence of the 'Schedula' in Portugal. Likewise, there are also no extant copies of any other medieval technical treatises dealing with pigment or colour preparation. Even so, this does not exclude the presence of such technical texts in Medieval Iberia. In the rest of the Iberian Peninsula, where the situation is similar, the main texts circulated since an earlier time. One example of such is the Codex Matritensis, held at the Biblioteca Nacional de Madrid (dating from ca. 1130); this text is in close relation to the 'Lucca' manuscript and the 'Leyden papyrus X'. In the same library there are records of the 'Mappae Clavicula', which is another similarity with Portugal, as there is a record of a copy of this treatise in the Monastery of Santa Cruz de Coimbra, one of the most important medieval scriptoria. Unfortunately, this manuscript is now lost, and there is no physical evidence of the procedures of colour preparation in Portugal, apart from a few common ink recipes<sup>28</sup>. Regarding the 'Schedula', there is evidence that it was known in Portugal. This can be seen in the treatment of human figures and the use of specific colours, such as grey, in (at least) one manuscript of the Alcobaça monastery, possibly also in some others from another scriptorium (Lorvão monastery), and some technical aspects of the working of gold that follow the instructions of the 'Schedula'. One should always consider, when it comes to the study of the Portuguese manuscripts – that there is still a great amount of work to be done.

<sup>28</sup> Cf. M. J. Santos, *Da visigótica à carolina. A escrita em Portugal de 882a 1172: Aspectos técnicos e culturais*, Lisbon 1994.

A second question that may be asked is why the 'Schedula' should be considered as an underlying source in the 'Livro das cores'. As previously mentioned, there is already a study comparing it with the 'Mappae Clavicula', which determined similarities in terms of the procedures to obtain artificial pigments and paints such as mosaic gold, silver blue, red lead, verdigris, and vermilion. However, there is no reference to mosaic gold on the 'Mappae Clavicula', and the procedures for other pigments are significantly different. Undoubtedly, the most relevant connection between the two texts is the recipe for silver blue, even though the procedure is not exactly the same. Moreover, the comparison of specific pigments such as mosaic gold and silver blue with 'Experimenta de Coloribus', the Montpellier Manuscript and with 'Segreti per Colori' determined that the similarities are essentially in terms of procedures and the names given to certain pigments and raw materials. Clearly, this does not imply the direct usage of the texts as sources, and the similarities can be second-handed or coincidental.

Hence, what was left to determine was the degree of influence, if any, of the 'Schedula diversarum artium' on the 'Livro das cores'. For this purpose, only the Book I of the 'Schedula' will be taken into account, as it deals with painting techniques and colour preparation, which is the main subject of the 'Livro das cores'. In analysing the first book of the 'Schedula', it is possible to divide the text into three larger parts according to the subjects. The first part, comprising the first sixteen chapters, focuses mostly on modelling techniques essentially for mural and panel painting. The middle part (chapters 17–30) addresses some technical procedures, among them the instructions for gold milling (chapter 28). This curious recipe clearly denotes the particular interest of the author, and could easily be incorporated into Book III, the most extensive (and comprehensive) of the three books of the 'Schedula'. A third and last part (chapters 33–38) deals with the preparation of pigments and ink for book illumination.

Let us begin by comparing a few important aspects similarities between the two texts. Naturally, the third part of the 'Schedula' is the most relevant, as it deals with techniques related to pigments (grinding, tempering, the more suitable, and so on). However, there are no instructions for the preparation of parchment, brushes or burnishers, perhaps because these subjects were already well-known and not worth repeating. The range of colours suggested in the 'Schedula' and in the 'Livro das cores' overlap to some extent: as is explained in the initial Prologue of the latter, gold was the most desired outcome, and throughout the text there is a significant amount of recipes for gold imitation or gold leaf application. Yet we do not find any recipes that involve any alchemic purification of materials. Instead, there is a very pragmatic approach to gold imitation in the best known ways: mosaic gold (two chapters), the combination of tin, mercury, sulphur and sal ammoniac; the already mentioned variety of procedures to the application of gold leaf, gold grinding, gilding with gold and pigments to imitate gold (saffron and orpiment). Even though in the 'Schedula' there is a reference to orpiment (chapter 14), it is used to obtain a different result and not intended for gold imita-

tion. Moreover, and as expected, there is no reference to mosaic gold (which was generally used from the fourteenth century onwards).

Another relevant aspect in the 'Livro das cores' is the colour blue, particularly silver blue (chapter 5), a copper acetate. There are also references to indigo, azure<sup>29</sup> and turnsole, which can produce bluish colours. In contrast, the most common pigment in the 'Schedula' is azure, which must be a synthetic copper, although there are some records of lapis lazuli in Europe since the eleventh century. An important fact is that none of the recipes for copper blue are from the same period, but there are some with blue vegetable dye (as referred in the 'Lucca' manuscript, and several other recipes), as well as those for ultramarine from lapis lazuli (the 'Heraclius' treatise refers to azurum, which must be ultramarine, as he mentions a heat test to which the stone is exposed before being ground). Also in the 'Mappae Clavicula', there are three recipes for blue colours: 'De Lazorio'<sup>30</sup>.

There is a significant amount of recipes for the tempering of blue pigments in the 'Livro das cores', as well as one recipe for the extraction of blue from silver (silver blue) using vinegar. The procedures are similar to other texts but have no parallel in the 'Schedula diversarum artium'. A common feature of both texts is the use of Indigo blue, a blue pigment extracted from plants such as the *Indigofera tinctoria*, which was altered by an alkaline source (frequently urine) and turnsole, whose possible parallel in the 'Schedula' is the mysterious folium (although in chapter 33 there is the elucidation that there are three types of folium: red, purple and blue).

In addition to blue pigments, another important intended result in the 'Livro das cores' is red and its related colours. Red is, perhaps, the most essential and common of all colours in any artist's palette. Since early times, vermillion, a bright scarlet colour, was obtained from cinnabar, and from the ninth century onwards, synthetic vermillion (a compound of mercury and sulphur) was also prepared. In the 'Livro das cores' there is no reference to cinnabar, and the vermillion obtained is clearly synthetic, created by heating together mercury and sulphur, which finds a similar example in chapter 34 of the 'Schedula'. It is interesting to notice that Daniel V. Thompson<sup>31</sup> suggests that the word "cenobrium" must correspond to vermillion and not to cinnabar. Another red pigment is minium (chapter 10 in the 'Livro das cores'), which was prepared from roasting white lead ("azarcon"), as it

<sup>29</sup> This is only mentioned by David Simon Blondheim in his translation of this treatise, chapter 27; cf. Blondheim, *An Old Portuguese Work* (nt. 18), 130: "If you wish to make a blue color, put azure in it." Nevertheless, both other transliterations use the word "azul", which is translated as blue and not azure.

<sup>30</sup> Cf. M. Orna/M. J. D. Low/N. S. Baer, *Synthetic Blue Pigments: Ninth to Sixteenth Centuries, I: Literature*, in: *Studies in Conservation* 25 (1980), 53–63; id., *Synthetic Blue Pigments: Ninth to Sixteenth Centuries, II: Silver Blue*, in: *Studies in Conservation* 30 (1985), 155–160.

<sup>31</sup> Cf. D. V. Thompson, *Theophilus Presbyter: Words and Meaning in Technical Translation*, in: *Speculum* 42,2 (1967), 313–339.

was the most common procedure. Again, the process in the 'Schedula' is similar (chapter 37). Also in the range of red colours, carmine is mentioned in both texts, although in the 'Schedula' it is essentially just a reference. The 'Livro das cores' presents several procedures to obtain it (chapters 13, 14 and 30). Finally, the preparation of rose is explained in both texts. In the 'Livro das cores', the main ingredient is brazilwood, a typical fourteenth century practice, although by the fifteenth century red inks made from brazilwood became very popular and were highly desired. Its preparation usually involved the scraping of the wood with a piece of glass, which was often soaked in glair and then mordanted with alum. The rose in the 'Schedula' is significantly different: it is the result of the mixture of white lead with vermilion or minium, and the intended result was the colour of the flesh.

Another common colour in both the 'Livro das cores' and the 'Schedula diversarum artium' is green, more precisely, verdigris, although in the latter it is called Spanish green and salt green. In the 'Livro das cores', the name for verdigris is "azinhavre" (chapter 11). Concerning the white pigments, the most common is white lead (ceruse), which can be found in both texts. Also common to both texts is a whitening agent, gypsum, a calcium sulfate, and limestone.

Leaving aside the pigments, and moving on to the binders, one should notice that there is no reference to gum Arabic in the 'Schedula diversarum artium', and the main binder for book illumination is glair, although oil and cherry or plum resin (chapter 25) are also used. In chapter 25, there is a warning that minium, white lead ("ceruse") and carmine should only be used with glair. Linseed oil is used for wood (chapters 20, 21 and 25) and on metal surfaces (24, 25 and 27). In the 'Livro das cores' there is also a reference to linseed oil, chapter 42, in the context of the manufacture of varnish. In addition, both texts suggest the use of animal glue (the aforementioned fish glue), and parchment glue.

With regard to varnishes, Thompson suggests that the word "*fornis*" or "*glassa*" (chapter 21 of the 'Schedula'), must be closely related to the ingredient described in the 'Livro das cores' as "garassa de nobra", which, on the other hand, should be read as "grassa d'eneblo"<sup>32</sup>. Thompson further explains that the word "glassa" originally meant amber. This is, perhaps, the most important similarity between the texts.

Finally, chapters 29–30 of the 'Schedula' describe the process of applying metal foil to books, and chapter 30 deals with the preparation of different types of glue for gold painting. Similarly, in the 'Livro das cores' there are several chapters regarding the application of metal leaves in books (chapters 3, 25, 36, 38 and 39), a common subject in texts for book illumination, and the processes are no different from the majority of such recipes, including also those of the 'Schedula'. Chapter 31 of the 'Schedula' describes the preparation of glue, and there seems to be a preference for fish glue (sturgeon), although alternatives are

<sup>32</sup> Op. cit., 316.

suggested, such as eel. In the ‘Livro das cores’ (chapter 3), there are also instructions for the preparation of fish (conger-eel) glue as size for the gold leaf. Chapter 38 of the ‘Schedula’ explains the process for the preparation of ink, another common subject.

## VI. Conclusions

Although the ‘Livro das cores’ cannot be considered a treatise in light of literature on the technical sources known and copied in Europe throughout the Middle Ages, it is undoubtedly gaining interest among scholars<sup>33</sup>. It is not a coherent book but rather a compilation (and perhaps adaptation) of recipes from one or more sources. This is particularly noticeable in the repetition of some procedures and the use of different nomenclature for the same materials, as well as the range of vocabulary that denotes Arabic and Castilian influences. In addition to the textual structure, the fact that it is written in the vernacular suggests that its composition was done in the fifteenth century. The division into several parts of the text and the specificities of each part suggest the use of several sources that may be direct or second-handed. That is, the ‘Livro das cores’ most likely is an original composition that results from the re-working of previously existing material found in several sources.

The main purpose of the present study was to determine whether the ‘Schedula diversarum artium’ was one of the underlying sources. Undoubtedly, both texts clearly were intended to convey knowledge in the most comprehensible way and therefore the recipes described are very practical and clear. There are some similarities between the two texts, such as the preparation of vermilion, verdigris or the reference to carmine, but these similarities are mostly arbitrary, since one can easily find the same correspondence in other medieval texts, and certainly they are not sufficient to establish a direct connection between the two texts.

However, the differences are conspicuous. The fact that the ‘Schedula’ is much more thorough, and the manufacture of pigments is only one third of the first book; that there are significant linguistic differences not only due to the fact that they are written in different languages and different writing systems, but also because the terms employed are significantly different, points to the conclusion that the ‘Schedula’ is quite different from the ‘Livro das cores’. Moreover, the most relevant aspect is the difference in terms of procedures and intended results. Concerning the most important pigments in the ‘Livro das cores’ (mosaic gold and silver blue), there is no correspondence in the ‘Schedula diversarum

<sup>33</sup> One should note that it has already been previously cited, among others, by D. V. Thompson, *The Materials and Techniques of Medieval Painting*, Dover 1956, and by S. Muñoz-Viñas, *Original Written Sources for the History of Mediaeval Painting Techniques and Materials: A List of Published Texts*, in: *Studies in Conservation* 43,2 (1998), 114–124, although it is referred to as a thirteenth century text.

artium'. Still, it should be taken into account that the first book of the 'Schedula' was part of the manuscript compiled by Le Bègue, and it has been established in recent research that this text had – to certain degree – some influence on the 'Livro das cores'. In fact, one of the most interesting features is the correspondence between "garassa de nobra" and fornis, although it is, for now, only a possibility. Therefore, the 'Livro das cores' continues to be in a category of its own in the context of the medieval technical texts for colour preparation, and its originality is gradually being assessed.

