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Combination of historical and experimental approaches for a better understanding of the black colour of the parchment of Margaret of Austria's *Basse Danse* manuscript (KBR ms. 9085)

Combinação de abordagens históricas e experimentais para uma melhor compreensão da cor preta do pergaminho do manuscrito da *Basse Danse* de Margarida da Áustria (KBR ms. 9085)

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Abstract

Margaret of Austria's *Basse Danse* manuscript is one of the earliest sources on dance and music in the medieval Low Countries. It also has a rare characteristic: it is written in gold and silver ink on black parchment. We lack information about the dyeing of parchment, particularly for producing black parchment. However, this knowledge is essential for understanding its current condition and for better planning its conservation. The manuscript shows extensive damage, probably due to the iron-gall nature of the black dye: the parchment, which is very fragile, has breaks and losses, that were the subject of a former, inappropriate restoration, resulting in further deterioration. By examining historical technical texts (recipes for the dyeing and for the making of inks) and conducting dyeing experiments on modern parchment, we aim to gain insight into the possible techniques used to create this remarkable manuscript.

KEYWORDS
Black parchment
Dyeing
Historical recipes
Reconstruction
Iron gall ink
Medieval manuscript

Resumo

O manuscrito da *Basse Danse* de Margarida da Áustria é uma das fontes mais antigas sobre dança e música nos Países Baixos medievais. Possui ainda uma característica rara: está escrito com tinta dourada e prateada sobre pergaminho preto. Carecemos de informações sobre o processo de tingimento do pergaminho, em particular no que diz respeito à produção de pergaminho preto. No entanto, este conhecimento é essencial para compreender o seu estado atual e para planear melhor a sua conservação. O manuscrito apresenta danos extensos, provavelmente devido à natureza ferrogálica do corante preto: o pergaminho, que é muito frágil, apresenta ruturas e perdas, que foram alvo de um restauro anterior inadequado, resultando numa maior deterioração. Ao examinar textos técnicos históricos (receitas para o tingimento e para a fabricação de tintas) e realizar experiências de tingimento em pergaminho moderno, pretendemos obter uma visão sobre as possíveis técnicas utilizadas para criar este notável manuscrito.

PALAVRAS-CHAVE
Pergaminho preto
Tingimento
Receitas históricas
Reconstrução
Tinta ferrogálica
Manuscrito medieval

Introduction

In our books, we are accustomed to reading texts written in dark ink on a light background. However, in some manuscripts from late Antiquity and the Middle Ages, this relationship is reversed: the text, written in gold and silver ink, sparkles on a dark coloured background. This is the case with the manuscript we are investigating: Margaret of Austria's *Basse Danse* manuscript (KBR ms 9085), a late fifteenth-century manuscript on black parchment. Although it is impossible to estimate how many manuscripts of this type were produced, it is certain that they are very rare today: only seven are preserved worldwide (the six other manuscripts are Vienna, Austrian National Library, Cod. 1856; Vatican City, Biblioteca Apostolica Vaticana, Ms. Vat. Lat. 9488; New York City, Pierpont Morgan Library, Ms. M. 493; New York City, Hispanic Society of America, Ms. B 251; Rouen, Bibliothèque municipale, Collection Leber, Ms. 136 (on black paper); Paris, Louvre, Cabinets des dessins, Inv. M. I. 1091; and Paris, Bibliothèque nationale de France, Ms. nouv. acq. Lat. 149). The black colour of the parchment raises many questions about the symbolic meaning of the black substrate, and about the techniques used to construct it, which in turn can inform the techniques to conserve it.

By the early nineteenth century, the state of conservation of the *Basse Danse* manuscript was already a cause of concern, as we can read in the description of the manuscript in the catalogue of the curator of the Royal Library of Belgium (KBR), baron de Reiffenberg in 1829:

> *D'un manuscrit du quinzième siècle, portant pour titre, sur le plat de la reliure: Plusieurs basse dance, format in-4 oblong; reliure en bois recouvert de damas rouge. Ce volume fort délabré, sans doute à cause du fréquent usage qu'on en a fait, est composé de vingt-cinq feuilles de papier noir glacé et doré sur tranche. …*" [1]
> [About a fifteenth-century manuscript bearing on the cover the title *Plusieurs basse dance*, oblong quarto format; bound in wooden boards covered with red damask. This volume, now severely deteriorated – undoubtedly due to the frequent use it once received – is composed of twenty-five leaves of black, glazed paper with gilt edges]

Its fragile state undoubtedly explains why, in the decades following this description, the manuscript underwent extensive restoration. Wide strips of thick paper were glued to the four edges of each folio to strengthen the parchment. Because they are too rigid and thick, these paper reinforcements on the parchment are now causing problems. Although the intervention aimed to reinforce the edges of the folio's, it has introduced significant stress to the parchment which has led to further breaks and losses (Figure 1).

Further conservation work is necessary to ensure the proper preservation of the manuscript, but also to improve its visual and aesthetic appearance.

The publication of a new facsimile of the manuscript in 2023 facilitated a major study of the manuscript's history and content, but many questions about its construction and condition remained unresolved. Therefore, we decided to launch a long-term project to study its materiality in depth. This paper focuses on one of the initial steps of this research: an attempt to gather information about the dyeing technique of the parchment. Before presenting our experimental research on this topic, the manuscript will briefly be introduced and both its parchment and the construction of its book block will be described.

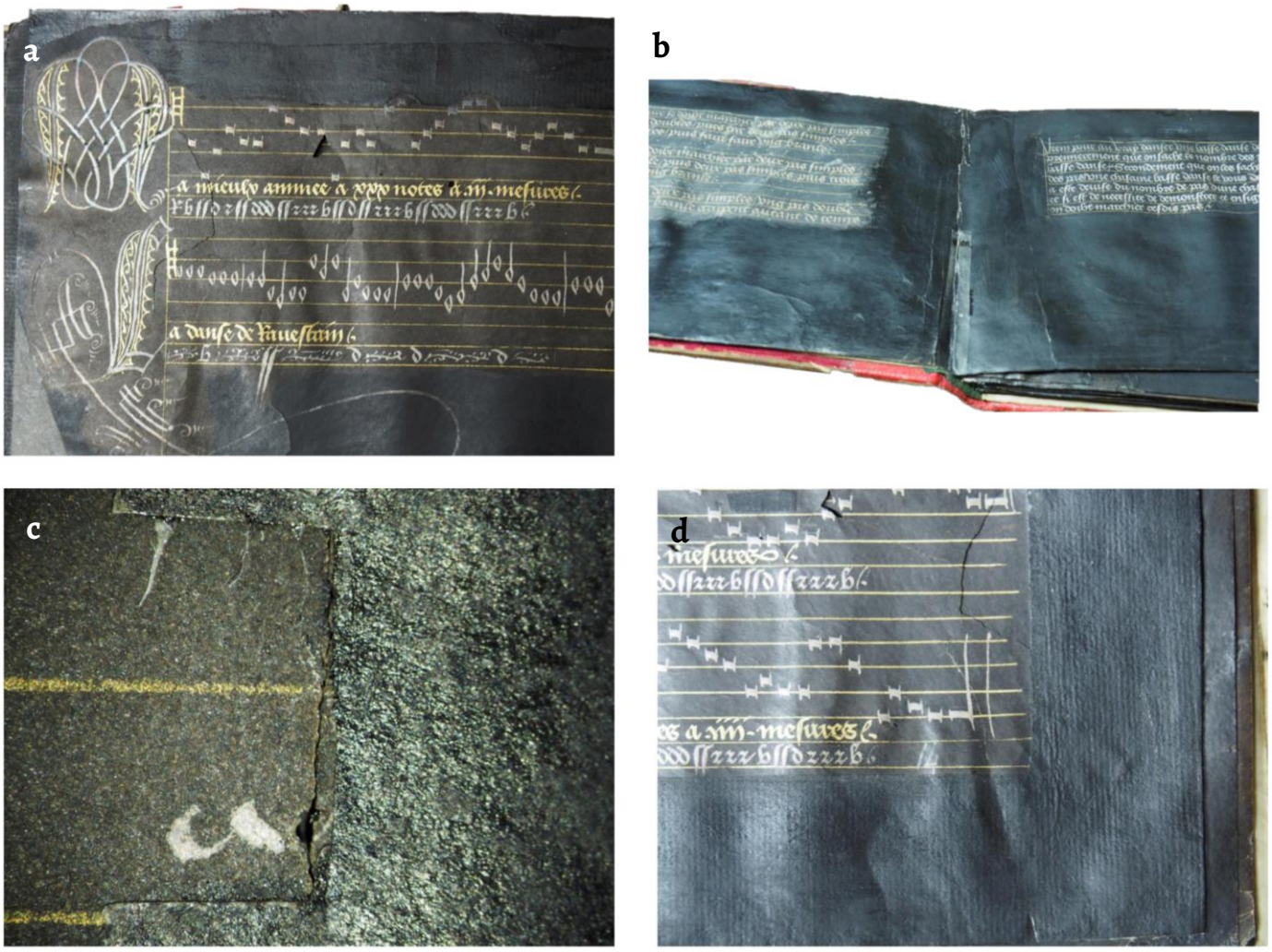

Figure 1. KBR, ms 9085: details of previous restorations of the folios: *a)* thick paper glued to the edges; *b)* overextensive retouching; *c-d)* new alterations related to these previous treatments (KBR).

An exceptional manuscript

History

Margaret of Austria's *Basse Danse* manuscript (KBR ms 9085) is the only manuscript on black parchment with a profane content. It opens with a theoretical treatise on dance followed by 58 "basses danses" written in golden and silver ink. The only decorations are initials with beautiful penwork executed with alternating golden and silver inks. (Figure 2) We know little about the context of its production and its patron. However, its stylistic and textual characteristics locate its production in the Low Countries at the end of the fifteenth century. This makes it one of the oldest sources on medieval music and dance.

Although the manuscript does not appear in the accounts of the Court of Burgundy, it can be found in the second inventory of Margaret of Austria's library from 1523-1524 [2]. Thus, it is certain that the book belonged to her, and that she even kept it in her private study alongside the books she particularly cherished [3]. However, there is no evidence to suggest that she commissioned it. Grantley McDonald opines that she may have received it around 1500 from Françoise of Luxembourg and Philip of Cleves as a token of their friendship and attachment to the court, despite the dissensions between Maximilian and Philip of Cleves following the revolts of the Flemish cities [4]. Several clues support this hypothesis: first many of the dances refer directly to the court of Burgundy (such as *Le joieux de Brucelles*) and its connections with other European courts (*La rochelle*, *Le petit Rouen*, *La portingaloise* and *La basse danse du roy despaigne*, for

example). There are also three dances that allude to Françoise of Luxembourg, wife of Philip of Cleves: *La danse de cleves*, *La danse de Ravestain*, and *La franchoise nouvelle*. In addition, a handwritten annotation on the upper endleave, in the hand of Margaret of Austria herself, provides further details, particularly with regard to the date (Figure 3). She indicates that the book belongs to the Princess of Spain (*Se liures est à la princese despaigne*), a title that Margaret held only between 1495, the date of her marriage with Juan of Spain, and 1501, when she lost this title to become duchess of Savoy after her marriage with Philibert of Savoy. The second part of this annotation – *et la robe ammadame de rauestain* – refers to Madam of Ravestain, who was Françoise of Luxembourg at that time. The dress (*robe*) refers probably to a chemise, secondary protective cover, lost today [4].

Finally, the black colour of the manuscript may be connected with the taste of Philip of Cleves for the luxury of the Burgundian court and for this colour. Indeed, since Philip the Good adopted an all-black wardrobe and imposed the colour in his court, black came to hold a strong symbolic value beyond the colour of mourning [5]. It also represented virtue, temperance and religious morals, and referred to civic qualities such as fidelity, humility, honesty, and loyalty [6]. Finally, the fineness of the black fabrics suggests that the use of black in all its shades contributed to creating an image of refinement and wealth. This effect was enhanced by the gold jewellery (particularly the Golden Fleece necklace) which sparkled against the dark clothing, much like the gold and silver letters on the manuscript's black parchment [7].

Figure 2. KBR, ms 9085: *a)* f. 2v-3r; *b)* f. 15v-16r (KBR).

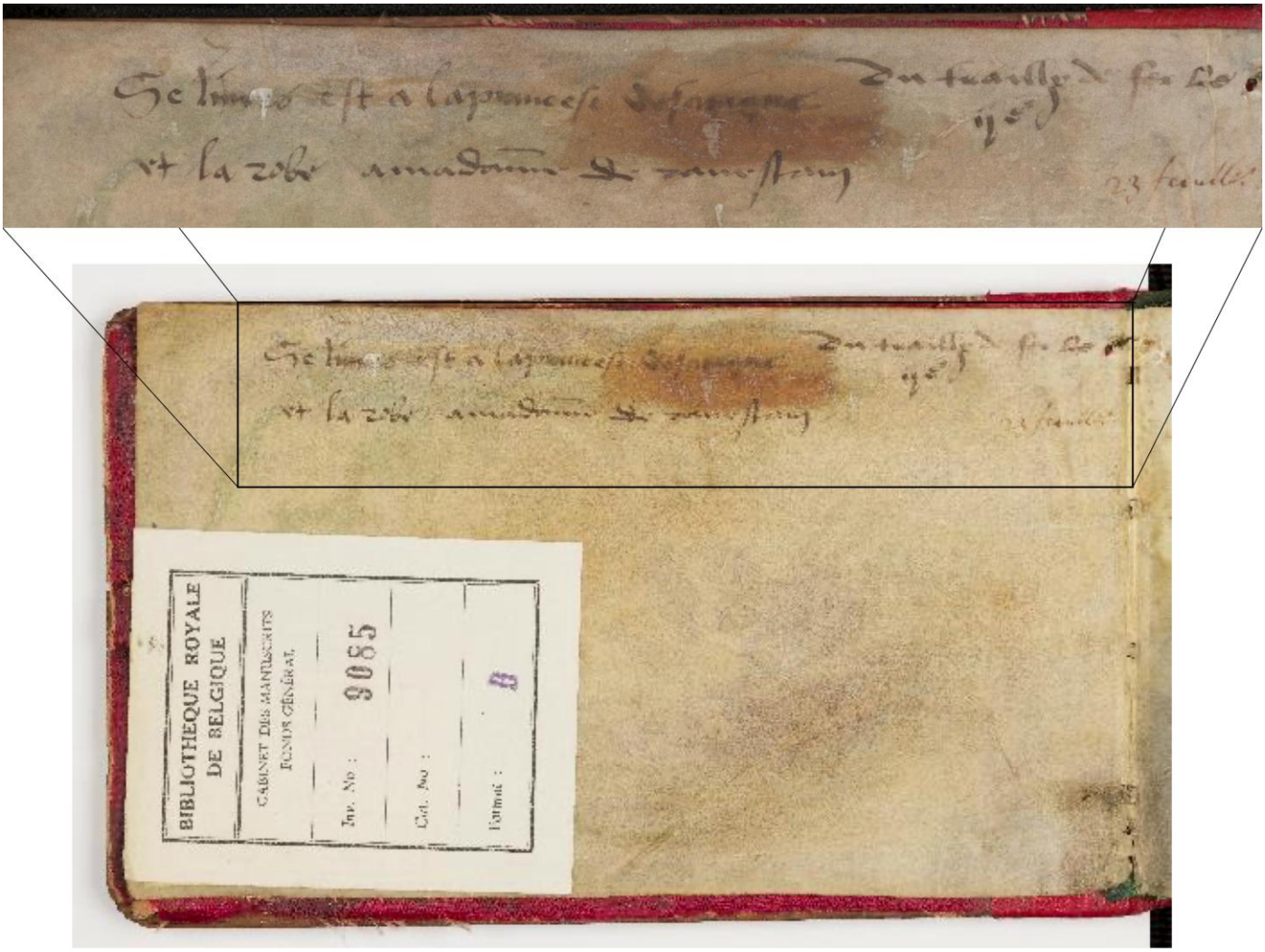

Figure 3. KBR, ms 9085, upper endleave: handwritten annotation of Margaret of Austria (KBR).

After the death of Margaret of Austria in 1530, Charles V left most of the books from their aunt's library to his sister, Mary of Hungary. After her death, those books came back to the Library of Burgundy, direct ancestor of the KBR. Over time, as discernible through the inventories, many of Margaret of Austria's manuscripts disappeared, but the *Basse Danse* seems to have always remained in place [8].

Material description

It is a small oblong book (128 × 210 mm) containing 25 black parchment folios. The original wooden boards and their textile cover, although in poor condition, are preserved, but the assembly of the book block and the spine are the result of a previous restoration (Figure 4).

During this restoration, the order of the folios was disrupted. This probably occurred in the nineteenth century, as the Baron de Reiffenberg's description of the manuscript indicates the original order of the folios [1].

The parchment itself is of high quality: it is quite thin (0.15-0.18 mm), very uniform and regular. No defects or noticeable visual differences between the hair side and the flesh side can be observed. It has a deep black colour, with only minimal browning. Although the dye is intense, it does not penetrate the core of the material: parchment fibres within the thickness of the skin remain white.

No brush strokes or tool marks are visible. The parchment appears opaque under natural light, but translucent under transmitted light. This makes it possible to examine the structural aspects of the animal skin and to reconstruct the original bifolios and gathering structure.

Figure 4. KBR, ms 9085, binding: original wooden boards and spine with leather restoration (KBR).

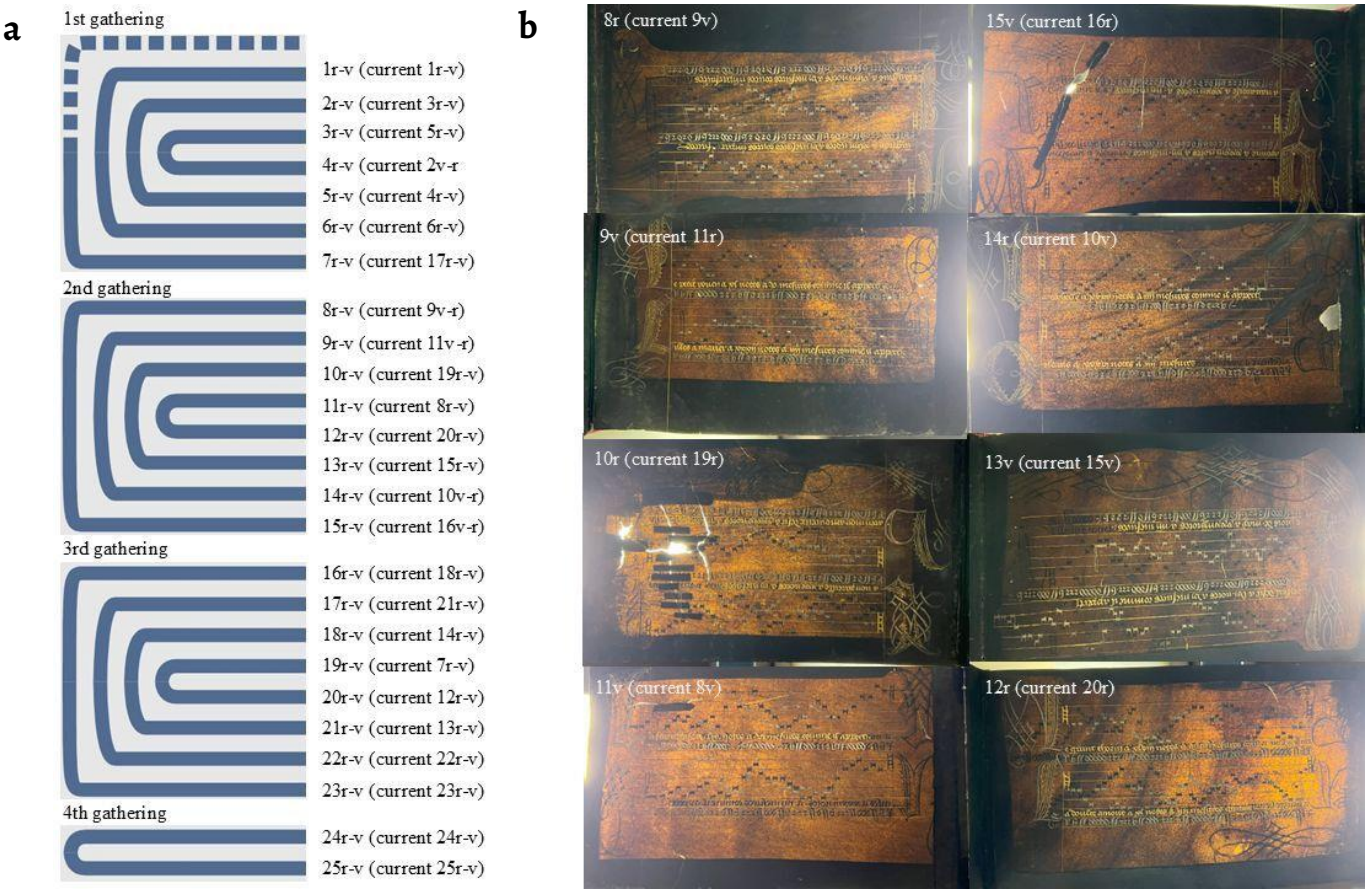

Figure 5. KBR, ms 9085: *a)* reconstruction of the original collation; *b)* reconstruction of one original skin (2nd gathering) (KBR).

Our hypothesis is as follows: since the manuscript comprises 25 folios, at least one folio must be missing, possibly from the beginning of the manuscript. By referring to the original order described in the nineteenth century description, we can reconstruct the bifolios and reassemble them into quires of eight folios each. The obtained results seem coherent. As shown in Figure 5, there is a correspondence between the morphological features of the animal skin across the folios. Thus, the manuscript may have been made from three skins, probably calfskins, though this has not been definitively confirmed through DNA or proteomic analysis.

Even if this remains a hypothesis – due to the condition of the folios and the old restoration, which sometimes make it difficult to trace the animal-skin features – this possible reconstruction of the folios will be important in the event of future conservation treatment. It may offer possibilities for proposing a reconstruction of the original bifolios, should this option be pursued. Moreover, it indicates that the parchment was probably coloured before being cut to the final dimensions of the bifolios, as demonstrated by Jiri Vnoucek in the study of the purple parchment of the Vienna Genesis [9].

Black dyeing of parchment, an unknown technical issue

Manuscripts on black parchment are rare and the question of which dyeing techniques were used remains largely unanswered: which materials were used? How were they applied? Who carried out the dying? Was it the parchment maker's final step or the copyist's first step? How can the dyeing agents or technique explain the manuscript's current condition?

Among the seven extant manuscripts on black parchment, two types of dyes were found: carbon-based dye and iron-gall compounds [10]. For the manuscript under study, sample analyses conducted with microprobe Cameca MS46 by the Royal Institute for Cultural Heritage in Brussels in 1984 detected the presence of iron, calcium, traces of aluminium, and potassium in the parchment remnants [11]. Although these results were not fully interpreted at the time, the presence of these chemical elements is consistent with both the parchment making process and the use of an iron-gall dye. This conclusion is supported by multispectral imaging done in 2023 since the parchment becomes transparent under infrared light and by preliminary results from ongoing XRF analyses, which also reveal the presence of iron, copper, zinc, and sulphur in the dye. All these preliminary results confirm that the *Basse Danse* manuscript belongs to the group of manuscripts dyed with an iron-gall dye.

Research of ancient recipes

The principle of producing a black colour through a chemical reaction between plant tannins and metal salts has been known since Antiquity. In the Middle Ages, it was widely used to dye leather and textile and to manufacture inks. As a result, there were relatively many recipes based on this principle. Nevertheless, we lack specific sources on parchment dyeing in the Burgundian period, despite the importance of the manuscript production and the textile industry in the fifteenth century Low Countries. For this reason, we broadened our research to adjacent fields (leather dyeing, textile dyeing, and writing inks), periods, and regions. This is possible because artistic and functional craft practices persisted in pre-industrial Europe without being fundamentally disrupted by the development of printing or the use of paper [12]. Furthermore, the ingredients used in the production of iron-gall dyes and inks were not replaced by new substances discovered in the New World [13]. We can however notice that specific instructions for leather dyeing are quite rare. While it is generally assumed that same kinds of colourants were used for leather and textile, this assumption remains to be substantiated through further scientific analysis of ancient leathers [14].

We therefore consulted about 150 recipes: 15 recipes for hide dyeing [15-16], 55 recipes for textile dyeing [15-23] and 70 recipes for iron-gall inks [18-20, 24-25]. Among these iron-gall dye and ink recipes, seven relate specifically to the surface treatment of parchment. They provided instructions for dyeing parchment green or making it as transparent as glass [18, 20, 24, 26-27], but none gives information on the composition of a black dye. However, they do offer valuable insights into the application methods used for such surface treatments. For example, all the texts emphasize the importance of drying the parchment under tension to preserve its flatness and physical properties. More specifically, one recipe seems to suggest that this type of work could be carried out by the end user rather than the parchment maker: it recommends using a frame to stretch the skin, as parchment makers do ("*ung cerceau de lette grandeur que ladicte peau*

se puisse tirer dedans avesques des cordes ainsi que font les parcheminiers" – a hoop of such a size that the said skin can be stretched with cords, just as parchment-makers do) [20]. Since the text explicitly refers to the parchment making practice, it is reasonable to think that the recipe is not intended for parchment makers but for the end users who have purchased parchment and wished to modify it for a specific purpose.

Although interpreting ancient recipes remains a challenging task, this research allowed us to highlight several key factors that may be crucial for dyeing parchment and useful for selecting the most relevant variables for the subsequent practical experiments. These factors concern both the composition of the dye and its method of application.

Composition

The primary components of iron-gall dye are vegetable tannins and metallic salts. In the large majority of recipes, the tannins are extracted from gallnuts, which are very rich in tannins (50 to 70 % of their weight depending on the quality and the origin of the gallnuts). However, particularly in textile dyeing recipes, other sources of tannins such as alder or oak bark are used, either alone or in combination with gallnuts. These alternatives are assumed to produce dyes of lower quality, suitable for more common and less expensive textiles. Identifying the metallic salts is even more complicated as many terms are used to name them: (green) vitriol, couperose, Roman vitriol, German vitriol, and so on. Nevertheless, from a chemical standpoint, it is probably mainly iron sulphate: the reaction between iron ions and the gallic acids of the tannins produces the more intense black colour. However, depending on its origin and fabrication, iron sulphate may contain other metallic salts or a relatively high proportion of impurities [28]. Moreover, some textile-dyeing recipes include other sources of iron such as iron fillings or rusty nails although these are known to be of inferior quality. Their use was forbidden early on for dyeing of the finest fabrics, as metallic particles could damage the fibres [29]. Those observations led us to select gallnuts and iron sulphate for our experiments, assuming that the manuscript on black parchment was a precious object likely produced with high-quality materials, especially since it was intended as a gift for Margaret of Austria.

Second, the relative quantity of each ingredient is very difficult to determine: the recipes often lack detailed measurements or provide imprecise instructions. In some cases, quantities are given for only one ingredient or described using vague expressions such as "as much as you deem necessary". Furthermore, working with old recipes raises the question of interpretation and equivalence between measurement units. Nevertheless, we were able to evaluate the proportions of gallnuts and vitriol (by weight) for 17 dye recipes and 51 ink recipes among the recipes consulted in this study. The results show that a 1:1 ratio seems to be the most common for dyes (10 out of 17 recipes) and that ratios of 1:1 and 2:1 are the most common for inks (12 and 11 out of 51 recipes, respectively). By the way, the 1:1 ratio is also found in standard laboratory recipes developed by various researchers to recreate iron-gall dyes or inks, such as those established by Ad Stijnman (iron-gall ink) [30] and Jo Kirby (dyes) [31]. This ratio appears to be a suitable compromise for preparing our dye for the subsequent experiments.

Moreover, there is a fundamental difference between the production of inks and dyes: the concentration of the solutions. The dyes are more diluted and liquid than the inks, allowing their application by immersion or impregnation of the material. Their viscosity must remain low to ensure uniform penetration and absorption. In contrast, inks must remain more viscous and concentrated to enable legible writing without bleeding on the parchment (or paper). We therefore decided to test both types of dilution in order to assess the impact of solution concentration on the visual appearance of the dyed parchment.

Arabic gum is a third ingredient frequently added: we find it in 25 % of the dye recipes and 100 % of the ink recipes. Arabic gum has mainly two roles: maintain the coloured compound in suspension and act as binder in the ink to ensure the cohesion of the pigment and their adhesion to the support.

Application

In most recipes of textile dyeing, the two solutions of tannins and iron sulphate are not mixed before application. Dyeing is generally performed in two steps: first, the fabric is soaked in a gallnut decoction, followed by an immersion in a vitriol solution. Thus, the chemical reaction between the tannins and the iron compounds occur within the material, potentially also forming chemical bonds with the fibres as tannins and iron sulphate can act as mordants. It is also possible, however, to apply the dye using a single solution where tannins and iron sulphate are mixed beforehand (as we do for the writing ink). Generally, the dyeing of the textiles was done in heated conditions. Heat allows the fibres to swell, making them more receptive to the dye and providing the energy needed to create the physical and chemical bonds between the dye and the textile fibres [13]. For hides, the use of heat is ruled out as it fundamentally denatures the collagen in the skin. The dye is therefore applied lukewarm or cold.

Various application methods are described, including the use of brushes, sponges, and other tools [32], or by immersion in a vat [33]. Recipes often recommend applying the dye in multiple layers until the desired result is achieved.

Experimentations

The examination of ancient sources reveals several variables that may have been used in the manufacture of black parchment: the concentration of the solutions, the application of the colour in one or two steps, and the methods of application. We will therefore base our experiments on these criteria in order to evaluate the results of these techniques in comparison with the visual aspect of the parchment of the *Basse danse* manuscript. This type of performative approach is not new in the fields of archaeology or conservation-restoration and allows us to test the viability of hypotheses through practice [34]. As research on purple parchment has already shown that other criteria can also influence the result, we will evaluate the influence of the animal species used for the parchment and that of pre-treatment of the skin (sanding) on the absorption and final appearance of the dye [35].

Dye recipes

In the absence of specific recipes for black parchment dye, we chose to test two types of solutions: a diluted solution, similar to those described in dyeing recipes, and a more concentrated solution, similar to ink recipes. We based our preparations on the standard formulations established by Jo Kirby [31] and Ad Stijnman [30]: our preparations are detailed in Table 1. However, we eliminated Arabic gum from the recipes, as it does not appear in recipes for dyeing skins and is not systematically used for dyeing textiles.

Table 1. Preparation of the tested solutions.

Solution	Recipe
Tannins – concentrated solution	25 g crushed gallnuts in 500 ml water. Bring to the boil, then reduce heat (simmer) for 1 h. Allow to cool. Filter before use.
Tannins – diluted solution	1 g crushed gallnuts in 500 ml water. Bring to the boil, then reduce heat (simmer) for 1 h. Allow to cool. Filter before use.
Iron sulphate – concentrated solution	25 g iron sulphate in 500 ml water, slightly heated (40 °C) until completely dissolved. Allow to cool.
Iron sulphate – diluted solution	1 g iron sulphate in 500 ml water, slightly heated (40 °C) until completely dissolved. Allow to cool.
Concentrated mixed solution	25 g crushed gallnuts in 250 ml water. Bring to the boil, then reduce heat (simmer) for 1 h. Allow to cool. Filter before use. 25 g iron sulphate in 250 ml water, slightly heated (40 °C) until completely dissolved. Allow to cool. Mix the two solutions
Diluted mixed solution	1 g crushed gallnuts in 250 ml water. Bring to the boil, then reduce heat (simmer) for 1 h. Allow to cool. Filter before use. 1 g iron sulphate in 250 ml water, slightly heated (40 °C) until completely dissolved. Allow to cool. Mix the two solutions

Suppliers: Gall nuts: La droguerie du lion (rue de Laeken 55, BE 1000 Brussels, https://droguerie-bruxelles.be/) and Kremer Pigmente (Hauptstr. 41 – 47 DE 88317 Aichstetten; https://www.kremer-pigmente.com/). Iron sulphate: Kremer Pigmente.

Application

These colouring solutions were applied in one or two steps. In the first method, the tannin and iron sulphate solutions were mixed before being applied to the parchment. In the second, we first applied the tannin solution and, after drying, we applied the vitriol solution. In this way, the coloured compound formed directly on the skin. The different solutions were applied in one and three layers on both sides of the parchment in three ways: with a brush (hog-bristle paint brush), with a sponge (synthetic sponge) and by immersion (5 minutes in the cold solution). After each application, the samples were left to dry under tension, held in place with pins on a rigid foam support so that air can circulate on both sides of the parchment. In all cases, the dyeing was followed by rinsing with clean tap water (immersion for 5 minutes).

Each solution and each method of application was tested on sheepskin, calfskin (from Norro M. & Fils (Norcuir) (Rue Mignot Delstanche, 72, BE 1050 Brussels; https://www.norcuir.com/www/index.php) and goatskin parchment (from Hewit & Sons Ltd (12 Nettlehill Road, Houstoun Industrial Estate, Livingston, West Lothian, EH54 5DL, Scotland; https://www.hewit.com/)

Half of the samples were lightly dry-sanded on the surface with pumice stone to soften the grain before dyeing.

Results

Applying diluted solutions, whether in one or two steps, does not yield a saturated hue with a brush or sponge. Even after three applications, the colour remains very pale and purplish. These tools allow for the absorption of smaller quantities of colour (Figure 6). Significantly increasing the number of applications could possibly achieve a more satisfactory result. Moreover the brush leaves tool marks, which are not visible in our original manuscript.

Application by immersion gives better results: after three immersions in the diluted solutions, a beautiful, deep and even black colour is obtained. The appearance of the parchment in transmitted light is preserved. And the differences between the flesh and the grain of the same parchment are reduced. Thus, the appearance is quite similar to that of the *Basse Danse* parchment.

With concentrated solutions, from the very first application, the result is more opaque and completely blocked (transmitted light observation is no longer possible) (Figure 7).

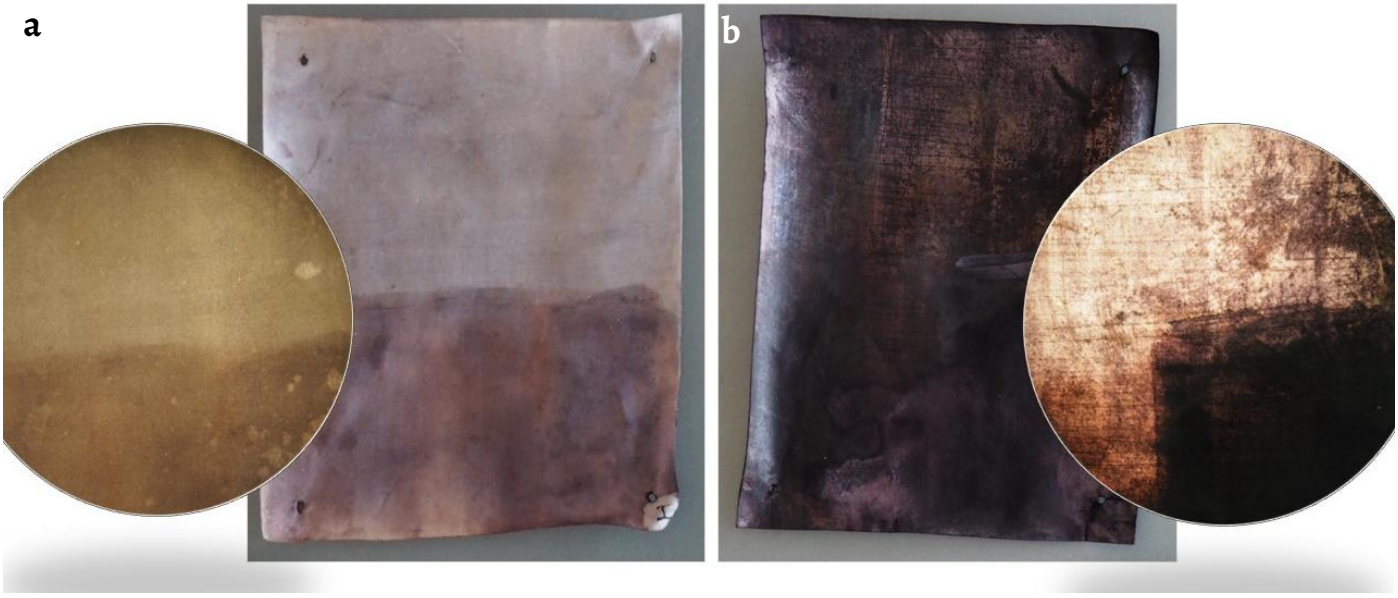

Figure 6. Sample of calfskin parchment dyed with: *a)* diluted solutions applied with a brush; *b)* concentrated solutions applied with a brush; brush marks details (KBR).

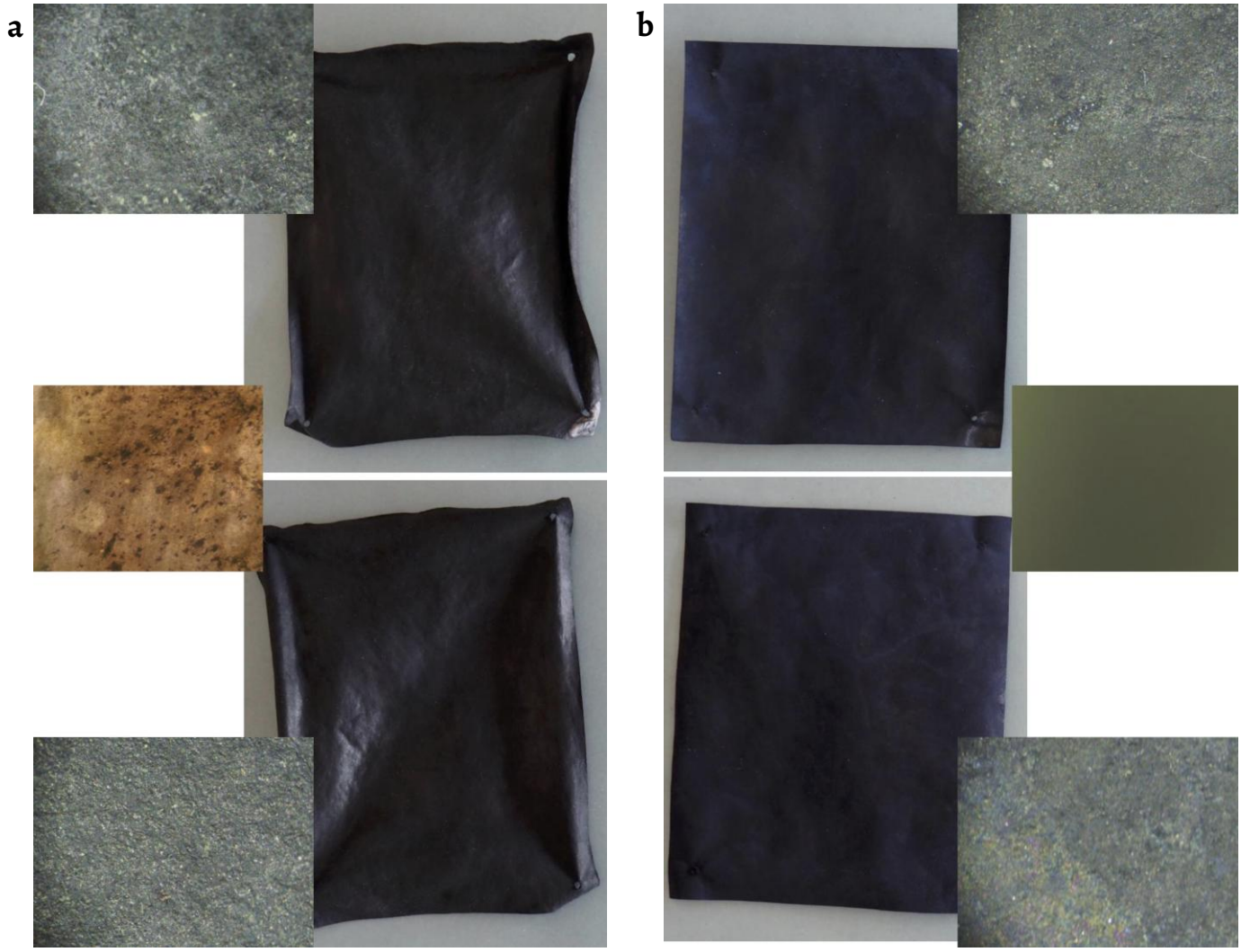

Figure 7. Sample of calfskin parchment, dyed with: *a)* diluted solutions applied by immersion in two successive baths; *b)* concentrated solutions applied by immersion in two successive baths (entire samples, front and back, with details under a microscope (50× magnification) and in transmitted light) (KBR).

In addition, the difference in surface appearance between the flesh and the grain is enhanced. Furthermore, at the time of application, the slightest excess of solution remaining on the surface of the parchment creates irregularities and/or colour iridescence: these marbled or iridescent effects are not attenuated by additional applications or by final rinsing. The concentrated mixed solution also leaves the surface looking very clogged and powdery: the pigments are deposited in a thick layer on the surface of the parchment and do not adhere, especially since we did not include a binder (Arabic gum) in the solutions tested. In general, mixed solutions, whether diluted or concentrated, stain the parchment more quickly and more strongly, but the colour remains quite bluish. On the other hand, applying the solution in two steps gradually produces a deeper and more intense black colour. This is particularly true with diluted solutions.

In all cases, the best result is achieved by applying the colour several times: the black becomes deeper and richer. However, successive applications do not mask any defects related to the quality of the skin or the initial application (Figure 8). For example, the uneven surface of sheepskin remains visible, as does the grainy appearance of goatskin parchment.

During application, goatskin seemed to absorb the solutions best. Nevertheless, after drying, the colour remains slightly purplish, and the difference between the grain and the flesh remains very noticeable. On the other hand, for calfskin, the black is much more even and uniform on both sides of the parchment (Figure 9).

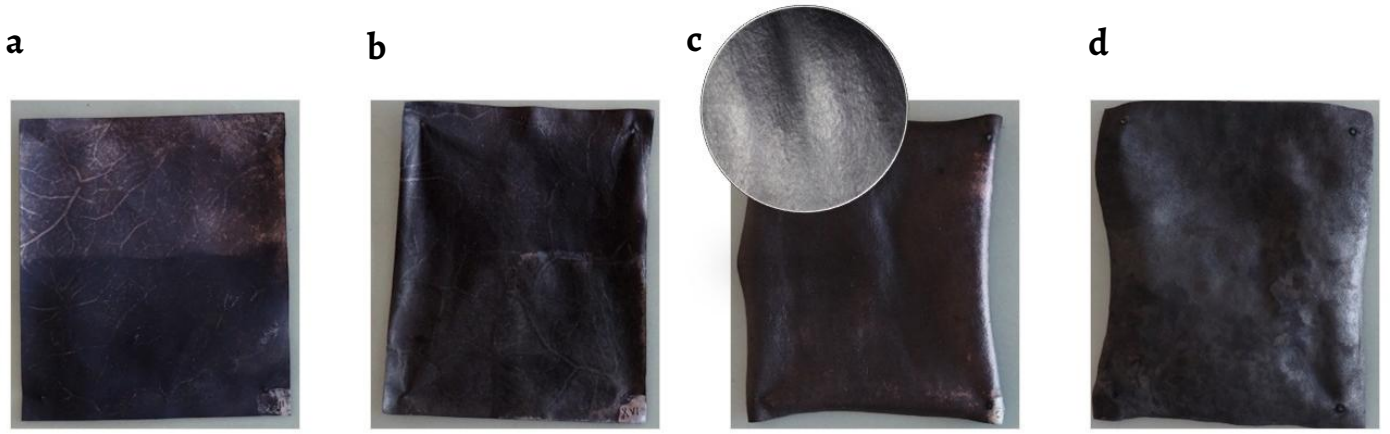

Figure 8. Dyed parchment with defects in the skin and/or in the application: *a)* calf parchment dyed with concentrated solutions - veins remain visible; *b)* calf parchment dyed with diluted solution – veins remain visible; *c)* goat parchment dyed with diluted solution – stains due to the grain of the skin; d) sheep parchment dyed with concentrated solutions – uneven dyeing (KBR).

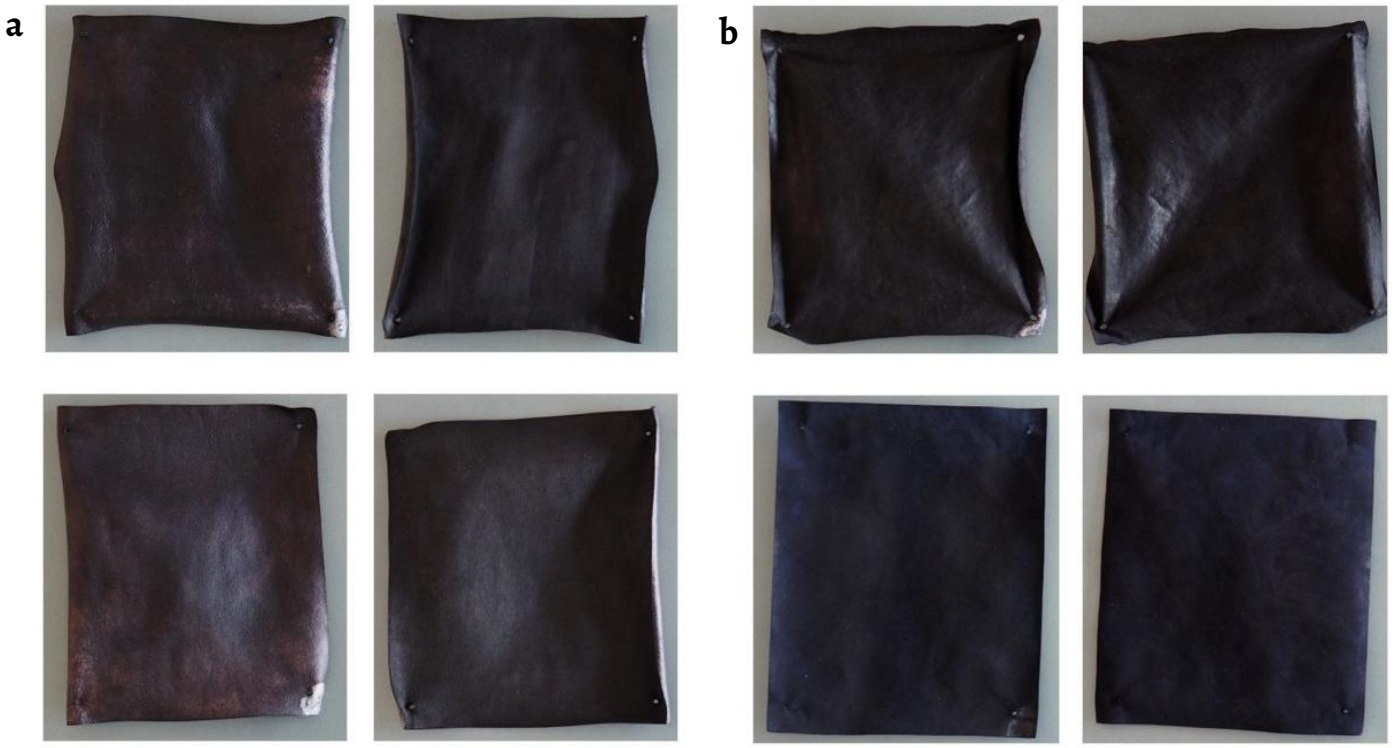

Figure 9. Samples of: *a)* goatskin with purplish black colour – above, goatskin dyed with diluted solutions, hairside and fleshside; below, sanded goatskin dyed with diluted solutions, hairside and fleshside; *b)* calfskin with deep black colour – above, calfskin dyed with diluted solutions, hairside and fleshside; below, sanded calfskin dyed with diluted solutions, hairside and fleshside (KBR).

Finally, it should be noted that, regardless of the animal species, the two sides of the parchment do not absorb solutions in the same way: the flesh always absorbs much more, whether or not it has been sanded beforehand. However, the grain is more impermeable without prior sanding (especially for brush and sponge applications). On the other hand, sanding does not seem to have a significant influence on the final result: it has no visible effect on the homogeneity or intensity of the colour, unless it has been insufficient.

In conclusion, the best results were achieved by applying the diluted solution in two steps (tannins followed by iron sulphate) with immersion on calf parchment (Figure 10).

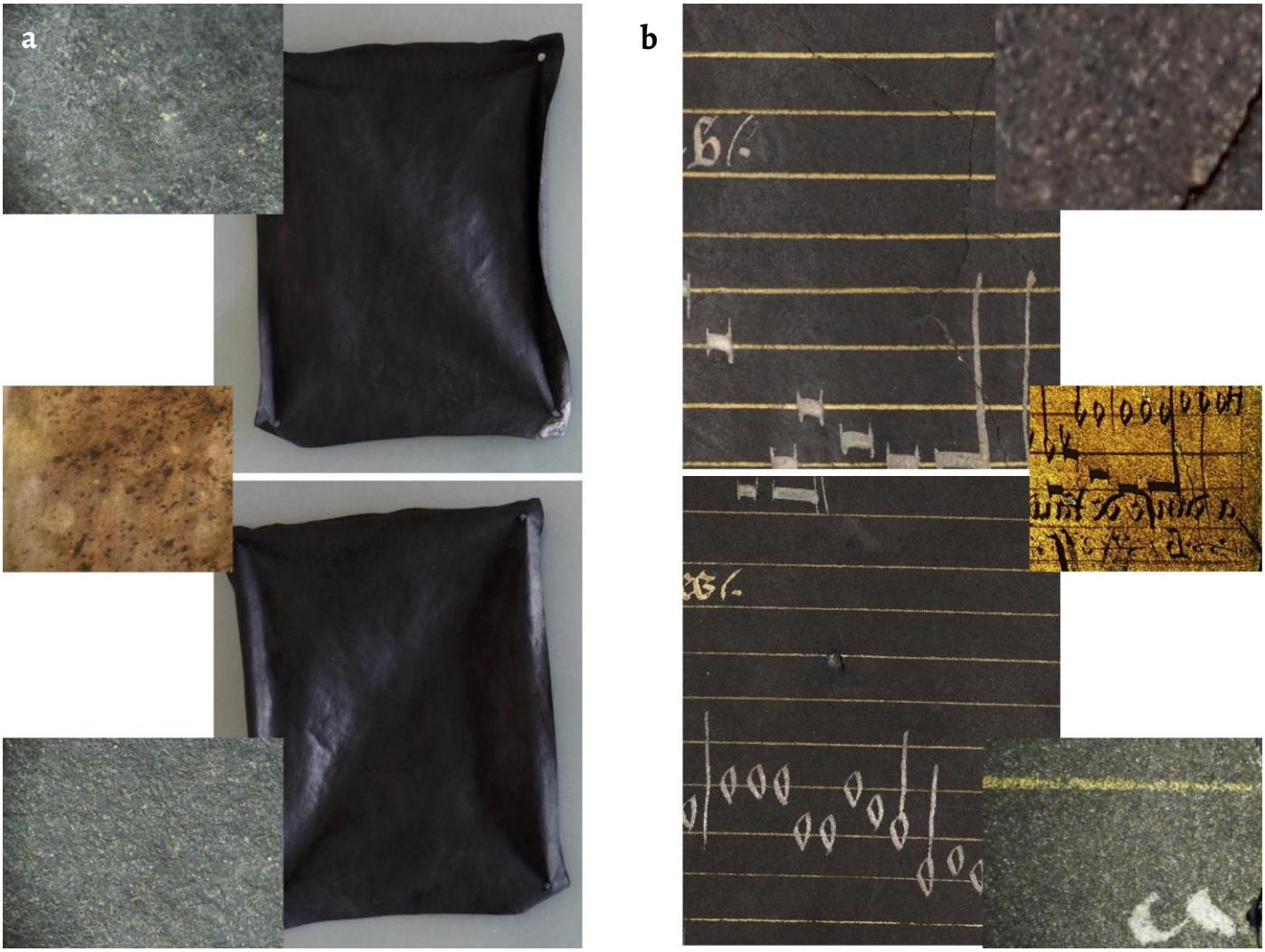

Figure 10. Front and back of: *a)* sample of calfskin parchment, dyed with diluted solutions applied by immersion in two successive baths; *b)* KBR, ms 9085, f. 14; details under a microscope (50× magnification) and in transmitted light (KBR).

Conclusion

This analysis of the black parchment – combining direct observations, preliminary scientific analyses, the study of historical texts and experimental testing – leads us to propose a hypothesis regarding the making of the *Basse Danse* manuscript. The bookblock appears to have been constructed from three calfskins which were likely dyed before being assembled into gatherings through immersion in dye baths. The dyeing process has probably involved successive baths in tannin and iron sulphate solutions, with drying under tension to preserve the physical properties of the parchment. Our experiments also indicate that high concentrations of dyeing solutions were not required to obtain an intense and deep black colour, on the contrary. Finally, the remarkable uniformity of the original parchment suggests that the use of high-quality skins would have been essential to achieve such a uniformly coloured writing support, as defects in the skins are not masked by the dyeing process.

We therefore now have a strong initial hypothesis regarding the possible production technique of this remarkable manuscript, which will be further refined and substantiated through in-depth analytical studies of both the parchment and the inks. A better understanding of the manuscript's materiality is essential for assessing its current state of conservation and for developing appropriate conservation strategies – particularly concerning the removal of old restorations, the consolidation of the cracks and the filling of losses. Moreover, the ability to reconstruct dyed parchment samples in a representative manner will enable more reliable

testing of conservation treatments, thereby increasing confidence prior to any intervention on the original manuscript. Ultimately, gathering all this information will enable us to make an informed conservation decision – whether to treat or not, and if so, how, to what extent and with which objectives.

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