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PAINTING TREATISE
ARS DE OMNIBUS COLORIBUS
FROM MANUSCRIPT BJ
RKP. 778 III THE JAGIELLONIAN
LIBRARY. A CRITICAL REVIEW
OF RECIPES AS SEEN AGAINST
OTHER TECHNOLOGICAL
SOURCES

DOI: 10.36155/PLib.12.00001

ABSTRACT

Ars de omnibus coloribus treatise from the manuscript 778 III of the Jagiellonian Library from ca. 1425 is a unique source discussing Polish miniature painting technology. The author or the inspirator of this original treaty was Jan of Dobra, a doctor and a professor of the Jagiellonian University and the owner of the original manuscript. The article is a broad, multi-aspect deal on this interesting piece of writing. It contains 65 recipes dealing mainly with pigments and painting dyes, various goldening techniques used then in book ornamentation. Recipes contained in the treaty are supported by commentaries detailing technological issues. These comments also pointed out potential analogies to other texts of similar character. Multi-disciplined comparative studies made it possible to

point out archetypes or sources of inspiration for many recipes and, as a consequence to determine sources of artistic influences on the treaty author. It was also possible to determine that the text is not only a creative compilation of multi-sourced recipes, but it contains original recipes of no substitute in any known technological texts.

KEYWORDS: painting treatise, recipe collections, art-technology, illumination, colours, pigments, dyes

INTRODUCTION

In 1977, Maria Kowalczyk published a text of a short technological treatise from manuscript bearing Call No. BJ 778 III kept at the Jagiellonian Library, and calling it *Ars de omnibus coloribus* (Kowalczyk 1977, pp. 165-174). She actually titled the text based on the explicit in which the author wrote down ‘Et sic est finis huius artis videlicet de omnibus coloribus’. The source text published almost half a century ago, and unique in the Polish sources as for its topic, had been relatively rarely recorded in linguistic literature (Klapper, Kołodziej, p. 56; *Opis źródeł*, p. 29), mentioned only in studies on art history (Gadomski, pp. 95-97; Adamczuk, p. 84; Ptak-Farmas vel Król, p. 115), and briefly quoted as a source (*Bibliografia źródeł*, p. 126; Baza danych ARTECHNE: <https://artechne.hum.uu.nl/bibliography?page=14&s=type&o=asc> (3 September 2023); Devriese, p. 286). However, there are no publications which analyse the treatise from any point of view. And although the text discussed in the present paper has superficially been present in the academic circulation and awareness as an important source on miniature painting of Lesser Poland, lack of its more detailed study and thorough analysis results in it continuing to be a work without saturation potential in various research fields.

The present study is to assess the originality and position of the treatise within the context of other texts of the same kind. Such an analysis can, on the one hand, reply the question related to the mi-

gration of similar sources within the cultural environment of late mediaeval Europe, yet, on the other, it can identify the direction of artistic influences revealed in technological texts, and the artistic or decorative oeuvre basing on them.

When studying the *Ars de omnibus coloribus*, respective recipes were analysed technologically in the context of other treatises, while at the same time an attempt was made to find identical or coinciding recipes in other texts. Moreover, the linguistic aspect was taken into consideration, since the terminology applied in the treatise was also analysed. At the same time, the focus was mainly on the texts written down in Latin, searching for analogies in the linguistic and terminological layers. In such an approach, texts in other languages: German, Italian, and French, were but an auxiliary and comparative material facilitating the explanation of some issues and transmission of technological procedures. Thanks to this methodology it was possible to identify the direction of cultural influences and the evaluation of the genuine character of the text.

It should be emphasized that the analysis of some of the recipes would not have been fully possible or sufficiently deepened without the practical experience the author has in illumination techniques, which made the reconstruction of some recipes possible. This provided an opportunity to more thoroughly evaluate some procedures, particularly those related to the application of dyes when making paints. It also allowed to more precisely specify numerous and very similar recipes, for instance those based on the use of brazilwood or verdigris.

The treatise is contained on leaves 174v-177r of the codex encompassing a collection of 66 texts, mainly of medical content, created in ca. 1425, and originally belonging to the book collection of John of Dobra, a doctor and professor of the Jagiellonian University (*Catalogus codicum manuscriptorum*, pp. 36-55). As can be suspected, that set of medical texts was created successively, depending on the availability of subsequent sources for copying. That is why treatises of varied volume, copied by one professional scribe alter-

nate with texts copied in a less meticulous handwriting, however, generally maintaining the same two-column layout with rubrication. As confirmed by Maria Kowalczyk on the grounds of the comparison of the handwriting from Codex BJ 1962 (column 284v), the marginalia as well as some manuscript parts may have been written by John of Dobra himself (Kowalczyk 1977, p. 165; also: *Catalogus codicum manuscriptorum*, p. 52). A professional scribe decorated the texts he copied with initials painted in red, green, and blue, meticulously rubricating them, and framing explicits in red. The text of the discussed treatise begins with the second column on leaf 174v, directly following Al-Rhazis's text *Almansoris librii* translated by Gerard of Cremona, and written with slightly smaller letters, albeit undoubtedly by the same hand as the work that precedes it. In the inner margin, levelling with the beginning of the treatise *Ars de omnibus coloribus* only the words 'Specialis tractatus' were written in red to mark the beginning of the text. Being a non-medical text, it may have been regarded by the scribe as less important, and respective recipes were only separated with a red line marking paragraphs, without any additional ornaments. An identical editorial format was applied to the text placed on leaves 298r–303v, and written down as titled *Experimenta et medicinalia...* in the catalogue of the Jagiellonian Library manuscripts. The scribe, whose hand can also be recognized in the treatise *Ars de omnibus coloribus*, revealed his Polish descent at the end of the text *Onomasticon...* by Gelasius of St Sophia where below the explicit on leaf 292v he wrote down: 'Myli mistrzu day finales'.

The treatise that is the subject of the present study contains recipes mainly for preparing paints for book painting and gilding methods for manuscript decoration. The set includes numerous recipes for preparing red: two to prepare minium, five to prepare vermilion, one connected with organic red, and as many as eight to prepare brazilwood. Furthermore, the treatise contains recipes to obtain six copper greens and one organic green, as well as five hues of azure and two organic blue colos. Among the four yellow hues, mosaic gold (No 21), orpiment with some organic dye (No

58), saffron (No 9), and the fourth obtained from an unidentified mineral component (No 6) are presented. Additionally, the treatise comprises recipes to prepare purple, grey, and brown, a recipe to obtain white inscription against black background, a recipe to make varnish, and a formula to prepare a glair for miniature painting. A category apart is formed by texts containing recipes to prepare soap, window membranes, and a cosmetic from lily roots respectively.

Apart from the records related to the preparation of paints, a substantial number of recipes concern gilding techniques and gilt imitations. This group of recipes contains as many as seven recipes for gold imitations, ten to make gesso and gilding with gold leaf, three recipes how to write in gold, and recipes for gilding other objects, including glass (Nos. 39, 40), pigeon feathers (No. 23), fruit or almonds (No. 41).

There exist dozens of brief theological treatises and short painting recipes coming from various areas in Europe, and compiled at different times. In principle, every mediaeval writing centre, including scriptoria or administrative and intellectual centres, may have been equipped with this set of adequate help facilitating work and organizing essential knowledge. In many a case they were extensive technological treatises copied for the purpose and popular within a given community, or sometimes less popular and known smaller works in several copies such as the *Liber colorum secundum magistrum Bernardum...* or *De clarea* talking about preparing binder from egg white (Travaglio 2008; Baroni 2016b). As can be expected, however, most often the most appropriate knowledge was amassed and written down gradually, taking on the form of compilations and thematic recipe collections, often copied by many different scribes. Such compendia frequently ended up among other minor treatises, generally of medical, practical, and alchemical content. The topic related to writing and painting skills stretched across various disciplines, since it covered both methodology and materials applied in the area of medicine, cosmetology, and alchemy. Creating artificial pigments, the use of plants of dyeing qualities,

or achieving colour effects thanks to the chemical properties of ingredients seemed close and related to the above disciplines.

The genuine Latin text of *Ars de omnibus coloribus* treatise was compared in the study with the Polish translation made by Fr Bartosz Leszkiewicz, with a minor contribution of the author of the present study. Respective recipes of the treatise were given extensive commentaries containing a thorough analysis of the text as seen from the technological angle demonstrating possible analogies and connections with other artistic treatises. These sometimes extensive and detailed explanations to a degree make up for the lack of more extensive studies of mediaeval painting techniques and technologies in Polish scholarly literature.

SPECIALIS TRACTATUS

Nota de coloribus et
temperaturis fere omnium
colorum, quomodo debent
temperari

1. Et primo de minio. Minium tere in lapide sicco. Et cum contritum fuerit, tunc pone in cornu et mitte liquefacere cum aqua per noctem. Crastina vero die fac clarum et intinge spuma in clarum. Ita diu exprime spumam donec recedat tantum [?] in cornu minium. Et moveas bene donec dissolvetur etc. Sequitur.

A note on colours and
preparation of almost all colours
and how to prepare them

First about minium. Grind minium dry on the grinding slab. When ground, place it in a horn and leave it so that it can soak in water for the night. The following day prepare egg white and dip the residue in it. Subsequently, press it hard until all the minium drips into a horn. And stir earnestly until well dissolved, etc. See below for more.

Lead tetroxide (Pb_3O_4), minium, a red pigment, has been known since the ancient times. It is a traditionally important pigment in book painting, and the word 'miniature' stems from it. The pigment was dry ground or ground with a binder: egg white. Minium tends to darken as influenced by sulphur compounds from the atmosphere, that is why many of the recipes provide means for

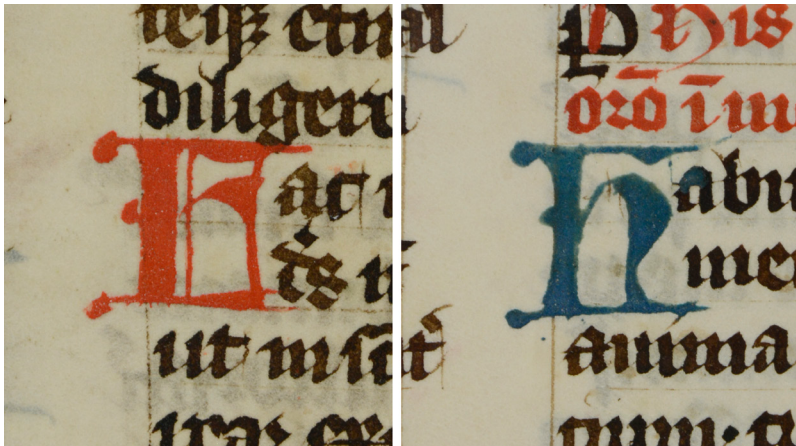


FIG. 1. A red „F” initial, on the left, made with a mixture of cinnabar and minium and a blue initial „h”, on the right, made with azurite – *Pontificale Plocense II*, II half of XIV century. Biblioteka Seminaryjna w Płocku, Plock Seminarian Library, MsEPI 7a.

Photo by Jacek Tomaszewski

cleansing it. In the *Liber de coloribus illuminatorum sive pictorum* from the first half of the 13th century, similarly as in the present recipe, ground pigment was soaked in clean water or more frequently in a mixture of water with vinegar or wine (*Minium molendum est cum aqua sicut vermiculum. et eiecta aqua de cornu: siccabis. et ita ponenda est glarea oui. et sic illinatur ex eo. Hoc minium cum nullo colore miscetur nisi cum albo et uermiculo* (Thompson 1926, p. 282). Also in a manuscript form 1464-1473 kept at the Bayerische Staatsbibliothek in Munich (Call No. Clm 20174, f. 203v) we find the recommendation to rinse the pigment: *Si autem Minium vulgariter menig vetus aut turpis coloris fuerit. ita lauari debet. Sume aquam et vinum ita. ut quinta vel sexta pars sit vinum. et mitte in cornu cum minio. et commoue. et permitte quiescere. Cum autem sedatum fuerit. eice aquam et vinum. et infunde claram quantum opus fuerit etc.* According to the manuscript *De diversis coloribus* by Johannes Alcherius (Merrifield I, p. 295) minium was rinsed with a mixture of water and wine (3 :1), following which it was dried, and the paint was made with an addition of egg white. The discussed recipe does not include the stage of drying the pigment following the rinsing in water.

2. Cinobrium temperatur primo sic. Recipe cynobrium et contere bene in lapide. Et cum contritum fuerit, tunc pone in cornu de minio tantum sicut de cinobrio et sic misce invicem et funde aquam desuper et remitte liquefieri. Et die crastina depone aquam et funde clarum desuper ita, quod nulla spuma sit ibi. Si modicum videtur [videns], tunc modicum rade de creta intra. Et si vis, ut splendeat, tunc pone de vitello modicum intra. Verumtamen quanto plus posueris, tanto plus splendeat. Et tunc moveas simul predicta cum vitello etc.

The first way to prepare cinnabar is the following: take cinnabar and grind it thoroughly on the slab. When ground, place as much minium as cinnabar in a horn, and mix them together adding water on the top. Then put it all aside to dissolve. The following day pour out the water, adding egg white and avoiding any foam. If you find the obtained volume insufficient grate some chalk inside. And if you wanted it to shine, add some yolk inside; obviously, the more yolk you add, the more shiny it will be, and subsequently, mix with it all the enumerated ingredients, etc.

It is the first of four recipes for cinnabar for painting. Two recipes instruct to mix cinnabar with minium (Nos, 2, 16). Vermilion for rubrication was most frequently prepared by mixing cinnabar with minium in different proportions. Several recipes with the use of both pigments are given also by the *Liber illuministarum* (Bartl *et al.*, Nos. 63–64, p. 88). Johannes Alcherius in his brief treatise *Experimeta de coloribus* contained in the compilation by Jean le Bègue from 1431 (Merrifield I, No. 177, pp. 140–142) gives recipes for preparing red for illumination, and explains why in order to obtain the best possible effect these two pigments have to be mixed. Minium by nature is too light for initial painting, that is why it was mixed with darker more luminous cinnabar. The usual proportion for fresh pigments was two parts of cinnabar with one part of minium. The colour of both cinnabar and minium altered with time: minium faded, while cinnabar darkened, therefore the pigment proportions changed. The older the cinnabar, the less of it was added to the rubric (Merrifield I, No. 311, p. 297).

Two recipes from the treatise recommended mixing the pigments in equal proportions. Pouring water over the ground pigments and leaving this for the night was most likely to secure purifying the two pigments from degradation products (Petrus de S. Audemaro: *Quomodo lavatur minium* - Merrifield I, p. 143, No. 178). Once the pigment was cleansed, the water was poured out, while a binder in the form of beaten up whites, left to stand, and cleaned of foam, was added. Adding some chalk to the purified pigments slightly lightened up the paint, also increasing its volume, however, at the expense of its quality. Adding the yolk to the paint did not only increase the luminescence of the paint layer, but also its elasticity. Many recipes recommended to add cerumen to boost the paint's sheen (Thompson, Hamilton, pp. 17-18).

3. Lazurium sic temperatur.
Accipe lazurium et contere
in lapide bene et liquefacere
in forti aceto vel vino. Et in
crastina die remove prefatum
acetum vel vinum et funde
gummi arabicum desuper. Et
scribe etc.

Azure is prepared in the following manner. Take azure, grind it thoroughly on the slab and dissolve in potent vinegar or wine. On the following day pour out the above vinegar or wine, following which pour some gum arabic on top. And write, etc.

It is one of the four recipes to prepare a blue pigment defined as 'lazurium'. The recipe does not specify what pigment is involved. In the *Tabula de vocabulis et equivocis colorum* contained in the manuscript by Jean le Bègue (Merrifield I, p. 29) we find a general definition of the colour, not the pigment: *Azurium vel lazurium est color; aliter celestis vel celestinus, aliter blaucus, aliter persus, et aliter ethereus dicitur*. All the natural mineral pigments as well as the artificially yielded ones can be defined as 'lasur'. In technological sources it is relatively rare for the names of blue pigments to be differentiated. Except for the lapis lazuli (lazurite, natural ultramarine) defined as *azurro ultramarinum* or *lazurium transmarinum*, or azurite given the name depending on the place of its origin: *azzurro della magna*,

azzurro d'alle magna, or *lazurium vel de anglia, vel yspania* (Thompson 1935b, p. 461), it was only through the description of the cleansing and grinding process that it can be deduced what plant dye or natural pigment we deal with (Bartl *et al.*, p. 708). The most frequently applied pigment in mediaeval book painting was azurite, alkaline copper carbonate ($\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$), a mineral accompanying copper ore deposits in various places, also Germany and Poland. The Latin name of *lazurium* comes from the Arab *lāzward* or Persian *lāšward* meaning blue colour.

As a natural mineral, azurite can boast a different chemical composition and various impurities essentially affecting its colour. Depending on the variety and quality, to a larger or lesser degree it usually requires the unwanted impurities to be removed. The most effective means was rinsing in lye, recommended in numerous treatises, e.g., in the *Liber colorum secundum magistrum Bernardum...* (Travaglio 2008, p. 132), *Segredi per colori* (Marrifield II, pp. 365–367), or the collection of technological recipes from the Tegernsee Abbey from 1464–1473 (Munich, BSB, Clm 20174).

Meanwhile, recipes rarely mention the use of vinegar to cleanse azurite. Such a procedure is contained in the *Liber illuministarum* (Bartl *et al.*, No. 160b, p. 136) where azurite was first soaked in vinegar for eight days, and subsequently cleansed with lye, to be finally cleansed again with vinegar. A slightly different process was contained in the recipe presented in the *Segredi per colori* where the pigment was first cleansed with lye, only to be later rinsed in potent vinegar, possibly to neutralize the products remaining after the alkaline effect.

In the Cracow recipe, possibly green copper compounds were created in the reaction with vinegar; they were later washed away together with small azurite particles. What remained were larger dark-blue grains of the pigment. However, the different-sized pigment grains could not be effectively separated with vinegar alone; this was possible only when using lye (Bartl *et al.*, p. 550). In the discussed recipe the pigment was to be used for making writing liquid mixed with the solution of gum arabic.

4. Grispon sic temperatur. Accipe grispon et contere in lapide cum aceto vel vino. Et sic mittas cum illa mixtura in cornu quod est et contere feces. Et siccum exprime de ipsis. Et funde hyspanum et modicum de melle favo et tunc moveas. Etc.

Verdigris is prepared in the following manner. Take verdigris, grind it on the slab with vinegar or wine. Pour that mixture into a horn. After that grind the sediment. And press out of it what is dry. Pour in Spanish green and some honey, following which stir it, etc.

This is one of the six recipes concerning the preparation of copper green, of which each differs in additives and the preparation procedure. In this case the pigment is ground with added vinegar or wine on the grinding slab. In the course of the process the pigment gradually dissolved in the organic acid, while the remains after filtering were poured into a horn. In this way, so-called ‘neutral verdigris’ was obtained which of various forms of copper acetate with the general formula of copper (II) acetate $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{Cu}(\text{OH})_2$, transformed into monohydrate $\text{Cu}(\text{CH}_3\text{COO})_2 \cdot \text{H}_2\text{O}$. The liquid obtained in such a way was added some honey as a binder.

From ancient times throughout the whole Middle Ages all the artificial copper greens, regardless of their means of production, were in Latin texts called *verdigris*, *viride hispanicum*: ‘Spanish green’, or *viride grecum*: ‘Greek green’. Within the German-speaking circles variants of the vernacular name: *grienspon*, *grinspon*, *spongrin*, or *spongrien* were used (Bartl *et al.*, pp. 544–545; *The Pigment Compendium*, pp. 177, 385–386, 390).

It is symptomatic that in this and in the other recipes the pigment’s German name: *grispon* was consistently applied by the author. However, in such an abbreviated word form the name was not recorded in any known technological source from the region of the impact of German terminology. At the same time, in the further part of the recipe a different name of the pigment: *hyspanum* appears. Once again, such a version of the name is not present in other known treatises, though its variant: *viride hispanicum* can be found (Thompson 1936, p. 392; Baroni 2016a, p. 281; Munich, BSB, Clm. 20174, f. 183r).

5. Briselium sic temperatur.
Recipe concham et pone
briselium intra et funde clarum et
modicum aluminem. Cum autem
vis scribere, pone ad peniculum.
Et ponens exprime [exprimens]
ad cornum suum colorem; tunc
scribe, quod vis etc.

Brazil is prepared in the following way. Take a bowl, put brazilwood inside, add glaire and some alum. When you want to write, pour it into a sponge. Having poured it there, press the pigment into your horn. Subsequently, write what you want, etc.

The treatise contains nine recipes to prepare a red dye from brazilwood. The recipes in question can be found at two places: in the initial part (Nos. 5, 7, 8) and the final one (Nos. 56, 63, 64, 65). Additionally, the obtaining of the dye is described in No. 38, and also in recipe No. 26 which speaks of preparing brown.

Despite the appearances, the name has nothing in common with the New World, but it is derived from the Old-French *brese* or Portuguese *brasa* meaning ‘glowing coals’ or ‘embers’, yet originally also flaming red (Franca, p. 291; Bartl *et al.*, p. 689). In the Middle Ages, the wood used represented the *Caesalpinia sappan* species (called red brazilwood by Krzysztof Kluk in the 19th century (Kluk, vol. I, p. 92). This dyeing material reached Europe through the Arab world, possibly in the 12th century. It was mentioned in the accounting books of Genoa in 1140 as *braxile* or *Brasile*, later in 1192, in Lodi, northern Italy, and in the early 13th century, at markets of Flanders (Ploss, p. 55). Initially widely used for dyeing textiles, it was soon applied in other domains, including panel painting and illumination. In later periods also related species coming from Southern and Central America were used in the process, such as *Paubrasilia echinata* (Pernambuco wood), *Caesalpinia violacea*, or *Haematoxylum brasiletto*. The wood of all those species contains the red neoflavonoid dye: brazilein which changes colour depending on the ways of preparing it and the additives. In acidic environment it turns yellowish-brown, and in alkaline environment it becomes a differently shaded red (*The Pigment Compendium*, p. 60).

In different Latin treatises the name of brazil differed slightly depending on the place in which the text was created and in what

tradition it was copied. In West European treatises we find different transcriptions. There is mention of *brasilium*, *bresilium*, *brisilium* (Heraclius, III, 34 and 35 - Merrifield I, p. 235), *brisilium* (Alcherius - Merrifield I, p. 271), *de brasil* (Hunt, p. 206), *braxilium vel Brexilium* (Jean Le Bèque - Merrifield I, p. 21), *lignum brasili*, *brasile* (*De arte illuminandi*- Lecoy de la Marche, pp. 17-20; Petrus de S. Aude-mar - Merrifield I, p. 145).

In Italy we come across the following transcriptions: *braxille*, *brasille* (Travaglio 2008, pp. 126-128), or *verzino* (Merrifield I, p. 21); in the German-speaking circles the following variants are found: *presilg*, *presilig*, *ligni prisiligen*, in Latin: *prisileto*, *prisilium*, *presilium*. Similarly, in Bohemia the tradition applies rather to the German version, which can be seen in the application of the form *prisilium* by Pavel Židek in the *Liber viginti artium*, called the Twardowski Book (Kraków, BJ, rkps. 257, f. 187vb). The later Czech names: *pryzule*, *prysila* confirm this linguistic tendency (Businská, p. 194).

In the treatise *Ars de coloribus* the version of the name of the dyeing material: *briselium*, *lignum briselli*, not found anywhere else, was used. The shift of vowels in the word core is present only in the manuscript of John of Dobra, and it seems to be a feature characteristic of Polish writing also in the later period. In the Polonized version the word *bryzelia* was actually used until the 19th century. Next to *bryzylia* and *bryzeliya*, this was the form applied by Marcin Siennik in his translation of *The Secrets...* by Alessio Piemontese or by the anonymous author of the *Sekret Wystawiony...* (pp. 114, 115). In the late 17th century, also Jakub Haur recalled the name *bryzelia* (Haur, p. 368), adding the variants: *brazylia* (p. 377) and *skorka z drzewa brazy* and *bráza* (p. 362). The name in this version could also be found in the 18th century (*Contant d'Orville*, p. 342). In 19th century dictionaries the names *bryzelia* or *bryzylia* appeared simultaneously with the form *brazil* (Linde, pp. 167, 178; Bantkie, pp. 36, 38; Trotz, column 684; Mrongowiusz, p. 31).

Out of the nine recipes to prepare brazil, four refer to the cold extraction of the dye with some egg white as a binder and alum. In the discussed laconic recipe the dye is prepared for writing, par-

ticles of wood are mixed with glaire and alum and deposited for colouring. In the next stage, as can be read from the context, the coloured graire is filtered through sponge to a horn. The word used here is *peniculum*. It can mean a 'brush' or a 'sponge', however, in technological texts it is most commonly used in the first meaning (Wattenbach, p. 222). The sources more commonly apply *spongia* for sponge. In the context of the discussed recipe the use of sponge is understandable, and it was used for filtering the dye, separating it from the solid parts of the wood, and beating of the albumen structure (liquefaction). In treatises the latter function of sponge appears relatively frequently, and in recipes many phrases related to preparing a binding can be found, e.g.: *claro ovi spongia liquidato* (Alcherius - Merrifield I, p. 273) or *accipe claram ovi bene fractam cum spongia* (Travaglio 2008, p. 131). The addition of alum caused the colour change towards dark red. At the same time alum was essential for the preservation of the colour. This is pointed to by the author of the treatise *Liber de coloribus illuminatorum sive pictorum* (Thompson 1926, p. 284) who emphasizes, possibly on grounds of his own experience, that without added alum the dye fades with time, leaving merely a colourless albumen binder on the leaf surface. However, cold extraction of the dye from brazilwood is not greatly effective, as a result yielding a relatively light and transparent colour. Such a method of obtaining the paint from brazilwood was popular and given in numerous treatises (see *Experimenta de coloribus*, Merrifield I, No. 102, pp. 92–93), however, no source for the discussed recipe can be identified, nor can it be directly connected in the linguistic layer with any other known recipe.

6. Glaucum, quod venditur,
in isto sunt quidam lapides,
istos contere optime cum aceto
forti et cum bene contritum
fuerit, tunc permittite molle
fieri per noctem. Et crastina die
remove acetum et funde gummi
arabicum et moveas.

Tawny/yellow colour, which
can be bought, contains some
stones: grind them, preferably
with potent vinegar, and once
they are thoroughly ground,
leave them for the night to
soften. The following day
remove the vinegar, pour in gum
arabic, and mix it all.

The Latin word *glaucus* is not a precise and unequivocal definition of a colour. Some dictionaries suggest light grey, greenish, greenish-blue, sea green, whitened green, sky colour, or that of a pale-blue fish. The very differentiation of the colour definitions found in dictionaries points to how an ambiguous colour definition we are dealing with. If we were to assume that the colour model was originally that of a small bluish fish pointed to by Pliny (Calonghi, column 1165), this differentiation can cover quite a wide colour range. In his *Etymologiae sive Originum libri XX* Isidore of Seville (Isidore of Seville, XII, vi, 28) described the fish called: *Glaucus a colore dictus, quod albus sit; Graeci enim album γλαυκος dicunt. Hic aestate raro apparet, nisi tantum in nubilo*. Authors of old artistic and technological treatises faced the challenge of the colour's definition (Thompson 1932, pp. 16–17; Thompson, Hamilton, p. 6, 25; Caffaro, pp. 27–28; Baroni 2016b, p. 298).

Those dictionary definitions of *glaucus* colour do not fully harmonize with some mediaeval definitions and recipes. In the *Tabula de vocabulis et equivocis colorum* contained in the manuscript of Jean le Bègue (Merrifield I, p. 29) the colour in question ranks among whites: *Glaucus est color albus, ut cerusa, que aliter dicitur album plumbum, aliter blacha, et aliter album Hispanie*. While remaining within the Cracow circles, in a collection of medical works from 1460 (Kraków, BJ, Rkp. 786 III, f. 158v) definitions of colours were contained, including: *Color flavus qui glaucus dicitur*. This explicitly identifies *glaucus* with yellow, however, it does not definitely decide upon its nature, though some recipes from that period unambiguously point to yellow hue. Among them mention can be made of the recipes from the collection of recipes from around 1400 (Munich, BSB, Cgm 824, f. 13r) in which the following record can be found: *ad glaucum colorem recipe rosam et crocum cum albugine oui mixtum 2. 3. guttas de vitello et postea mitte in cornu tuum cum albugine et habebis*, unequivocally pointing to that colour. In the Middle Ages, colour definitions were generally not very precise, not differentiating shades and values. However, the majority of recipes to make paint of that colour show that the aspiration was to obtain a light colour, showing shades of muted yellow, in green-ochre tonality which can sometimes be defined as

tawny colour. While talking about the Cracow collection of recipes the final doubts as for the colour direction in the *glaucus* definition are finally dispelled with recipe No. 58 in which the name defined a mixture of orpiment and saffron.

In the discussed recipe there are no premises suggesting the shade of the stone pointed to by its author. It must have been a mineral used for producing pigments and paints, possibly also from the ochre group. The additive of a binder in the form of gum arabic did not have any impact on the paint's shade.

7. Briselium sic temperatur.

Recipe cimentum inextinctum, ponendo ad unam testam vel ad aliquid. Et funde super hoc aquam mundam et misce aquam cum cemento in eadem testa sic, quod aqua turbidatur. Post [per] hoc mittas stare per unam horam quousque clarificabitur et iterum move simul quociens volueris. Deinde aquam clarificatam de cemento sume et cola eam per panniculum tociens quod amplius ibi nulla videbilur inmundicia cimenti. Et appone modicum clarum in aquam, sic quod fundas hoc mixtum, scilicet aquam cum claro super briselium, secundum quod tenue vel spissum haberi debeat. Et tunc in unam ollam novam ponas. Et ponatur iterum super ignem vivum, non cum lignis, ne fumus ingrediatur buliante, quod non suffletur intus [etc. Sequitur], et postquam cito bulitum fuerit, appone modicum aluminis ad quantitatem unius grani de piso.

Brazil is prepared in the following way. Take quicklime and put it in a pan or another dish. Pour clean water over it, and mix it with the lime in the pan so that the water is stirred. Put it aside for an hour to clarify. Then stir it in a similar way, as much as you wish. Following that pour out the lime solution. Strain it through a piece of cloth as many times as necessary to remove any lime sediment. Add some glair to the water so that you pour the mixture, meaning water with glaire, over the brazilwood depending on whether you want the hue to be weak or intense. Then put everything into a new dish. Put it on fire, but not on firewood, so that the smoke does not get into the extract, and does not contaminate it from inside. When it boils, add some alum: a lump of a size of a pea.

The recipe concerns obtaining a dye through hot extraction in limewater with some alum added. High pH of limewater and added alum yield blood-red lake. The recipe emphasizes the need to precisely cleanse the limewater of calcium particles, since, if left, they could lighten the paint, which would not be a desired effect. However, adding the white of an egg prior to the boiling of the liquid with the wood shavings is not technologically justified. After the solution is heated, the diluted glaire undergoes denaturation, no longer serving as a potential binder. Furthermore, the recipe emphasizes that no smoke should get into the liquid in the process of heating, since soot could contaminate and darken the paint. What strikes in the recipe is the application of the word *cimentum inextinctum* [*cementum*] to define quicklime used in order to, as can be judged from the procedure, obtain lime water. The notion more frequently used to define it was usually more specific: *cementum vivum* or *calx viva* (Bartl *et al.*, p. 702).

An analogical procedure of preparing the dye can be found in the Bologna manuscript (Merrifield II, pp. 436–439). In this case, however, white of an egg was not added before boiling the dye. A binder was used: gum arabic was added at the end of the process. A similar procedure is contained in the manuscript from the Tegernsee Abbey from 1464–1473 (Munich, BSB, Clm 20174, f. 176v). In this case, following a similar procedure, a binder in the form of animal glue (*bitumine*) was added prior to boiling the dye.

The recipes based on adding an alkaline element in the form of lime or lime water or chalk constitute a separate group. In the treatise *De arte illuminandi* (Lecoy de la Marche, p. 17) an anonymous author distinguishes two types of paint obtained with the use of brazil. The first is liquid, transparent paint used for shading and darkening: *De colore brasili liquido et sine corpore ad faciendum umbraturam*, and a covering one (*rosecta corporea*) used for painting main parts of initials and covering parts of decorations and miniatures. As all the recipes speaking of colouring brazilwood shavings cold in white of egg rank as the first category, the second group contains recipes in which alkalis with added alum are used. Added

chalk (Munich, BSB, Call No. Cgm 822, source: <https://artechne.hum.uu.nl/node/86184>), gypsum, or ceruse (Alcherius, *De coloribus diversis* - Merrifield I, p. 298) do not form true lake, but a covering gouache.

8. Briselium sic temperabis.
 Recipe lignum briselli et pone
 in clarum et mitte stare per
 triduum donec putrescat. Tunc
 recipe et tere bene in lapide. Et
 [superpone] cum contritum bene
 fuerit, cola per panniculum et
 habebis pulcrum colorem etc.

Brazil can be prepared in the following way. Obtain brazilwood, put it into albumen and leave aside for three days until it rots slightly. Then take it out and grind thoroughly on the slab. When ground, strain it through a piece of cloth, and you will obtain a beautiful dye. Etc.

This is the second after No. 5 recipe speaking about the brazil dye obtained through cold extraction in glare. In this case the longer colouring time and later grinding of wood shavings in a mortar was to lead to a maximum dye extraction. Another difference consists in the lack of added alum, this leading to obtaining a darker claret colour. The dye obtained in such a way was cleansed of wood remnants by being strained through a piece of cloth. It was of importance for the colour purity to remove solids from the dye, therefore it was recommendable to use a silk or linen cloth, namely a tightly-woven fabric: *per cendale vel in panno lini subtilissimo bene texto* (Franca, p. 290). The albumen putrefaction process occurring after several days liquidated the binder, at the same time weakening its adhesive strength. A partly spoiled albumen was used in gilding, in panel painting and painting on parchment leaves (Alcherius - Merrifield I, p. 283). In his recipe to prepare a dye from brazilwood, Theophilus also recommends extraction of the dye in glair until the beginning of the putrefaction process, which he calls ‘maturing’ (*coeperit maturescere ponitur*) (Theophil, p. 412). An almost identical recipe can be found in the Czech manuscript from the Library of the Prague Metropolitan Chapter (KPMK, Call No. M. VIII, f. 56r), where but minor discrep-

ancies in the recipe's wording can be found. In the latter, however, the name *lignum presilii*, characteristic of German-speaking circles, is used.

9. Crocus autem sic temperatur. Pone in concham sive in testam. Et pone in fornacem, ut siccabitur. Cum autem siccum bene fuerit, tunc contere cum aceto et mitte cum aceto stare usque per noctem. Et crastina infunde de tenui cervisia modicum. Et tunc moveas. Si autem penna vis scribere cum eo, tunc pone in pannum et exprime in cornu. Et sic scribe, quid vis.

Saffron is prepared in the following way. Place saffron in a bowl or a cauldron. And place it in a stove to dry. When it is sufficiently dry, grind it with vinegar and put away for the night. The following day pour in some weak beer, and mix it. If you want to write with this using a pen, put the mixture in a cloth and squeeze it into a horn. Like this write what you want.

The name *crocus* refers to cultivable saffron (*Crocus sativus* L.) whose main dyeing substance is crocetin (*The Pigment Compendium*, p. 337). Saffron was an extremely important organic dye, not only used in mediaeval miniature painting, but also in a number of crafts, first and foremost in dyeing. It was used as a separate dye in book illumination, but even more frequently as refinement for other colours. In the Middle Ages, crocus was cultivated in southern Europe: in Spain and Italy, where the best species was imported from Sicily (Merrifield I, p. CLXV). The plant was also cultivated in France, and even England, Switzerland, and Germany. In the Cracow collection of recipes it is used as an additive to orpiment (No. 58), to vermilion (No. 59), to verdigris (Nos. 10, 37), to gesso under gold (Nos. 25, 57), to soap (No. 45), and as a dye for dove feathers (No. 23). For painting purposes saffron could be prepared in various ways. According to Alcherius in the *De coloribus diversis...* (Merrifield I, No. 337, p 312) the dye could be extracted with the use of pure water, glair on its own, or white wine. This list can also include vinegar applied in the discussed recipe. In technolog-

ical-artistic recipes it was most commonly recommended to use glair without any additional substances, and such are the recipes found in the *De Clarea* (Baroni 2016b, p. 306), *De arte illuminandi* in the recipe 'De corco' (Thompson 1933, p. 19, Lecoy de la Marche, p. 33), or in the Bologna manuscript (Merrifield II, No. 234, p 504). Wine was recommended as frequently as glaire, e.g.: *Liber de Coloribus Illuminatorum siue Pictorum* (Thompson 1926, p. 284) or *Illuminierbuch künstlich alle Farben zumachen vnd bereiten...* by Valentin Bolz (p. 29). Extraction in vinegar is found in the 16th-century manuscript from Padua: *Recette per far ogni sorte di colori* (Merrifield II, No. 128, p. 707), where saffron put in a cloth was soaked in vinegar, and later strained, with a binder: glaire or gum arabic added to the extract.

Compared to other records, mentioned above, the discussed recipe ranks among unique ones, in a way being a testimony to the environment in which it was created. The first activity described is drying saffron placed in a dish in a warm place. Saffron was imported to Poland mainly as a dried spice (Małowist, pp. 126, 130), therefore mentioning that it should be dried did not apply. Assuming, however, that the recipe was conceived in our latitude we should analyse whether saffron (*Crocus sativus* L.) was the only plant defined with the Latin name of *crocus*. Three different species are found under this name in our region. The first of them: *crocus vernalis* (*vernus* L.) growing wild in southern Poland can be eliminated at least for the fact that it is not a good source of a yellow dye, this already mentioned by Krzysztof Kluk (Kluk, vol. 1, p. 164) in the description of this plant. According to Stefan Falimirz (cap. 15), which was also repeated by Hieronim Spiczynski (cap. 15), the name 'crocus-saffron' in 16th-century Poland denominated '*crocus ogrodny*', meaning *Crocus sativus* L, but also '*Cartamus-krokosz*' (*Carthamus tinctorius* L.), imported to Poland, '*ktory na wschod słońca roście*'. Szymon Syreński (pp. 1526-1527) called the Safflower '*szafran płony/krokos* (*Cnicus, Cartamus, Crocus hortensis, Crocus Saracenicus*)', used as a cheaper spice instead of saffron or mixed with it. At the same time, he distinguished between saf-

fron and turmeric named ‘*Ostryż Indyjski, żółcieniec Indiański* or *szafraniec* (*Crocus Indicus, Curcuma, Cyperus Indicus*)’ (Syreński, p. 28). In reality, however, the first two plants could be identified as one and denominated in Polish as saffron, and ‘crocus’ in Latin. The earlier descriptions of plants provided by Stefan Falimirz and Hieronim Spiczyński were created, however, a 100 years later than the manuscript by John of Dobra, and are not necessarily credible in terms of terminology. In the accounts of the court of Vladislav Jogaila from the turn of the 14th and 15th centuries two names of the spice imported to Poland appeared: *saffranus* and *crocus*, though it remains uncertain whether they referred to one or two plant species (*Rachunki*, pp. 180, 181, 236, 239, also: Hryszko, p. 387).

In the discussed recipe dried *crocus* was ground with vinegar (white wine vinegar most probably) and left for the night in order for the dye to be extracted. Following this, light beer was added, and after straining through a cloth the dye, in this case serving as ink, was ready for use. Beer as a binder does not appear in any recipe speaking about preparing a paint or ink of saffron found in the known treatises or collections of technological formulas. It was used as a weak binder, generally in combination with other binders, including *aloe hepatica*, mainly as an ingredient of gilding gesso. In the latter context it is mentioned in the German collection *Liber illuministarum* (Bartl *et al.*, p. 591) or the collection from 1464–1473 (Munich, BSB, Clm 20174, f. 197v). It was also used in the recipe yielding a dye from brazilwood in the Czech codex from the first half of the 15th century (Praha, NK ČR, Cod. XIV H 16, f. 21v).

Beer as an additive may have been applied in the countries where it was more widely used than wine (Bohemia, Germany, Poland). At the same time, the mention of drying the *crocus* in the recipe may be pointing to the southern border of the beer-drinking culture region where the cultivation of this plant could appear.

10. Si vis habere viridem colorem, recipe viridem pannum vel grispon et tere super lapidem cum aceto. Et appone modicum de creta. Et imponatur eciam de glauco colore et eciam crocum cum tenui potu. Et contere super lapidem et impone in vasculum. Et depinge, quid vis. Probatum est. Etc.

If you want to have green colour, take a piece of green cloth or verdigris and grind it on the slab with vinegar. Add some chalk. You can also add some yellow, as well as saffron with light wine. Grind it all and put into a dish. And paint whatever you want. It has been tested. Etc.

As distinct from recipe No. 4, in the discussed one through adding chalk and saffron the natural light-green colour of verdigris is modified towards more vivid and lighter green. The adding of yellow is essential, since the adding of calcium carbonate could contribute to creating copper-calcium acetate ($\text{CuCa}(\text{CH}_3\text{COO})_4 \cdot 6\text{H}_2\text{O}$), which is bluer than green. The genuine element in the discussed recipe is the use of green cloth for the paint's preparation. A similar procedure is not mentioned in any known technological treatise. The cloth suggested is likely that dyed with the use of verdigris, which under the action of vinegar and mechanical grinding dissolved and was released from the cloth fibres. As testified by preserved recipes, in the Middle Ages, verdigris was widely used to dye fabrics, sometimes with some added organic dyes changing the shade of the green (Edmonds, p. 49). The indirect means of obtaining copper acetate may suggest that the recipe was dedicated to individuals dealing with book decorating as amateurs, for whom fabric dyed with verdigris was more readily available than the pigment itself. However, the fabric in question is most likely not incidental cloth dyed green, but a special piece dyed in order to preserve the dye. It is much later that Marcin Sien-
nik wrote in his *Herbarz* [Herbal] (pp. 589-590) about the 'dyeing of leaves' where verdigris dissolved in vinegar with some additives: saffron and rue extract was soaked several times into fabrics for storage.

The shade of verdigris was often modified by adding organic dyes. In this case, the additive is saffron coloured in wine or any yellow mineral pigment (orpiment, ochre). The colour modification with the use of *croco* is recommended by Petrus de S. Aude-marro (Merrifield I, p. 123) or in the manuscript from Bohemia and kept at the Munich Bayerische Staatsbibliothek Call No. Cgm 824 (f. 12r). Similarly, in the *Liber de coloribus* (Thompson 1926, p. 286) an additive of saffron and white of burnt bones is suggested.

11. Si vis habere viridem colorem, recipe viridem pannum et grispon etc., ut prius dictum est. Ad temperandum viridem colorem recipe potum mensalem et superfunde modicum de cimento et fac stare usque ad putrefaccionem. Et appone ad ignem. Postea cola per pannum et exprime cum vino et impone modicum albuginem. Et post putrefaccionem infunde ad vesicam magnam et tempore estivali superpende ad solem. Et tempore hyemali fac parvum foramen in vesica, ut vapores exeant etc.

If you want to have green colour take green cloth and verdigris, etc., as described before. To obtain green take a kitchen mug and pour in some lime. Leave it to start rotting. Heat it on fire. Then strain it through a cloth, press out with wine, and add some glaire. After it has gone bad, pour it to a bladder. If it is summer, leave it in the sun. If it is winter, prick a small hole in the bladder for the humidity to be able to escape. Etc.

This recipe is a variation of recipe No. 10, though the procedure of making the paint is not clearly presented. It is not known whether the reference to the beginning of the previous recipe: *ut prius dictum est* refers also to grinding the cloth and pigment with vinegar on the grinding slab, or only to the selection of the right source of copper acetate. Regardless, however, of the initial stage of preparing the colourant, copper acetate was mixed with lime water and left to rest for a longer period. Following this, it was heated, and having been filtered, it was mixed with wine and glaire.

At the final stage of the process the mixture was dried in the sun or in an animal bladder. During the drying process what occurred was crystallisation of blue copper-calcium acetate, the compound also obtained in recipe No. 10. At this point, the adding of egg white substantially boosted the lustre of the paint being prepared with the use of this pigment.

Adding burnt lime (*calx viua*) when preparing verdigris can be found in the recipe included in the above-mentioned manuscript from the Munich Bayerische Staatsbibliothek (Call No. Cgm 824, f. 12r), in which, however, the process followed a slightly different track.

12. Item si viridem colorem habere volueris, recipe grison et contere cum modico mellis et post hoc mittas in cornu et succo uve tempera. Et moveas cum stipite et habebis bonum colorem.

Similarly, if you want to have green take verdigris and grind it with a bit of honey, following which place it in a horn, and dilute in grape juice. Mix with a spatula, and you will get a good colour.

In this case the pigment was prepared without vinegar; it was ground with a bit of honey, and then diluted in grape juice. Depending on the type and degree of acidity, grape juice may have had strong qualities of dissolving copper acetate, while the honey acted as a binder. Grape juice is not mentioned in any of the treatises. The procedure only partially resembles that given in recipe No. 4. A similar one can once again be found in the manuscript from the Bayerische Staatsbibliothek (Munich, BSB, Cgm 824, f. 12r), which is close to the discussed recipe not only in view of the procedure, but also the language, therefore it is worth being quoted at full length: *Si vis habere grunspou tunc tere in lapide cum quinque guttis fauo mellis et post hoc mitte in cornum et tempera et moueas optime*. Interestingly, both texts mention the use of the horn.

13. Nota. Si vis facere de cupro viridem colorem, tunc accipe cuprum et pone in pelvim, deinde infunde forte acetum et bonum et mitte stare per noctem. Mane autem facto accipe et videbis rubedinem. Infunde pelvi [pellivis] et move illam rubedinem. Hoc facto mitte iterum stare per noctem, si vis clarius habere. Et postea sume et impone in cornu et ponas [cum] gummi arabicum ideo, quod non defluat.

Note: if you want to obtain green of copper, take copper and place it in a basin. Following this pour in good-quality and potent vinegar, and leave it for the night. When you look into it in the morning, you will see some reddenings. Pour it into a basin and scrape off the reddenings. Having done this, leave for the night again if you want to obtain pure colour. Then take it and pour into a horn adding gum arabic so that it is not too thin.

This is the only recipe in the treatise telling us how to obtain copper green. Most generally *verdigris* was produced by exposing copper plates in a closed dish to the effect of acid substances for several weeks. Green and blue-green products of copper corrosion were created, mainly alkaline and neutral copper acetates. Numerous variants of the production enumerate further additives: salt, copper, urine, sour milk, salt ammoniac, alum, etc. (Bartl *et al.*, pp. 544–545).

In the recipe the process of producing green copper acetate is presented in much simplification. It remains unclear whether the metal was supposed to be covered with vinegar or whether the reaction occurred merely in vinegar vapour. However, mentions of the red metal surface suggest that the copper was immersed in vinegar, since otherwise the recipe would speak of scraping off a green corrosion product. The two-day waiting for the reaction of vinegar with metal described here is definitely too short a period for obtaining any copper corrosion effect. Generally, producing some amount of verdigris would last several weeks or months. Moreover, it remains unclear whether finally it was the scraped off green copper acetate in its solid or liquid form, diluted in vinegar, that was mixed with gum arabic. It can be supposed that the

recipe's author did not have practical experience in producing copper green.

14. Si vis temperare pulcrum flaveum colorem, recipe flores flaveos et contere in lapide et exprime succum et funde ad cornu plumbeum. Et adde parum gummi arabico etc.

If you want to prepare a beautiful yellow [blue] colour, take yellow [blue] flowers, grind them on the slab, press out the juice, and pour it into a lead horn, Finally, add some gum arabic, etc.

This and subsequent entry might lead to an erroneous interpretation of both recipes on the linguistic level. The term *flaveos* should be derived from the word *flavus*, which means 'yellow'. However, both the numerous recipes known telling how to obtain the dye from *flores flaveos* and the very word *lazurium* (Du Cange, vol. 5, column 49b) from recipe No. 15 suggest blue colour. Numerous recipes from various sources tell us what colour we are dealing with and what flowers were used to obtain it. In the *Liber illuministarum* there is the *Lasurium sic facies* recipe in which *flores flaveos* were used to obtain blue (Bartl *et al.*, No. 1161, p. 348). Meanwhile, in the manuscript of Czech provenance of Call No. Cgm 824 from the Munich Bayerische Staatsbibliothek (f. 12 r), older than the Cracow recipe by about 30 years, the flowers used to obtain *de flaveo colore* are *cornblumen*, namely cornflowers (*Centaurea cyanus* L.). Similarly, in the manuscript containing various medical writings of Call No. M. VIII (f. 55v) from the Library of the Prague Metropolitan Chapter mention is made of the 'flores flaveos qui vocant *choren plum* et alio *modrak*'. The recipe from the latter manuscript, although more extensive than the Cracow one, also recommends the additive in the form of gum arabic and collecting the juice in a lead horn.

It is likely that in the relatively wide family of recipes copied many times a mechanical error occurred. As suggested by Mark Clark in the analysis of the recipes in the manuscript from the turn of the 13th and 14th centuries *Secretum philosophorum* (Glasgow, GUL,

MS Hunterian 110) the swap of the first letter in the word *blau eos* for *flau eos* was not corrected by the scribes lacking any experience in preparing pigments and dyes (Clarke, p. 51). Instead, the correct lettering: *flores blauos* is contained in the *Liber de Coloribus Illuminatorum siue Pictorum* (Thompson 1926, p. 292) or the treatise by Petrus de S. Audemaro *De coloribus faciendis* (Merrifield I, No. 171, pp. 136-137). Based on the similarity to other recipes it has to be admitted that the discussed recipe describes the way of obtaining a blue dye from cornflowers.

The recipe is quite simple. Petals were ground in a mortar, juice was pressed out, to be poured into a lead horn, following which a binder in the form of gum arabic was added. Cornflower petals contain anthocyanin pigments present in many flowers, e.g., hollyhock (black variety), peony, and in the fruit of elderberry, blueberry, or blackberry. Without any additives, the juice of cornflower petals is navy blue featuring a purple shade. Anthocyanins can change colour in reaction to pH. It was still in the 19th century that Józef Wyżycki wrote that cornflower juice could be used to dye vinegar red, while when added alum it yielded a colour close to ultramarine (Wyżycki II, p. 247).

In none of the mediaeval recipes there is any mention of additives which could cause the change of the solution reaction, leading to colour change (chalk, vinegar, alum). The only additive mentioned is ceruse serving as a pigment carrier (*Secretum philosophorum* - Clarke, p. 51), or earlier put on the base, used as an undercoat for the dye (*Liber de Coloribus Illuminatorum siue Pictorum* - Thompson 1926, p. 292; Petrus de S. Audemaro, *De coloribus faciendis* - Merrifield I, No. 171, pp. 136-137). It is only in the recipe from manuscript M. VIII from Prague that there is mention of a lead horn in which the prepared dye with gum Arabic was added should be placed. There is no rational justification for the use of this metal. It is likely that, similarly as in the error in defining the flower colour, here, too, an imprecise copy of an older model was made.

15. Item aliter tempera flaveum colorem. Accipe lazurium et tere cum flaveum modico mellis in lapide et infunde aquam desuper. Deinde inpone in unum cornum et munda cum aqua. Deinde tempera cum gummi arabico tenui. Et scribe.

Yellow [blue] can also be prepared differently: take azure, grind it in a mortar with a bit of honey, and pour water on top. Then pour it all into a horn, and drain the water. After that delicately mix it with gum arabic. And write.

Similarly as in recipes Nos. 14 and 19, in this one, too, the meaning of the word *blaveum*: blue was changed to *flaveum* [*flavum*]: golden yellow. It is therefore a recipe to prepare blue from azurite. The pigment was thoroughly ground with some honey added, and later water was added to remove impurities and dilute the honey. After the mixture was poured into a horn, the water was drained and gum arabic added. In the course of such a procedure, after the water has been drained, some honey still remained in the pigment, serving as a plasticiser of the painting layer, similarly as in recipe No. 20.

Azurite was ground not only in pure water, yet most frequently with some thickening substance added, such as an adhesive (Munich, BSB, Clm. 20174, ff. 180v-181r), gum arabic (*De arte illuminandi* - Lecoy de la Marche, No. 27, p. 28), egg yolk (Bartl *et al.*, No. 322, p. 216), glaire with lye - Bologna manuscript (Merrifield II, p. 411), goat milk and soap (Petrus de S. Audemaro, Merrifield I, No. 167, p. 135; No. 197, p. 157), or lye on its own - *Liber colorum secundum magistrum Bernardum* (Travaglio 2008, p. 132). Grinding azurite with honey is mentioned only in the *Liber illuministarum* (Bartl *et al.*, No. 184, p. 148).

16. Cinobrium temperabis sic. Tere ipsum in [de] lapide et tantum multum de minio et sufficit. Et temperabis cum clariovi et nunquam cum aqua, quia demergitur etc.

Cinnabar can be prepared in the following way: grind it on the slab, add the same amount of minium and that is enough. Stir it with egg white, never with water, since it sinks in it, etc.

It is the second recipe to prepare red recommending the combination of cinnabar with minium in equal proportions. The pigments are ground on the slab and mixed with glaire, without added water. The author of the collection consistently recommends mixing vermilion with minium in a 1:1 ratio.

17. Item accipe cinobrium et tere fortiter cum claro. Postea accipe pomice[m] et tere cum cinobrio et adde parum de vitello, ita quod plus sit de cinobrio quam de pomice. Et scribe in pergamen[o] et fac siccari. Et cum siccatum fuerit, plana cum anulo. Etc.

Similarly take cinnabar and grind it thoroughly with glaire. Subsequently, take pumice and grind it with the cinnabar, adding little yolk so as to have more cinnabar than pumice. Write on parchment and leave it to dry. When dried, smooth it with a ring. Etc.

Pumice as an additive is found in three recipes in this collections: Nos. 34, 55, and the discussed one. They all deal with an inscription resembling gilt. In the discussed recipe cinnabar was thoroughly ground with added glaire. However, it remains unspecified whether after having been ground, the pigment was dried. Subsequently, cinnabar was ground again with some pumice and egg yolk added. When an inscription was made with this paint, after it dried it was smoothed with a ring. In this way the sharp edges of fine-grained pumice would accumulate particles of the metal, while the cinnabar inscription acquired a golden shine. As it seems, the yolk in the paint's composition played the role of a stronger binder and plasticiser thanks to the presence of lipids in the composition. The role similar to that of the pumice was sometimes played by crushed crystal (No. 43).

In the Cracow treatise recipe No. 55 beginning with the phrase: *Si vis scribere anulo, quod apparebit quasi aurum* in its core almost literally repeats the procedure as described here. Both recipes must have come from the same source, and when edited, they were not verified by the compilation's author. An almost identical version of the recipe is also contained in the manuscript from the Library of the Prague Metropolitan Chapter Call No. M. VIII (f. 45v), and it should be quot-

ed here: *Accipe cinobrium et tere fortiter cum claro. Et accipe pumicem et tere simul cum cinobrio. Et appone medium modicum de vitello, ita quod plus sit de cinobrio quam de pumice. Et scribe in pargameno et quod siccatum fuerit cum anulo aureo vel argenteo (perfrica eum?) et apparebiunt auree vel argentee.* The appearance of two identical versions in the Cracow treatise, differing, however, from the recipe from the Prague manuscript, testifies to the character of such records. These recipes circulated among various writing centres in the form of small compilations of a working character or even in the form of single recipes. The author of the treatise *Ars de omnibus coloribus* used two different sources containing recipes Nos. 17 and 55, sources which may have served as reference aids for his writing profession.

18. Item minium tere cum claro et vitreollo et adde parum de blaveis et habebis pulcrum colorem super pargamentum. Probatum est.

You can also grind minium with glaire and vitriol. Following this add some blue, and you will have a beautiful colour for parchments. It has been tested.

This is the second recipe to produce minium. In this case the pigment is ground with some vitriol and blue pigment. As much as we understand that the second ingredient modifies the paint, the adding of vitriol (hydrated iron (II) sulphate or hydrated copper (II) sulphate) remains unclear from the technological perspective. No recipe otherwise is known to recommend this additive to a paint. Manuscript Cgm 824 from the Munich Bayerische Staatsbibliothek (*Si vis habere colorem roseacum...*, f. 13r) recommends adding good ink (also vitriol) to vermilion.

19. Item si vis habere griseum colorem, accipe cretam et conteras cum vitello. Postea mitte in cornu cum albugine. Etc.

Similarly, if you want to have grey colour, take chalk and grind it with yolk. Then put it in a horn with glaire. Etc.

In the genuine text this recipe was not separated with a red line as a distinct paragraph. However, it constitutes a section apart, and in this study it has been considered as another recipe. Obtaining grey colour

generally was not a problem, therefore recipes describing how to get this colour appear relatively rarely. Generally it was ceruse or chalk mixed with a black pigment, or possibly blue with light brown (see: *Liber Illuministarium* - Bartl *et al.*, No. 392, p. 246). Among the less typical recipes mention can be made of those in which chalk was mixed with ink or egg yolk, as was the case of the recipe from manuscript Cgm 824 from the Bayerische Staatsbibliothek in Munich (f. 8v) *Item gryseum colorem accipe incaustum canne et cretam rosam cum vitello*. In the latter case the main ingredient yielding greyness was black ink.

In the discussed recipe chalk is ground with egg yolk, and subsequently combined with glaire. What results in effect is not grey paint, but white with a yellow shade coming from lutein in the yolk. In the above-mentioned Munich manuscript Call No. Cgm 824 (f. 13r) a much similar recipe can be found, this only speaking of making white paint: *Ad album colorem accipe cretam rosam et tereas in lapide cum vitello et postea mitte in cornum cum albugine oui et habebis*. A recipe with a similar formula was also included in the recipe collection from the Tegernsee Abbey from the first half of the 15th century (Munich, BSB, Cgm 822, f. 7r). Maybe an error occurred in the Cracow recipe, and the word 'album' was replaced with 'griseum'.

20. Item si vis temperare lazurium, accipe artum lazurii, in concham pones et superfunde aquam, purissime lavando lazurium bis vel ter. Cum satis sit clarum tunc accipe gumini arabicum et mitte in cornu et infunde claram aquam. Et fac per tres dies et noctes stare et iterum fac lazurium humidum. Et accipe gummi arabicum et funde super lazurium et moveas. Tunc scribe, quid vis. Nota. Lazurium temperabis cum gummi arabico et stilla mellis et briselio. Et sic bene stat in pargameno. Etc.

Similarly, if you want to prepare azure, take a portion of azure, place it in a shell and pour water over it, rinsing clean twice or three times. When it is adequately clean, take gum arabic, put it in a horn and cover with clean water. Leave it aside for three days and nights, following which immerse azure in water. Take gum arabic, put it into a horn, and pour clean water over it. Then write what you want.

Note: you will mix azure with gum arabic, a drop of honey, and brazil. And then it stays solidly on parchment. Etc.

As mentioned above (No. 3), the best results of cleansing azurite were obtained by soaking it in lye. However, in many recipes recommended cleaning involves regular water (see also No. 62). Sometimes it was enough to mix the pigments with water in a horn, just prior to adding a binder, as recommended by the *Compendium artis picturae* (Silvestre, p. 127) or rinsing in the shell or horn several times (Munich, BSB, Cgm 20174, f. 199v-200r).

In the discussed recipe the already ground pigment undergoes cleansing. It is rinsed with water several times, and then mixed with the earlier-prepared solution of gum arabic with added honey and brazil. Being a mineral pigment, azurite may have various impurities affecting the pigment's colour. Careful grinding and rinsing several times with clean water essentially improved the pigment's quality. According to Petrus de S. Audemaro, the pigment should be rinsed several times, gradually removing the impurities, the lighter and yellowish parts which are lighter than pure azurite sinking to the bottom as the first (Merrifield I, No.168, p. 135). This cleansing means is also provided by the treatise *De arte iliuminandi* (Lecoy de la Marche, p. 28). Meticulous cleaning greatly improved the colour's intensity. However, azurite is a relatively coarse-grained pigment, and that is why it requires the use of a binder of high cohesion and adhesion. In the decoration of many mediaeval manuscripts it can be seen clearly that the use of too weak or not sufficiently elastic binder is the reason for crumbling or powdering of the painting layer. In the discussed recipe the author paid special attention to the kind of the binder which is gum arabic, an addition of a plasticiser preventing quick drying of the painting layer and the dye correcting the paint's colour. As he emphasized, such paint attached well to parchment. The additive of honey was widely used and mentioned in numerous recipes as an essential element. Gum arabic as a binder produced a shiny dark-blue painting layer (Bartl *et al.*, p. 551). Adding the brazil dye, depending on the proportions, yielded a colour close to crimson, as observed by the author of the *Compendium artis Picturae* 'Preterea cum colorem purpureum facere volumus, lazurium

et brisillium antea conmisscemus' (Silvestre, p. 125). According to the recipe of a Friar Michael from the Benedictine Abbey in Melk contained in the *Liber illuministarum* (Bartl *et al.*, No. 321, p. 214), cleansed azurite could be divided into four fractions depending on the granularity category: the first coarse-grained served for initials, similarly as the second one serving also for shading, the third light one, mixed with ceruse was used for marginal decorations, while the fourth served to create purple through mixing with white and pink. According to such a division the azurite in the Cracow recipe belonged to the last category of a well-ground and fine pigment. The remark placed at the end may once again point to its Czech sources. In manuscript M. VIII (f. 56v) from the Library of the Prague Metropolitan Chapter a recipe of the structure resembling the Cracow one was included: *Lazurium sic temperabis cum gummi arabico et cum stilla mellis et cum presilio. Et valet in pargameno.*

21. Item ad faciendum auripigmento accipe stannum et vinum artum [*vivum argentum*] unum tantum sicut aliud. Et bulire lac in uno caldare et postea sume sulphur eciam tam multum et tere invicem in lapide. Et pone in vitrum collum habentem et cooperi cum luto sapiencie et sal pone [~~sa pone~~] armoniacum, et mitte bulire. Et fiat bene. Probatum est.

Similarly, to make orpiment take tin and mercury in proportion one of this to one of the other. Boil them all together in one cauldron, and then take as much sulphur and grind it all in a mortar. Subsequently, place it in a dish with a neck. Close the vessel with a mixture of clay with horse dung. Add sal ammoniac and boil. It will all be fine. It has been tested.

In this case the name 'orpiment' is confusing. The amalgamate obtained through combining tin (*stannum*), mercury (*vivum argentum*): in the genuine text the abbreviations suggest reading it as *vinum artum*, and sulphur (*sulphur*) with sal ammoniac is mosaic gold (*aurum musicum*) or, in other words, purpurin (*purpurino*, *purpurinus*), and was one of the most favourite pigments imitating gold of mediaeval illuminators. The recipe given here is a simplified

description of the procedure of creating the pigment. A precise description of making purpurin was given by the anonymous author of the 14th-century treatise *De Arte Illuminandi* (Thompson, Hamilton, pp. 4-5). According to him, initially tin (possibly in the form of filings) and mercury in equal proportions with added vinegar and regular salt should be mixed, following which pure sulphur and sal ammoniac, also in equal proportions, should be added. Mixed thoroughly, the ingredients were placed in a glass dish with a long neck tightly corked up with putty called *lutum sapience* (Norri, p. 615). As the effect of long heating on fire a yellow pigment was created, this extracted after breaking the dish.

The pigment was willingly used for imitation of golden writing (*Si vis scribere cum auro siue cum incausto* – Munich, BSB, Cgm 824, f. 68v). Purpurin was still popular in the 16th century, this testified to by the fact that Valentin Boltz in the *Illuminierbuch* (pp. 14-16) gave as many as five different recipes to make the pigment (*The Pigment Compendium*, p. 274).

22. Nota. Si vis scribere cum albo super nigrum, accipe cerusa et vitella ovi, ita de uno sicut de alio. Et terge (!) in lapide et infunde de aqua modicum. Deinde pone in cornu et scribe, quid vis. Et mitte exsiccare. Deinde pone pulcre fundamentum.

Note: if you want white writing on black, take ceruse and egg yolk, the same amount of the first as of the other. Grind it in a mortar and add some water. Then put it into a horn and write what you want. Subsequently, leave it to dry. After that, put a nice undercoat.

This recipe tells us how to make a white inscription against a black background. The ‘ink’ serving for the purpose is composed of ceruse and egg yolk in equal proportions, ground together with some water added. However, the means of reaching the effect of white writing against the black background was not presented clearly. The recipe speaks of applying the *fundamentum* after executing the inscription. Previously, the latter word used in other recipes meant gilding gesso, however, in this case it has to be un-

derstood as a 'base' or 'background', and as results from the context, it is black and put on the leaf. It remains unclear though how the final effect was achieved.

Recipes speaking of obtaining a white or light inscription against a black background appear relatively rarely among technological recipes, and so far only three such sources can be pointed to: two in German and one in Italian. All the three differ, however, from the Cracow recipe in the composition of the writing fluid containing merely egg yolk diluted with water. The oldest record: 'Ein schwartzen prief mit weysser schriftt zu machen' coming from the manuscript *Vier puchlin von allerhand farben vnnd anndern kunnsten* (Berlin, SBB, Germ. Quart. 417, f. 63v) speaks of a secret writing. After putting the layer of black on the leaf the writing could be read only when the paint over it was scraped off with a knife.

The two other recipes come already from the 16th century, and thanks to Marcin Siennik, and in the following century through the intervention of Jakub Haur, they entered the circulation of Polish technological literature. Chronologically the first of the two: 'Ein schwarzen Brieff mit weisser Geschrifte an tag zuthun', to be found in the *Illuminierbuch* by Valentin Boltz (Boltz, p. 65), generally repeating the wording from the manuscript at the Berlin Staatsbibliothek, was quoted by Jakub Haur in his work *Skład albo skarbiec...* (Haur, p. 375): *Na Czarnym iak biało pisać Papierze. Wziąć od Iaia żółtek, wlać nań czystey wody, y vmieszać dobrze, tak gęsto, iako tylko pisać może, potym nowym piorkiem na Papierze, co potrzeba, kreślić, aby tak vschło, wziąwszy miękkiego pedzlika, ktorym zwolna pomazać Papier, wszędzie inkaustem, gdy zechce kto owe przeczytać litery, vskrobać nożem owey iaieczny materyey od Papieru, Inkaust zostanie, a pismo się białe pokaże* (How to write white on black paper. Take egg yolks, add clear water to them, and mix well for it to thicken enough to be used for writing, after that with a new pen write on paper what is needed, and let it dry; then take a soft brush, and slowly spread the ink on paper; whoever wants to read these letters will scrape that egg substance off the paper with a knife, the ink will stay, and white writing will appear).

The last of the recipes: 'A far lettere bianche in campo nero' comes from the work *De' Secreti* by Alessio Piemontese (pp. 159–160), and reached the *Herbarz* by Marcin Siennik (Siennik, p. 583): *Jeszcze białego pisania iny obyczay: Weźmi mleka figowego / a wystaw go we sklenicy na słońce społ godziny. A gdy nim pisać chcesz / weźmi ktemu wody / w ktoreieś Gumi Arabskie rozpuścił / zmieszawszy wespoł / pisz co chcesz na papierze / a gdy uschnie / poleżyżę wszystek papier Inkaustem y po piśmie / a zaś ususzywszy / zetrzy chustą albo płatkem sukiennym / a wnet sie pismo okaże mlekiem figowym pisanie / bo na nie inkaust przylnąć niemogł / a tak na czarney harcie / użrżysz iasne pismo białe. Rownie też tego dokażesz / pisząc żółtkami iaiowymi / ktore też z wodą musisz ubić / A gdy także papier pomażesz* (And another way for white writing: take fig milk/ and put it in a glass in the sun for half an hour. And when you want to write/ bring some water for it/ in which you have diluted gum arabic/ having mixed it all together/ write what you want on the paper/ and when it dries/ pour ink over the writing/ and when it has dried/ wipe it with a handkerchief, or a cloth piece/ and promptly the writing written with fig milk will emerge/ since it could not stick to the ink/ and so on a black leaf/ you will see white writing. You can achieve the same /writing with chicken yolks/ which you can beat up with water / And when you also smear the paper with ink / and when you also wipe the paper with a handkerchief or a piece of cloth, you will see light writing). Following in the footsteps of Alessio Piemontese, Marcin Siennik also gives two ways of achieving the same effect; and in both cases, too, ink was used to blacken the leaf, while the writing was revealed through wiping off a layer of dried ink from the letters' surface with the use of fabric.

The three quoted recipes show that the one contained in the manuscript of John of Dobra is not complete: it lacks the description of the recommended procedure after black has been spread over the leaf. The discussed wording, however, points to the existence of an earlier Latin version of the recipe, later preserved in other languages.

23. Nota. Si vis deaurare columbam, sume crocum et fel de pisce luteo et tere simul. Deinde sume pennam et madida et macula columbam. Deinde mitte exsiccare et poluas. Etc.

Note: if you want to gild a dove, take saffron and bile of a yellow fish, and grind them together. Subsequently, take a feather, dip it in the mixture, and smear the dove over. After that leave to dry and smooth it. Etc.

The discussed recipe concerns ‘gilding’, however, it differs from other records applicable to artistic domains. The recipe may have been taken from a collection of the type of *Secreti*, extremely popular in a later period, containing various untypical recipes, ‘ruses’ or ‘juggler’s tricks’, as they were called by Alessio Piemontese in his *De Secreti*, followed by Marcin Siennik using the same names.

In the laconic recipe the gold colour was obtained from saffron ground with fish bile. At the last preparation stage the dye was probably filtered through a piece of cloth. As it is generally known bird feathers are waterproof thanks to the lipids from the uropygial gland spread over the body in the course of care treatments. Due to this the use of the water extract of the yellow dye of saffron would be ineffective. Animal bile, including fish bile, overcomes the surface tension of the greased feathers, this allowing to evenly spread the dye. The paint was gently applied with a wetted feather to prevent the structure of the dove’s feathers from damage.

24. Si vis cum auro de penna scribere, sume cuprum et tere cum lapide forti in scutella. Deinde impone in cornu et sume gummi arabicum in aquam permissum. Hoc facto sume medium folium aureum et impone in cornu et misce hoc bene. Etc. Postea mitte stare per horam. Hoc facto moveas iterum et scribas. Postea poluas cum dente exsiccando. Etc.

If you want to write gold from a pen, take copper and pulverize it with a hard rock in a bowl. Following this, put it in a horn and add gum arabic mixed with water. Having done this, take medium-size gold leaf, put it into the horn, and mix it well. Etc. After that put it aside for an hour. Having done this, stir it again and write. After it has dried, smooth it with a tooth. Etc.

It is one of two recipes (the second being No. 44) concerning the preparation of the imitation of golden ink of pulverized copper. Technological treatises provide numerous recipes telling us how to obtain powdered gold and gold imitations from pigments and dyes. Few recipes are based on powders obtained from copper or bronze. One of them is given by Alcherius in the *De coloribus diversis* (Merrifield I, No. 312, p. 299), where he recommends grinding on hard slab with gum arabic, and polishing the inscription written with such ink with a burnisher of hard stone. Similar recipes are contained in two 15th-century manuscripts: from the Paris Bibliothèque Nationale de France (Ms. latin 6749b) and from the Cambridge University Library, Call No. Ms II.3.17 (Thompson 1935 b, p. 467), in which ground metal was creamed with egg white with added gum arabic, while the inscription was polished with a dog tooth. As distinct from the above-quoted recipes in this case gold leaf was added to the ink prepared in this way, and the gold leaf was mechanically ground in the horn. This process was meant to refine the ink with an additive of gold, which, however, it was impossible to sufficiently grind. After the inscription was made and it dried, its surface was polished with a tooth in order to obtain an appropriate lustre.

25. Nota ad ponendum aurum super capitalia vel super flores. Tunc accipe cretam et tere in lapide cum claro in prima vice secunda extor[quen]da [?] usque ad tertium clarum. Et recipe crocum et solve in paniculum in eodem claro, quod per diem et noctem iaceat, sed pendere permitte, tunc crocum sume et exprime vires ipsius croci et iterum tempera cum predicto claro, addendo duas vel tres guttas. Et cum imposueris super spacium tale ipsius

Remark how to apply gold to initials and fleuron. Take chalk, grind it on the slab with one egg white, then with another, then with the third until all is ground. Take saffron, and dilute it with the whites in a piece of cloth so that they stay together over a day and night. Then, take the saffron, squeeze the essence of it and dilute it with the whites, adding two or three drops. Put it on parchment surface, so as not to be concerned about it. Then let it

capituli, ita quod non timeat pro pargameno. Tunc exsiccare permitte. Quo exsiccato subtiliter cum cutello rade, ita quod nec macula videatur. Tunc madidando auri folia simul fundamento apponantur imprimendo auri folia cum lana super fundamentum. Quo facto exsiccare permitte et dente aliquo plana. Gummi arabico (!) et aliquantulum de croco, ut aliqua glaucitas appareat, appone et duas mellis donec habebis. Et est firmum, quia probatum est pluries.

dry. After it has dried scrape it gently off with a little knife so that no stain is seen. Then moistening gold leaf put it simultaneously on the gesso, pressing it onto it with wool. Having done this, put it aside to let it dry, and gently smooth it with a tooth. Add gum arabic with a bit of saffron for some yellow to show. And add two drops of honey to obtain the effect. And it will hold, since it has been tested on many occasions.

This is one of the two recipes (the other being No. 57) telling us how to obtain chalk ground tinted with saffron, applied to a leaf with a brush meant for gilding larger parts of miniatures, fleuron elements, and initials 'to be polished'. Initially, chalk was thoroughly ground, three times being added egg white. When being ground, the glaire partially evaporated, this causing the binder to thicken. The similar principle was applied in grinding cinnabar in recipe No. 59. The dye obtained from saffron placed in a piece of cloth extracted directly in the prepared mixture for 24 hours, which was a common procedure at that time (see: *De Clarea* - Baroni 2016b, p. 308; *De arte illuminandi*, No. 27, (Lecoy de la Marche, p. 33); Petrus de S. Audemaro, *De coloribus faciendis* (Merrifield I, No. 165, pp. 131-133); Alcherius, *De coloribus diversis* (Merrifield I, No. 337, p. 312). Having squeezed the little sack with saffron, some water was added to the ground, and it was applied to a leaf with a brush. At the end of the recipe there is a mention of adding the solution of gum arabic tinted with saffron and two drops of honey to the ground in case it did not look sufficiently yellow. Added to the foundation in a limited volume, honey was to play the role of a plasticiser and facilitate moistening of the ground. An excessive

amount of honey in gesso caused the danger the author of the *De arte illuminandi* (Lecoy de la Marche, pp. 20–22) warned against. After it dried, the surface was smoothed with a knife (*cutello*). Although the recipe speaks of moistening the gold leaf before applying it, in practice it was the ground that was moistened or the binder contained in the ground was activated being breathed onto. Following the application the gold was pressed, this time with a piece of wool, and after it dried, it was polished with a tooth to obtain sheen. Two similar recipes, one in Latin and the other in German, are contained in the manuscript by Peder Månssons (f. 74, ‘Facere fundamentum’ and ‘Malgrund machen’ - Johannsen, pp. 38–39).

In two subsequent sources: in the collection of medical and technological recipes from ca 1400 of Czech provenance (Munich, BSB, Call No. Cgm 824 (f. 57v) and a Nuremberg manuscript from ca 1390 (Nuremberg, GNM, Call No. 3227a, f. 74v) there are two recipes of a similar wording derived possibly from the similar common source they shared with the Cracow one. In order to show substantial similarities between the records we have to quote the above-mentioned Munich manuscript in extenso: *Ad ponendum aurum super capitalia vel flores assis sic tempera accipe cretam et tere in lapide cum claro et prima vice et 2a vice exstat da et ad 3am clarum crocum et solue crocum ad panniculum in eodem claro et per noctem vel per diem tende et permitte tunc crocum summe extra claro exprimendo vires ipsius croci et iterum tempera cum predicta creta ad tende duas vel 3 guttas mellis et cum impleberis spacium litere capitales ita eminet pergamenum tunc exsiccari permitte quo ex siccato cultello curialiter rade ita quod nulla macula videatur tunc madendo aurifolio simul ex fundamento ponendo aurum et primendo aurifolium cum lana bona super fundamentum quo facto exsiccare permitte et dentes prius ad hoc preparata polire et videbit splendore perfice et pulchre et optime.*

26. Item si vis habere colorem
brunaticum, tunc accipe
briselium et coque in olla parva

Similarly, if you want to obtain
dark brown, take brazil, boil it
with water in a small pan.

cum aqua. Deinde appone
alumen cum gummi arabico
et examina cum penna in
pargameno. Deinde exprime per
paniculum in unum cornu. Dum
siccabitur, tunc infunde gummi
arabicum.

Subsequently, add alum and
gum arabic, and test it with
a pen on parchment. Strain into
a horn through a piece of cloth.
When it has dried, pour gum
arabic into it.

In this recipe the dye was prepared by boiling wood shavings in clean water, following which alum and a binder (gum arabic) were added. The dye was filtered and placed in a horn. When the paint has dried in the horn it could be re-thinned with a solution of gum arabic. In reality, the paint prepared in this way is not brown, but claret-red. Recipe No. 64 mentions that the more alum is added to the paint, the darker it is: 'nigrior'. Possibly in this case it is not brown that the recipe speaks about, but 'dark brown' (PL: *brunatny*). According to Aleksander Brückner, the term 'brunaticum' defined a 'darkish' colour of a fabric already in the 14th century, this modelled on the old-German 'brunāt' (Brückner, s. 42). It may have emerged in Poland from Latin. If correctly, dark brown colour should be transcribed as 'brunus' (Du Cange, Vol. 1, col. 761a). However, the authors of mediaeval technological treatises provided recipes saying how to prepare paints from specific pigments or dyes, while a more detailed definition of the obtained colour was more challenging to them. The author of the *Liber de coloribus illuminatorum sive pictorum*, who was of the opinion that brazilwood was more appropriate for dyeing fabrics than for painting, also stated that *brunum quidam color est mortuus, nec niger nec rubeus* (Thompson 1926, p. 296). There is only one recipe telling us how to prepare brown from brazil: *De Colore Bruneo* contained in the manuscript dated from 1464–1473 from the Tegernsee Abbey, Call No. Clm 20174, (Munich, BSB, f. 202r), however, based on a totally different procedure. The only source containing recipes of the kind, and encompassing the word 'brunaticum' in the context of preparing a dye from brazilwood is the 15th-century Czech-German manuscript (Praha, NK

ČR, Cod. VI. F. 19 Ms. 2045, f. 21v) in which we come across the 'De presilio colore' recipe. In other collections that could have served as the model for the Cracow recipe no such recipe has been found.

27. Fundamentum auri. Accipe cretam et tere in lapide cum aqua. Deinde pone fumitraces ad cretam tritam et tempera cum bitumine tenui.	Foundation for gold: take chalk and grind it with water on the slab. Subsequently add soot to the ground chalk, and mix it with a weak adhesive.
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It is one of three recipes how to prepare ground for gold containing soot as an ingredient (Nos. 32, 33), and one of six recipes for grey grounds (Nos. 29, 30, 46). It was made from chalk, thoroughly ground with water, to which soot was added, and it was mixed with a weak adhesive. In this respect the not specifically defined *bitumine* may denote hide glue or, as it is specified in some recipes, that made from sturgeon bladder (*Liber Illuministarium*: Bartl *et al.*, No. 282, p. 194). The term *fundamentum* in the meaning of gilding ground appears exclusively in German sources (Nuremberg, GNM, 3227a, f. 93r; Munich, BSB, Cgm 822, source: <https://artechnie.uu.nl/node/86169>; *Liber illuministarum* (Bartl *et al.*, p. 786)). In French, Italian, and English it is more the terms *assis* (*assisa*) (*De arte illuminandi* - Lecoy de la Marche, p. 20) or *scisa* that are used (Bologna manuscript- Merrifield II, pp. 471-474). The lack of analogical recipes in Italian or French treatises shows that the recipes to obtain *griseum fundamentum* are characteristic of the region covering Germany, Austria, and the countries of Central Europe.

Recipes containing similar ingredients can also be found in the *Liber Illuministarum* (Bartl *et al.*, No. 195, p. 150, No. 1026, p. 310). In one of the recipes in the manuscript with the collection of recipes from the Munich Bayerische Staatsbibliothek, Call No. Cgm 824, (f. 57r) from ca 1400 to make chalk ground the additive is *tenuo bitumine*, similarly as in the Cracow, exceptionally succinct recipe.

The tradition of making grounds in cool shades existed in Poland still in the 16th century. Marcin Siennik in his herbal (p. 585)

gives a recipe as brief as the discussed one: *To też grundt czarny pod złoto: Weźmi sadz Lampowych / abo inych subtylnych / a rozmaćwszy z woda / w kthorey sie Gumi rozeszło / na to pisanie złoto kładź.* (This is also blackground for under gold: Take loot from a lamp/ or others/ and having mixed it with water/ with gum dissolved in it/ put gold on this writing).

28. Item fac farnisium. Accipe oleum lini et coque et cum separabis, accipe picem silvestrem et comisce simul. Et fac bulire bene.

Similarly make varnish (lacquer). Take linseed oil and boil it. When you take it off the stove, take forest resin and mix it together. Then boil it thoroughly.

According to Du Cange (vol. 3, p. Col. 441b) *fernisium* is a glutinous fluid composition which was applied on wood to make it glossy and to conserve it. It is thus any varnish, regardless of its composition, which serves to protect and give the finishing touch to wooden surfaces. The German terms : *fornis*, *firniss* come from Latin *vernix*, and were Latinized to *fernisium*, *firnisium* lub *farnisium*. Theophilus gives the recipe to prepare *Gluten Vernition* in which linseed is mixed with *gummi fornis quod Romane glassa dicitur*, namely with sandarac (*Theophil*, pp. 24, 66; also: *Mappae clavicula*, No. 98). Another additive to the oil could be mastic or amber (Bartl *et al.*, No. 101, p. 111, No. 317, p. 213; Johannsen, p. 40). However, the names *firnisium*, *fernisium*, *vernisium* hide various compositions, also serving as lacquers or protective substances applicable to various surfaces and boasting different properties. They were not based on linseed oil only, but could also be made using substances soluble in water. Such *firnis* serving to cover the paint layer on parchment or board could be made with albumen, gum arabic, and honey (Bartl *et al.*, p. 231, No. 345) using sour cherry gum as the base (Bartl *et al.*, p. 231, No. 1224a). Even in the Cracow treatise in recipe No. 39 concerning gilding glass minium was mixed with *farnizium* (*fernizium*), following which gum arabic was added. In this latter case the lacquer had to be based on components soluble in water, or otherwise it



FIG. 2. Black ground visible in goldened areas in the hand-written *Hieronymianum hoc opus per Johannem Andraee urgente deuotione compositum*, ca. 1400, BUWr IF 128.

Source: <https://bibliotekacyfrowa.pl/publication/21193> (2024.11.19)

would not combine with the water solution of gum arabic. Thus it is a recipe to prepare lacquer composed of linseed oil varnish and conifer resin or rosin, namely a classical preparation for centuries used in crafts dealing with wood processing. Recipes using rosin can be found in the manuscript *Secreti diversi* from the Biblioteca Marciana in Venice, Call No. IT.III.10, (Merrifield II, Nos, 399, 402, pp. 631–633), in the latter case with mastic resin added.

29. Item si vis cum auro scribere, recipe lignum tilie et comburre bene et postea tere carbones cum arabico et fac arabicum de bitumine cerusarum [merusarum]. Et appone acetum et post hoc laxa et post appone de creta. Et tunc scribere quid vis et postquam siccabitur, tunc appone tabulam auri cum bombice et polluas.

Similarly if you want to write with gold, take linden wood, and burn it thoroughly, and then grind the charcoal produced with gum arabic. Make this gum from sour cherry resin. Then add vinegar, dilute it, and add chalk. Then write what you want. After it dries apply gold with a silk swab, and smooth it out.

This is another recipe telling us how to make grey ground for polished gilding on parchment. In two cases (the discussed recipe and No. 30) charcoal of linden wood was used with added chalk. In the discussed recipe charcoal was ground with a solution of sour cherry gum, following which vinegar and chalk were added. Having applied gesso to a leaf and after it dried, gold was applied (the gum binder may have been activated by breathing onto it), and it was pressed with a piece of silk fabric. The gilding was polished with a burnisher.

This recipe to obtain rarely-used grey ground testifies to the tendency to apply local materials, hence the replacing of gum arabic with the generally available sour cherry gum. The linden tree charcoal (*Tilia platyphyllos* L. or *Tilia cordata* Mill.) is also a genuine ingredient of ground applied quite rarely. It is used in two recipes to make ground in the *Liber illuministarum* from the Tegernsee Abbey (Bartl *et al.*, No. 1059, 1060, pp. 320–323), albeit of a different composition.

The gum (*gummi cerusarum*) obtained mainly from the sour cherry tree (*Prunus cerasus* L.) was often used as a binder for paints (Theophil, No. XXVII, p. 34; *Compendium artis picturae* (Silvestre, p. 132)), as a lacquer ingredient (*Mappae Clavicula*, Nos. 246, 247, p. 54) or as leather lacquer (Bartl *et al.*, p. 588). There are several recipes known to prepare sour cherry gum, sometimes defined as artificial. They come mainly from German sources, e.g., from the Munich manuscript, Call No. Cgm 824, (Munich, BSB, f. 58v), from a Strasbourg manuscript (Berger, No. 50, p. 165), or from the *Liber illuministarum* (Bartl *et al.*, pp. 76–77, No. 41). The author of the discussed recipe added another name next to the ‘de bitumine cerusarum’ gum: ‘merusarum’, the latter found only in the *Liber illuministarum* (Bartl *et al.*, p. 430, Nos. 472–474) in recipes for sour cherry preserves.

30. Item si vis bene aurum
apponere tunc recipe tilie
carbones, quos diligenter

Similarly if you want to apply
gold well, take linden tree
charcoal, grind it carefully,

contere et appone modicum de creta, ut predicatur, confectum recipe tilie carbones facies sicque scribere, quod igitur color nec multum albus nec niger appareat, sed quasi griseus cognescatur; pluries autem illud facies, gummi laxabis et tunc de penna procedat et mitte modicum de puro liquore mellis sed valde modicum. Sic quod feceris, scribe eodem confectu, quid vip. Postquam siccabitur, tunc desuper pone aurum sive argentum. Quo posito paulatim desuper bombice vel panniculo sericeo tege, ita quod confectus ille aurum capere possit. Post modicum vero tempus dente porcino polluat. Et quantum magis potes et diucius, tanto magis elucescat.

In the original text the recipe was not separated with a red line from the previous one, but at its beginning the rubricator placed only a small *capitulum* mark. He may have signalled in this way that he associated the two on the content level, and that they constituted two variants of the procedure. In the discussed recipe, as distinct from the one above it, there is no vinegar, and the type of gum as a binder is not specified. The new component is honey, meant to serve as a plasticiser thanks to its hygroscopic properties, while at the same time activating the binder after the ground dried in order to effectively adhere gold leaf. The mixture was to be used for writing with a pen, so its consistency could be modified for it to appropriately flow off the pen. After metal leaf was adhered and dried, the gilt was polished with a pig tooth. The burnisher made of the tooth of that animal is mentioned only in the Bologna man-

add some chalk, as described. Make charcoal of it, and write with paint so that the colour is neither too light nor too dark, but looking grey. Each time you do it, dilute it with gum, so that it flows off the pen. Add liquid honey bit by bit, but very little. When you have done it, write what you want with this mixture. After it has dried, apply gold or silver to it. After application dry slowly with the use of a silk swab or a silver cloth so that the gold can adhere to the ground. After some time smooth it with a pig tooth. And the more and longer you smooth it, the brighter it will shine.



FIG. 3. Gray ground visible on the sides of goldings in the hand-written *Summa de casibus consciencie (Summa Pisana)*, 1377 r., BUWr II F 75, f. 1r.
Source: <https://bibliotekacyfrowa.pl/publication/21193> (2024.11.19)

uscript (Merrifield II, No. 177, p. 477) where a recipe is provided for making gilt on the ground of grated ceramic vessels using parchment glue as a binder.

31. Item si vis cum auro de penna scribere in modo faciliori, accipe pomum silvestre [dzikie jabłka] et exprime succum eius et divide super duo vel tria folia auri vel argenti thabulati. Et pone succum predictum et mitte stare sic, quousque dissolvetur in succo. Et scribe, quid tibi placuerit. Et deinde polluas etc.

Similarly, when you want to write with gold in an easier way, take a forest apple, and press it for juice, while divide gold and silver leaf into two or three portions. Pour the juice over them and leave them to dissolve. And write whatever you want. And then smooth it. Etc.

Two recipes: the discussed one and No. 47, concern making golden ink for writing purposes. In this case, gold or silver leaf was to be dissolved with apple juice. The name *pomus silvestris* hides the fruit of the forest silver tree (*Malus sylvestris* L.). In German recipes mainly leaves and bark of the forest apple tree were applied when dyeing hides and yarn yellow (bark) and red (leaves) (Bartl *et al.*, p. 681). Bark was also used for dyeing feathers (*Vier puchlin von allerhand farben vnnd anndern kunnsten*, Berlin, SBB, Germ. Quart. 417, f. 73r). Apples providing acid were enumerated in the *Liber Illuministarum* (Bartl *et al.*, p. 397, No. 1260) and the Munich recipe book, Call No. Cgm 824, (f. 67r-v) in the context of dyeing objects yellow with the additive of saffron (Bartl *et al.*, p. 395). Apple juice is also mentioned in the recipe speaking of removing ink from a leaf: ‘Item ad delendas litteras de Carta’ in the manuscript from the Tegernsee Abbey from 1464-1473 (Munich, BSB, Clm 20174, f. 254r). However, there are no recipes speaking in such an unequivocal way about using the juice of forest apples to create golden ink as in the two discussed recipes from the *Ars de omnibus coloribus*.

From a chemical point of view such a reaction is infeasible. Both gold and silver are chemically resistant, and do not react with acids, particularly weak organic ones. In such a situation both recipes can be interpreted in two ways:

1. In the first let us consider the wording as full and read it literally. With such an assumption, the recipe does not speak of dissolving these noble metals, but of dissolving the additional components of the metal ores. In mediaeval Poland two kinds of gold leaf were produced: ‘feingold’ obtained from 23 K metal and that of a lower quality, with a silver layer strengthening the gold, called ‘cwiszgold’. However, in practice gold leaf could have a lower content of the noble metal in an alloy with copper. When in contact with acids under oxidizing conditions, copper undergoes digestion. In this case the leaf made of an alloy of gold with copper, placed in acid, can disintegrate thanks to the reaction of the acid with copper, forming a suspension of

gold molecules. Why is, however, the juice of forest apples recommended here as the source of acid, and not ordinary vinegar used in many other recipes? The reasons possibly being the colour side effect of the reaction of copper with acid. Copper malate $C_4H_6CuO_5$ is a much lighter salt than the green-blue copper acetate $Cu(CH_3COO)_2$ which would have a substantial impact on the colouring of the golden ink. The binder of the molecules in this ink can be found in the pectines and sugars contained in the juice.

However, we find an analogical recipe to obtain gold ink 'Ad scribendum aurum cum callamo' in the Bologna manuscript (Merrifield II, No. 158, p. 467), where actually the copper from the alloy with gold is digested resorting to a different reaction: with the use of cinnabar water, saltpetre, and common salt. Although the applied ingredients cause a different reaction, the reached effect could be just the same.

2. In the second interpretation of the recipe it should be assumed that the description passed over the grinding of the gold stage, although the statement 'quousque dissolvetur in succo' questions this interpretation. There are, however, known records in which in a similar procedure gold leaf is ground in order to obtain powder. One of them is a recipe contained in the manuscript from the first half of the 15th century from the Tegernsee Abbey (Munich, BSB, Cgm 822, ff. 7–8 b): *Ad aurum. Si vis temperare aurum accipe aurum percussum et pone in acetum et mitte ibi stare per vnum diem et noctem et tere in lapide et accipe gummi arabicum et funde aqua de gummi super aurum et tunc scribe et cum siccatum fuerit purga cum dente Lupino* (source: <https://artechne.hum.uu.nl/node/86167>), where gold leaf was placed in vinegar for 24 hours, following which it was ground on the slab, and after the gum was added, it was used as ink. Recipes of similar formulas are also contained in two other manuscripts: a codex of Czech provenance, Call No. Cgm 824, (Munich, BSB, f. 57r) and the Bavarian manuscript from ca 1390 (Nuremberg, GNM, Call No 3227a, f. 93r). It is likely that pro-

longed soaking of high-quality gold leaf in vinegar was aimed at removing additional metals, however, not causing disintegration into small particles, that is why additional gold grinding was necessary.

32. Item fundamentum ad ponendum aurum vel argentum. Et paratur sic. Capiatur creta et teratur [sic] in lapide. Deinde infundatur bitumen pargameni tenue in aqua permissum. Deinde imponantur fumitraces et teratur hoc totum bene. Deinde ponatur czucrum candi. Et postea depone de lapide et impone in cornu. Et calescit aqua calida in olla. Et sic scribe, quid vis, et polluas bene.

Similarly ground for applying gold or silver is prepared. ~~And you prepare it like this.~~ Take chalk and grind it on the slab. Then pour weak parchment glue dissolved in water into it. Following that add soot, and grind everything thoroughly. After that add candied sugar. Then take all from the slab, place it in a horn, and heat with hot water in a pan. Then write whatever you want, smoothing well.

This is the second of the three recipes to make grey ground for gold or silver (Nos. 27, 33) with some soot added. In treatises and recipe collections the majority of recipes concern making white ground or in warm colours with the use of plaster, chalk, or ceruse with the additive of Armenian bole, saffron, aloe, or fine-grained pigments: ochre, cinnabar, minium, or carmine. Preferable materials were fine-structured, not containing impurities, such as e.g., quartz, as the majority of earth pigments do. Such unwanted particles could contribute to creating flaws and scratches on the gilt surface during the polishing. Amorphous soot is one of homogeneous materials. However, the ground colour affects the shade of the thin metal layer. That is why when gilding with gold, the general preference was for warm-coloured grounds emphasizing its shade, while white, black, and grey ones seemed ideal for gilding with silver (Bartl *et al.*, p. 509).

In the discussed recipe, a thin solution of parchment glue and soot was added to well-ground chalk, and all the components were

ground once again. Candied sugar was added to the gesso, and it was put into a horn. Owing to the contained parchment glue the ground had to be heated during writing or painting. After it dried, and prior to applying gold, the ground was smoothed. A similar composition of ground can be found in the recipe for the ‘Fundamentum Gotuicense’ contained in the *Liber Illuministarum* (Bartl *et al.*, No. 282, p. 194), which came from the Benedictine Abbey in Göttweig in Lower Austria. In it the binder used was *bitumen de vesica esocum wlgariter mundleim*, namely glue from sturgeon bladder; meanwhile, in another recipe found in the *Liber Illuministarum* to make grey ground (Bartl *et al.*, No. 195, p. 150) parchment glue was used, just like in the Cracow recipe. Although different binders were applied, such as gum arabic, *serapinum* gum, or white of egg, it was only when glutin glues were used (parchment, isinglass, fish) it required being heated to keep it fluid. Therefore, the discussed recipe contains the remark about heating the ground with hot water in a pan. In order to omit an additional activity, sometimes bad glaire or partly spoiled glue were used, since at this stage they had lost the gelating property at room temperature. In one of the recipes from the *Liber Illuministarum* (Bartl *et al.*, No. 1026, p. 310) *bitumine putrefacto* was applied: putrid glue whose adhesion with increased fluidity was, nevertheless, sufficient for gilding.

33. Alia informacio ad fundamentum. Et temperatur taliter: capiatur creta combusta et teratur in lapide. Deinde imponatur ad fumitraces et temperatur cum claro mundo. Et scribe, quid voluerip. Et appone aureum vel argentum folium desuper, quod debet poni super lapidem planum vel lignum. Et pollue dente bono. Et quanto est diucior, tanto est lucidior. Probatum est ect.

Another recipe for foundation. This is how you make it: take burnt chalk and grind it on the slab. Then add soot and mix it with pure white of egg. And write whatever you want. Apply gold or silver leaf to it. Make it on even stone or wood. Afterwards, smooth it carefully with a tooth. The longer you do it, the more it will shine. It has been tested. Etc.

This is the third recipe to make grey ground for gold or silver (next to Nos. 27, 32) with added soot, serving for writing. However, as distinct from the two above ones, in this case ground burnt chalk was used, thus quicklime, which were mixed with soot and glaire. In the two previous recipes the binder was animal glue. After applying gold the decoration was polished with a tooth on a hard smooth stone or wooden foundation. The latter detail: to polish gild on a hard foundation, as much as it looks obvious, had not been previously emphasized in other recipes from the Cracow collection. The need to put a smooth plank under the leaf in the course of this action is mentioned in various sources based on tested practical knowledge, e.g., *De arte illuminandi* (Lecoy de la Marche, No. 15, p. 24), as well as by Cennino Cennini in his Treatise (*In che modo dèi miniare e mettere d'oro in carta* - Cennini CLVII, p. 109).

The *creta combusta*, namely quicklime (CaO), mentioned in the recipe, creating slaked lime with water (in this case the egg white) is mentioned only twice in the context of gilding ground in the recipes contained in the *Liber Illuministarum* (Bartl *et al.*, No. 33, p. 72, No. 200, p. 296). In that case, however, the recipes speak of warm-coloured ground with added ochre or saffron, or Armenian bole.

34. Ad scribendas litteras aureas, argenteas vel cupreas recipe pomice et tere bene / et fortiter in lapide cum aqua. Et postea mitte exsiccare. Et iterum tere bene et admisce gummi et scribe. Et mitte exsicari. Et tunc quocumque metallo tergas sive auro, sive argento, talis erit semper scriptura.

In order to write golden, silver, or copper letters, take pumice, grind it thoroughly and hard with water on the slab. Leave it to dry. Grind it again thoroughly, add gum, and write. Leave it to dry. And then whatever metal you rub it with, gold or silver, the inscription will be of that same colour.

In the collection it is the second of four recipes describing the method of obtaining an inscription or an initial on a metal surface (Nos. 17, 43, 55) thanks to the use of light abrasive material allowing to apply a metallic layer on the inscription surface through rub-

bing the dried layer of ‘ink’ with a metal object. The recipe is close to No. 43, however, it differs in the material used. Instead of pulverized crystal, the material used here is ground pumice (like in recipes Nos. 17 and 55), while the binder applied is the solution of gum arabic, and not glaire as in the remaining recipes. A similar formula can be found in the 14th-century French *Tractatus qualiter quilibet artificialis color fieri possit* (Thompson 1935b, p. 467), where, however, egg white is used instead of gum.

35. Si vis scribere flores aureos vel argenteos, tunc recipe cerusa et bleues bleuueiip. Et tere in lapide cum gummi arabico permissum in aqua munda. Deinde imponatur czucrum candi et armoniacum et tere hoc totum simul parvum tempup. Et pone in unam testam et scribe, quid vip. Et appone argentum vel aurum cum bombice, emittendo flatum super fundamentum. Et nota. Ubicumque czucrum candi imponitur, ibi superdens (!) flatum emittere de ore, quia tunc fundamentum mollificatur. Etc.

If you want to write gold or silver flowers, take ceruse and blue flowers [?]. And grind them on the slab with gum arabic mixed in pure water. Then add candied sugar and sal ammoniac and grind it all briefly. Put it in a vessel and paint what you want. Then apply silver or gold with a silk swab, breathing onto the ground. Note that wherever candied sugar is applied, there you have to breathe onto the ground to soften it.

This recipe tells us how to make blue-coloured ground under gold or silver leaf. Prepared from ceruse, possibly with added juice of cornflower, ground on the slab with gum arabic, candied sugar, and sal ammoniac, it was meant to be applied with a brush. The strangely defined ingredient: *bleues bleuueiis*, whose transcription may have been a scribe’s error, is most likely a pigment extract of cornflowers. These flowers are defined as *flores blauos* (see: recipe No. 14, *Mappae Clavicula* p. 187; Petrus de P. Audemaro, Merrifield I, No. 171, pp. 136–137), in the French version as ‘bleues’ (Alcherius - *De diversis coloribus*, Merrifield I, No. 314, p. 299), or as *Bleu bleuet*, which may point to the French source of the discussed recipe. Cornflower juice is most

often either mixed with ceruse or applied to a surface covered with ceruse (see: recipe No. 14). The juice without additives is navy-blue, while adding white lightens this hue. The addition of candied sugar and sal ammoniac secures hygroscopicity of the ground for gilding. The salmiac of slightly acidic reaction was able to change the colour of the cornflowers towards shades of purple. *Sal armoniacum* appears in many recipes for gilding grounds, e.g., in two manuscripts from the Bavarian Tegernsee Abbey: in the *Liber Illuministarum* (Bartl *et al.*, No. 9, p. 60, No. 279, p. 192), and in the recipe collection from the Tegernsee Abbey from the first half of the 15th century (Munich, BSB, Call No. Cgm 822, source: <https://artechne.hum.uu.nl/node/86186>), both from the Munich Bayerische Staatsbibliothek, and in the manuscript *Ain gar schones unnd vast nutzliches handbuechlin von allerlaye farbenn De Coloribus. Von den Farbenn- Von den Farben aus der federn zu schreyben* from the mid-16th century (Heidelberg, UB, Cod. Pal. Germ. 489, f. 21v-22r). Sal ammoniac is also mentioned in recipes as an additive to gold leaf binder (Jean de Bègue, *Experimenta de coloribus* (Merrifield I, No. 18, p. 55; No. 24, p. 59); *Il Liber colorum secundum magistrum Bernardum ...* (Travaglio 2008, p. 124); *De arte illuminadi* (Lecoy de la Marche, No. 31, p. 37).

At the end of the recipe the way of applying gold or silver leaf is pointed to. Thanks to hygroscopicity of the ingredients the binder could be easily activated: gum arabic through breathing onto it, thanks to which gold applied with the use of silk fabric was stuck to the primed surface. In recipes sugar was often replaced with honey. After it dried, the gilt layer could be polished, which the recipe author does not mention, yet which is mentioned in analogical records.

36. Si vis cum auro scribere, accipe iecur agni et totidem de sale et impone ad vitrum. Et pone in humidum locum. Et mitte stare tamdiu, donec erit aqua. Deinde accipe clarum et aurum et misce simul. Et scribe, quidcumque vip. Et apparebit totum aurum [item].

If you want to write with gold, take lamb liver, add salt to it, put into a glass vessel, and put it aside in a humid place. Leave it until it releases water. Then take glair and gold, and mix them together. And write whatever you want, and it will all look like gold.

The use of lamb liver secretion when preparing gold ink is a genuine solution as seen against other mediaeval recipes from the majority of the known treatises and manuscripts containing collections of recipes of the type. To-date only two similar recipes have been found; although differing in detail from the discussed one, they undoubtedly come from a similar group of recipes. One of them is found in the above-quoted manuscript of Czech provenance kept at the Bayerische Staatsbibliothek in Munich, Call No. Cgm 824, (f. 57r). It needs to be quoted at full length so as to demonstrate the likeness between the two records: *Si vis alter scribere aurum de penna accipe iecur Hirçy et tantum de sale et tere simul et fac ad vitrum quod habet artum collum et pone ad locum donec in aqua conuertur et cola per pannum cum aur[o] et misce cum claro et scribe.* The second, slightly different from the first one, is found in the Bavarian manuscript from around 1390 (Nuremberg, GNM, Call No. 3227a, f. 93r).

Both the discussed recipe and the German ones describe the same procedure with a similar language, though they essentially differ in the source for the animal liver. In here it is 'lamb', while the German manuscripts speak of 'deer'. Although the animal species differ, both rank among ruminants. The secretion obtained in this way is mainly bile, whose extraction was boosted with salt. The liver was put aside in a glass vessel at a humid place to prevent the fluid from evaporating. Bile obtained in such a way was mixed with ground gold, and glair was added as a binder.

'Gold inks' prepared with powdered gold or its imitation were very often based on bile as an additive. In many recipes contained in the *Mappae Clavicula* for making writing ink in gold an additive of bile of different animal species was included. The bile used included that of mixed kid and beef (*Mappae Clavicula*, No. 6, p. 14), pig and fox (No. 8, p. 15), vulture (11, 12, p. 15), turtle (No. 43, 46, p. 35), and fish (Nos. 68, p. 37). This variety may have resulted from peculiar properties of bile of respective animals, and from the alchemical and medical knowledge and experience. Most frequently, however, it was beef bile with gum arabic as a binder that were used for

producing gold inks: Heraclius, VII, *De aurea scriptura* (Merrifield I, p. 191); Alcherius, *De diversis coloribus* (Merrifield I, p. 310, No. 336); *Mappae Clavicula*, (No. 249, p. 54), yet equally often fish bile (Heraclius, XV, *De colore auripigmento simili* (Merrifield I, I, p.199); the Strasbourg manuscript (Berger, p. 157); *Tractatus Qualiter Quilibet Artificialis Color Fieri Possit* from the 14th century (Thompson 1935b, p. 466). The discussed recipe is the only one known mentioning lamb bile.

37. Item si vis grispon temperare, accipe et terre cum aceto in lapide tamdiu, donec fiat mollis et mitte stare bonam horam. Et tere crocum et infunde ad grispon sine aqua. Tunc temperutum clarum et infunde. Etc.

Similarly, if you want to prepare verdigris, take verdigris and grind it with vinegar on the slab until it all becomes soft. Put it aside for an hour. Grind saffron, and add it to the verdigris with no water. Beat egg white and pour it in. Etc.

Similarly as in recipes Nos. 4 and 10, and possibly 11, the pigment was ground with some vinegar added. The recipe mentions putting the mixture aside for an hour: supposedly sufficient time for the verdigris to dissolve in the vinegar. Following this, ground saffron was added with white of egg as a binder. We find a similar recipe again in the Munich manuscript, Call No. 824, (Munich, BSB, f. 12r). Recipes Nos. 10, 11, 12, and the discussed one reveal affiliation to the recipes contained in the mentioned manuscript.

38. Si vis briselium temperare, accipe lignum briselii et scinde ad hastulas et coquas in aceto bono vel vino, tamdiu donec videbis ruffum colorem. Tunc mitte infrigidari et tempera cum trito alumine.

If you want to prepare brazil, take brazilwood, cut it into long pieces, and boil in good vinegar or wine until you see red. Then put it aside to cool, and mix with ground alum.

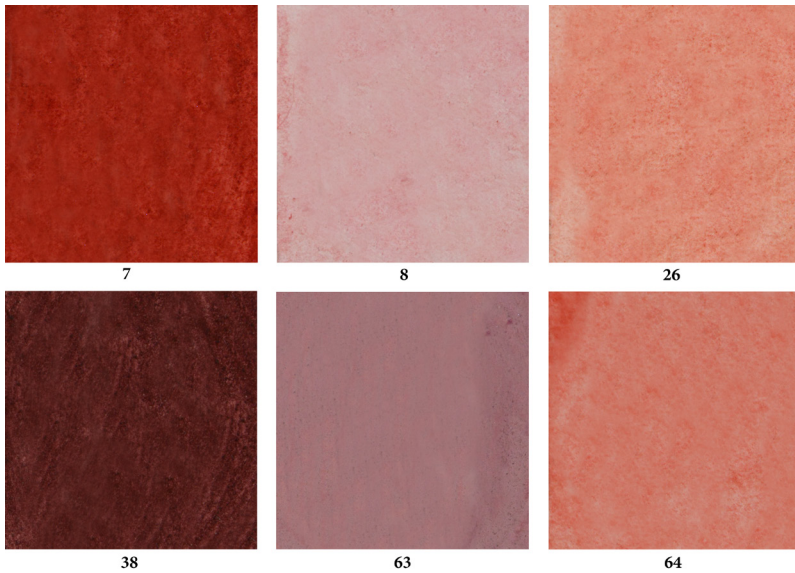


FIG. 4. Reconstruction of recipes 7, 8, 26, 38, 63, 64 making use of brazil.

Photo by Jacek Tomaszewski.

This is the only recipe in the whole collection to prepare a dye from brazil with the use of acid substances. In the remaining recipes the dye was obtained in solutions of neutral or alkalic reaction. In this one, wood shavings were boiled in vinegar or wine, and after the liquid cooled down, alum was added. At the same time, the author does not specify if it was supposed to be red or white wine, although the phrasing ‘tamdiu donec videbis ruffum colorem’ suggests light-colour liquid. In this way a transparent claret-brown dye was obtained. The use of vinegar or wine was relatively rarely mentioned in the recipes. We find them in the Bologna manuscript (Merrifield II, No. 133, pp. 450–453) where alum and gum arabic were added to the dye being boiled; in the treatise contained in the manuscript by Johann Boloniensis (Copenhagen, KB.DK, Call No. Gl.Kgl.S.1656, f. 170r; Thorndike 1959, p. 17), where apart from wine there is also mention of urine; or in the *Liber Illuministarum* (Bartl *et al.*, p. 146).

39. Si vis aurum ponere super vitrum, recipe minium et terge bene. Et postquam tritum fuerit, tunc infunde farnizium [farnizium] vel loco farnisii [fernesy] firmum acetum. Et fac stare poi noctem. Et cras surgens, effunde et relaxa cum gummi arabico et scribe in vitro. Cum siccabitur, exsuffla et appone aurum vel argentum mediante bombice.

If you want to put gold on glass take minium and grind it thoroughly. Once ground, add lacquer or potent vinegar instead. Then leave it for the night. On the following morning, having got up, strain it and mix with gum arabic, and write on glass. Once it has dried, breathe onto it, and apply gold or silver with a silk swab.

Two further recipes deal with gilding glass and glass vessels, which has to be ranked among methods of cold painting on glass. Both recipes, however, cause difficulties with the interpretation of some ingredients used in gilding. In this case glass was gilded with ground made of minium mixed with gum arabic. Gold was adhered to an almost dried ground and pressed with a silk swab. Although the stage of gilding as such is clear, and does not arouse any doubts, the above-mentioned *farnizium* term is not unambiguous. The word appears on three occasions in the treatise. For the first time it is in recipe No. 28 concerning the preparation of *farnisium* using linseed oil and colophony as its base. In recipe No. 40 we also have to do with *oleo lini farnisii*. In the discussed recipe the binder for the layer of gold is a solution of gum arabic, while ground minium is initially mixed precisely with *farnizium* or strong vinegar. As was noted while speaking about recipe No. 28, the name *farnisium*, *fernisium* can denominate various compositions also created on the basis of substances dissolved in water. Such a lacquer could have had egg white, gum arabic, sour cherry gum, or glutin glue as its basis. In this case the *farnizium* had to be based on water-soluble ingredients, or otherwise it could not have been replaced with vinegar or it would have been impossible to later combine it with a water solution of gum arabic. However, the recipe's author did not leave us any suggestions as for the actual nature of this

component, while infrequent analogical recipes do not facilitate a full explanation of this issue.

The methods of painting and dyeing glass were to a greater degree described by Theophilus and Heraclius. The latter described gilding of glass vases (*De coloribus et artibus romanorum* (Merrifield I, No. 5, pp. 187-189), where gum was used as a binder, however, a permanent binding of gold with glass occurred only after the vessel had been fired at a very high temperature. Two further gilding recipes on glass with water-soluble binders were provided by the *Liber illuministarum* (Bartl *et al.*, No. 199, p. 152) and a brief treatise *De Fenestris*, contained in the manuscript *Thesaurus pauperum* kept at the Bodleian Library, Call No. mp. Canonici Misc. 128, (Travaglio 2012, p. 608). In the first case gold was put on the solution of gum arabic with sugar, while in the second on euphorbia sap or figs.

The discussed recipe differs, however, from the above-mentioned records first of all through the use of red ground below the layer of gold.

40. Item aliter sic. Si vis aurum ponere super vitrum, accipe minium et tere in lapide cum oleo lini farnisii. Deinde impone cum [~~de tantareo~~] detaurino motam [motan] et tere simul. Sed quanto magis conteras, eo melius valet. Et sic scribe pulcre super vitrum. Deinde mitte exsiccari in sole per unum diem, ubi est calor magnus. Si non, tunc per duos dies, sic quod nullus pulver desuper cadet. Deinde appone aurum vel argentum cum forpice vel bombice. Et mitte iterum exsiccari [per] in sole per septimanam vel per duas, non compulsive, quia non valet circa ignem, nec in stupa, sed solum

The same differently. If you want to apply gold to glass, take minium and grind it on the slab with boiled linseed oil. Then add detaurino motam [?] and grind together. The stronger you grind, the better it will be. And so write beautifully on glass. Then leave it to dry in the sun; at a hot place for a day, at a different one for two days, so that it does not catch dust. Following this apply gold or silver with tweezers or a silk swab. And once again put it aside for a week or two to dry in the sun, not too strong, so leaving it by the fire in a chamber will not be effective, only at a sunny spot. And make sure you get the right

in sole. Et nota quod instancie sunt iste, quod oleum lini quanto est antiquius, tanto meliup. Et quanto magis tenue poteris apponere super, tanto magis valet. Precipue hoc maxime debes precustodire, quod non apponas spisse. Et si detaurinum non potes habere, tunc labora solum cum oleo antiquo. Et eodem modo similiter posses apponere super ciphum ligneum vel amphoram.

ingredients, since linseed oil gets better the older it grows. And the finer the application, the more durable it will be. This is something you have to be particularly careful about, so as not to apply it thickly. However, if you cannot have detaurinum [?], work only with old oil. This is exactly the way you can apply gold to a mug or jug.

In this case glass was gilded on *farnisium* on the basis of linseed oil with some added minium, serving as oil drying agents, and a complementing ingredient of not unequivocal character. The ingredients were ground, following which such-prepared varnish was applied to glass. The varnish based on linseed oil as the main ingredient, had to be exposed to the operation of sunrays, in the effect of which it partially polymerized, turning more viscous. Gold or silver was adhered after two days to a thin membrane of sticky varnish called *odlip* on the glass surface, and was pressed with a silk swab. Following this the vessel was exposed to sunshine again, this time for 1-2 weeks. The author of the recipe emphasizes at the same time that leaving the vessel to dry by the fire or in a *stupa* would not be equally effective.

What is noteworthy in the text is the name of the room: *stupa*. The name comes from the Old-German *stuba* denominating a separate building serving as a bath house (Du Cange, vol. 7, col. 618a.). In a broader meaning of mediaeval Latin in Poland it meant a chamber, room, as well as a bath house (SŁŚwP, vol. VIII fasc. 10, col. 1481). In such a space often used in old Poland there was a stove serving to heat water and create steam. There was usually quite high temperature there, but also high humidity. The recipe's author, familiar with the properties of linseed oil, was aware of the fact that in the course of polymerization of linseed oil it was not the heat, but light

and air that played the role, while high humidity in a bath house or in a similar room could slow down the process.

The discussed recipe for gilding on glass also hides an unclear definition of the ingredients. In this case gold was to be applied to the undercoat with minium ground with linseed oil varnish defined as *farnisium*, exactly as above. The ground mixture was later added the substance identified by Maria Kowalczyk as *detaurino motam* [*motan*] and difficult to interpret. The recipe's author had a problem with its name, since initially he wrote it down as *detantareo*, to later cross it out. It is one of the two crossings out in the whole treatise, which as a rule was written down with no errors. The word *detaurino* can be associated with *fel taurinum*, namely beef bile, or with *taurino pinguedine*: beef hide glue (Heraclius - Merrifield I, p. 191; *Liber de coloribus illuminatorum ...* - Thompson 1926, p. 304). The two substances connected with the word *taurus* appear in technological-painting treatises. However, both beef bile and gluten glue have no application in combination with linseed oil, since water solutions of those substances do not combine with fats. Beef bile might only emulsify oil, which in practice does not improve the properties of the *oleo lini farnisii*. Also, the author's remark purposefully formulated in the final part of the recipe speaking of the varnish components is important: *Et si detaurinum non potes habere*, this suggesting that the unidentified ingredient was not readily available, as distinct from a regular glue or beef bile.

The analysis of other recipes to make 'firnizium' shows that the main additives to linseed oil were resins: sandarac or mastic (Cennini), colophony (*pix Greca*), and amber in German recipes. In the recipe found in the Bologna manuscript (Merrifield II, No. 207, pp. 489-491), in which similarly as here minium appeared, also incense was added. Turpentine could be another ingredient of oil varnishes. Mentioned as *trementina*, *terebentine*, or *terebintum*, it was added to gold lacquers (*Mappae Clavicula*, Nos. 246, 247, pp. 53-54) or varnishes (*Liber illuministarum* - Bartl *et al.*, No. 447, p. 270, No. 519, p. 436). The entry 'Oleum terebentine' was also included in the *Mundinus. Simphaum medicinarum herborum* contained in the further part of manuscript BJ 778 (f. 262v).

In the final remarks of the recipe (in the manuscript separated from the first part with a paragraph marker) the author emphasizes that it is better to take old linseed oil, already substantially polymerized, therefore thicker. At the same time he stresses that the layer applied to glass should not be too thick. If turpentine was added to the varnish, it would make the application easier, since diluting linseed oil would allow to apply a thinner layer of varnish for gilding.

41. Si vis aurum super nucem vel pomum vel muscatum vel ad aliud consimile ponere, recipe gummi arabicum et pone in cornu et infunde vinum vel aquam et fac stare per noctem. Et cras, mediante penna, macula totam nucem. Et sicca. Et cum siccatum fuerit bene, tunc anhelitum supermitte et pone aurum vel argentum mediante bombice. Etc.

If you want to apply gold to a nut, apple, nutmeg or something similar, take Arabic gum, place it in a horn, pour wine or water over it, and leave it for the night. The following day smear it over the whole nut with a feather. Let it dry. And once it is well dry, then, breathing onto it, apply gold or silver using a cotton swab, etc.

This recipe addresses the gilding or silvering of various objects for decorative purposes during e.g., occasional ceremonies. It can be associated with No. 23 speaking of gilding live doves, which may have possibly constituted a decorative and ideological element in ceremony settings. Leaving aside the symbolic motif resulting from the ancient tradition of gilded fruit and ‘golden apples’, it can be supposed that the methods of gilding such objects are also derived from distant sources, in the Middle Ages transferred more in the works of alchemical content. We find them, among others, in Michael Scot’s manuscript of the *Tractatus Alkimie* from the first half of the 13th century (Cambridge, Gonville & Caius College, Mp. 181, f. 30), where it was recommended for nutmegs, rings, apples, or seals to be gilded with the use of almond gum dissolved in egg white (Singer, pp. 13–14). It is from the same source that the recipe contained in the treatise *Qualiter Quilibet Artificia-*

lis Color... (Thompson 1935, p. 467) is derived. Similar texts can be found in the collection of medical-alchemical writings from the fourth quarter of the 15th century in the recipe *Ad aurandum poma vel nucem muscatum vel quidquid aliud volueris hoc modo poteris* (Innsbruck, ULBT, Cod. 422, f. 62v) or in the collection of medical recipes from ca 1400 of Czech provenance (Munich, BSB, Cgm 824, f. 70r). The last recipe also recommends the use of gum arabic as a binder for gold: *Wilt öppil oder nüsse vbergolden so nim gummÿ arabicum vnd czulazz in heÿssem wasser vnd westreich ÿ nüsse oder öppil da mit vnd leg geslagen golt dar auf etc.* In the discussed recipe the gum was dissolved in cold water or wine, with no sugar added, as was the case in the quoted recipe. Sugar boosted the hygroscopicity of the binder, which facilitated the pasting of gold leaf. Breathing onto it moistened the binder to a degree, restoring its viscosity, and then pasting of the gold was possible through pressing with a cotton swab.

42. Si vis colorem facere et tamquam aureum, recipe vitellos sex vel quatuor et pone ad vitrum. Et obstrue bene, ne humiditas intret. Et pone in fumum. Et mitte ibi stare per 90 diep. Et postea accipe et pone ad solem per 7 diep. Et tempera cum gummi. Et illumina.

If you want to make a colour looking like gold, take six yolks, or even four, and place them in a glass vessel. Cover tightly, so that dampness does not come into it. Put it in smoke. And keep it there for 90 days. Following this, take it and put in the sun for seven days. Dilute with gum. And paint.

Egg yolks are mostly used as a binder, but also as a source of yellow colour or imitation of gold colour. In the recipe the yolks underwent long lasting conservation through the smoking process in which thanks to various chemical compounds contained in smoke a slow transformation of the yolks' structure and their microbiological stability were achieved, accompanied simultaneously by their colour transformation. The time for the smoking process is defined in the manuscript with a figure: '90 dies'. At the next

stage the yolks were exposed to temperature and light radiation for a week. However, the interpretation of such a process is difficult, since it has not been studied, and would require a thorough physical and chemical analysis. The obtained substance was combined with a solution of gum arabic. It is likely that in the long-lasting process of the structural transformation, also crystallization of the compounds contained in the yolks occurred, these visually imitating the shine of a gold or gilded surface. Although it was already in the *Mappae clavicula* (*Auri inscriptio, Item alia confectio*, No. XLV, p. 20) that the recipe to obtain a mixture imitating gold, containing, among others, egg yolk was given, the process of obtaining gold colour was nowhere else described as equally complicated and long-lasting.

A similar recipe, also linguistically, based possibly on the source shared with the Cracow record can again be found in the manuscript of Czech provenance from ca 1400 (Munich, BSB, Cgm 824, f. 57r): *Si vis cum auro scribere Recipe vitellum quantum vis et pone ad vnum vitrum et obstrue bene et pone in fimum et mitte iacere per nouem dies postea accipe de fimo et pone ad solem per nouem dies et post modum tempera cum gummi arabico.*

In the quoted recipe the process of preparing 'gold' paint has a similar course. Differences show up in the length of both stages of processing the yolks. Doubts particularly arise when the length of the first stage in both recipes is considered. In the Munich manuscript it is defined as 'nouem dies', while in the Cracow manuscript it is expressed with digits: '90 dies'. This symptomatic difference may have been caused by the incorrect grammar of the Cracow record in which '0' following '9' signifies superscript 'o' following many Latin numbers. Such a supposition is supported by another record describing the preparation of 'gold colour' based on the same ingredients and derived from Peder Månssons's manuscript in which the duration of the first stage was defined as 8-10 days (*Ad idem (Aureus color)* - Johannsen, p. 35). And so the first stage in both recipes would last equally long, while the difference in the exposure to the operation of sunlight would amount only to two days.

43. Tere cristallum subtilissime in marmore, clarum ovi apponendo, de quo scribe, quid voluerip. Postea litteram siccata[m] polluas, quocumque metallo volueris, et recipiet eundem colorem. Etc.

Grind crystal on marble in the most possibly delicate way, adding egg white. Write what you want with this. Later polish the dried letters with a metal of your choice, and the letters will take on its colour. Etc.

In the collection it is one of four recipes in which the method for obtaining an inscription or initial of a metallic surface is described (Nos. 17, 34, 55); this is achieved by using a writing liquid with light abrasive material permitting to apply a metallic layer to the inscription surface by rubbing the dried layer of ‘ink’ with a metal object. In this case *cristallum* is an undefined mineral, possibly mountain quartz, or, which is less likely, Venetian glass (Bartl *et al.*, p. 625). In the remaining three recipes in the collection the abrasive additive was, however, pumice ground with a binder, in two recipes mixed with cinnabar. In the discussed case the colour effect achieved differed from that obtained through using pumice mixed with cinnabar. The red pigment allowed to achieve a warm-red metallic coat, while the use of light finely ground pumice or crystal mixed with a colourless binder permitted to obtain a metallic surface of the colour of the used metal. It is difficult to identify heritage writing specimens in which this gilding method was used, and by the same token to assess its effectivity. Some academics (Clarke, p. 62; Bartl *et al.*, p. 625) point to the lack of examples of the use of this technique in late-Gothic manuscripts. It seems likely that the method was sporadically used as a cheaper and less professional substitute for proper gilding methods with the use of gold leaf or pulverized gold. However, in technological-artistic treatises and in recipe collections from the late Middle Ages recipes to obtain such decoration were substantially popular, and were often placed side by side with proper gilding techniques. In this way authors of their technological compendia enriched the scope of the techniques they provided with less typical solutions.

Similar recipes can be found in the *Secretum philosophorum* from ca 1300-1350 (Clarke, p. 62); in the collection *Experimenta de coloribus* by Jean le Bègue (Merrifield, Vol. I, p. 63); in the *Compendium artis picturae* (Silvestre, No. 17, p. 126); in the manuscript *Bamberger Malerbüchlein* from 1503-1509 (Bamberg, Staatsbibliothek, Msc. Theol. 225, f. 203v); or in the writings of the Swedish clergyman and scholar Peder Månssons from the early 16th century (*Color multiple* - Johannsen, p. 32). However, the recipe version which is the closest was contained in the *Liber illuministarum* (Bartl *et al.*, No. 24, p. 68): *Recipe cristallum, et tere in lapide uel mortario minutissime ad modum minij, apponendo de albugine oui quod sufficit. et cum hac confectioe scribe quid volueris, et permitte siccari. postea frica ipsam litteram cum quocunque metallo volueris: et accipiet colorem huius metalli.* Similarly close recipes can be found in the 13th-century manuscript, Call No. Plut. 30, cod. 29, (f. 72rb), from the Biblioteca Mediceo Laurenziana in Florence (Thorndike 1960, p. 63), or the Czech manuscript M. VIII from the Library of the Prague Metropolitan Chapter (f. 56v).

44. Alius modus, Tere es aut cuprum cum forti aceto sale mediante, ut tibi sufficere videatur. Postea lava pulverem aqua munda et desicca. Cum autem ipso scribere volueris, tempera cum aqua gummi arabica. Et scribe, *quid* voluerip. Postea cum siccum fuerit, polluas cum dente lupino. Etc. Sequitur.

Another way: grind as much bronze or copper as you think is essential with strong vinegar and salt. Then rinse the dust with clean water and dry it. If you wanted to write anything, dilute it with gum arabic. And write whatever you want. Then, when it dries, polish it with wolf tooth. Etc. Further part below.

This is the second recipe in the treatise, next to recipe No. 24, addressing the making of an imitation of gold ink with the use of copper or bronze. In the commentary to recipe No. 24 two source records related to making analogical metallic inks were pointed to: contained in Alcherius's treatise (Merrifield I, No. 312, p. 299) and in the anonymous manuscript, Call No. Ms II.3.17, from the

Cambridge University Library. As distinct, however, from recipe No. 24 and the two quoted records where metal filings were ground with water, in this case bronze or copper were ground with vinegar and salt. It is likely that the use of these ingredients, creating hydrochloric acid in the reaction, was to purify metal of oxidation products, and to obtain the cleanest possible product. Possibly the application of lye in the recipe to obtain copper and bronze powder contained in the *Liber illuministarum* (Bartl *et al.*, No. 230, p. 170) was to yield an analogical effect. In this case metallic powder was also mixed with the solution of gum arabic. Similarly as in recipe No. 24, the dried inscription was polished with an animal tooth to make it shine. The ending of the recipe with the word ‘Sequitur’ suggests continuation of recipes concerning gilding, this manifesting that it was extracted from a different collection of recipes from the one following it, namely recipe No. 45.

45. Smigma sic paratur.
Cineres vulgariter popyolu
brzostowego et stercora canina
et fac lixinium. Et cum fuerit
factum, effunde de vase et illam
substanciam, que remanet
ibidem, sub paniculo fac
exsiccare in sole valde bene, ita
quod fiat dura illa substancia.
Et cum iam fuerit sicca, tunc
imponere eam ad caldar et effunde
lixinium eundem desuper et
fac bulire. Et capias in tantum
de sepo alias topyonego loyu,
quantum erit de cineribus et
stercoribus. Et mitte pariter
bulire. Et quando vides, quod
iam debuliunt, tunc infunde
plus de lixinio et fac bulire. Et
quando vis scire, quod habet
satis, tunc capias lignum cum
quo misces et aspergas prunam.

Soap is prepared in the following way. From the ash of the tree called colloquially ‘wych elm’ and dog excrement prepare lye. And when it is ready, pour out of the vessel and leave the remains under a cloth for it to dry in the sun, until it all hardens. And when it is dry, put it in a cauldron, pour the remaining lye on top, and cook. Add lard, namely ‘melted suet’ in the amount equalling the ash and excrement, and cook again. And when you see that it is boiling, add more lye and cook it. If you want to check if there is enough suet, take the spoon you are stirring it with, and let some drops fall on the coals in the fire. If they are set ablaze like suet, it means there is not enough suet

Si tunc pruna ardebit sicut
sepum, non habet satis [sepum].
Si autem carbo extinguitur, tunc
habet satip. Et si vis, quod sit
glaucum, tunc impone modicum
de croco, vel quantum vip. Et
infunde ad formas et sic tunc
fiat bene. Probatum est. Etc.

yet. If they go out, then there
is enough. If you want it to be
tawny, add saffron, a bit or as
much as you want. Pour it into
tins and it will be ready. It has
been tested, etc.

Although soap could be used as an additive in various recipes concerning preparation of pigments, recipes telling us how to make it are relatively rare. Practically focused recipes, useful in daily life, were usually a supplement to the main set of recipes connected with painting. Such information can be found in broader collections, like the *Mappae clavicula* (No. 280, p. 60, No. 288, p. 62), *Liber illuministarum* (Bartl *et al.*, Nos. 332, 333, pp. 220–222), *Segredi per colori* (Merrifield II, pp. 497–499), Peder Månssons's manuscript (Johannsen, p. 115), or else in treatise collections, like the exceptional *Thesaurus pauperum* from the Oxford Bodleian Library (mp. Canonici Misc. 128), containing, among others, the '*Liber Henrici de modo faciendi sapone cum multis aliis receptis notabilibus*' (f. 58r–62r).

Soap could serve as a hygroscopic ingredient of burnish clay, to cleanse azurite as an additive to lye (Petrus de P. Audemaro, *De coloribus faciendis* (Merrifield I, p. 157); Bartl *et al.*, pp. 322, 330; *Tractatus Qualiter Quilibet Artificialis Color Fieri Possit* – Thompson 1935b, pp. 461–462), when making green copper pigment or blue dye from flowers (*Mappae clavicula*, p. 8, No. 108, p. 30). Theophilus recommended to use soap for cleansing gold and silver (*Theophil.*, pp. 338–340).

Soap was usually made from potash, sometimes with added quicklime or oil, or animal fat. If soap was made with the lye of the ashes of plants containing potassium, so-called soft soaps were created which only needed some flour to be added as the hardening agent (Bartl *et al.*, p. 723). In the discussed recipe, however, ingredients differ slightly from those usually used for soap making. In this



FIG. 5. Black ground visible on the sides of goldings in the hand-written *Missale*, Cracow, ca. XV century, Gniezno, AA Ms 146. Photo by Jacek Tomaszewski

case lye is made from dog excrement and potash made from ash of the field elm (*Ulmus minor Mill.*) according to Linde (Vol. 1, p. 183) or wych elm (*Ulmus glabra Huds.*) according to Gabriel Rączyński and Krzysztof Kluk (Rączyński, p. 295; Kluk, t. III, p. 140). As much as ash from a deciduous tree was a common ingredient in the process, dog excrement was an original item in the recipe. It may have been used here owing to its high calcium content coming from animal bones which were one of the main elements of the dogs' diet at that time. In towns, dog excrement was a precious resource used by tanners and parchment makers, but also for soap producers. This material was, however, sporadically mentioned in treatises: in the *Mappae clavicula* we can find a recipe for dressing leather prepared for being dyed green, while in the *Liber illuministarum* dog excrement was an ingredient of dark ink, so-called Indian ink (Bartl *et al.*, No. 329, pp. 219–221).

In the discussed recipe lye was made in two stages: at the first one, dog excrement was cooked with potash, following which the liquid was poured into another vessel, and the remains were dried in the sun. At the second stage the dried remains were cooked again in the obtained lye in order to strengthen it, and ‘melted suet’, namely animal fat, was added in an equal proportion to the remaining ingredients. In this case no information is provided on the kind of the animal fat used. Other recipes recommend beef or deer fat (*Segredi per colori* - Merrifield II, pp. 497-49; *Mappae clavicula*, No. 280, p. 60), or goat or sheep fat (*Liber illuministarum* No. 329, pp. 219-221).

Soap could be coloured with a dye. In the *Liber illuministarum* when making ‘saracenic soap’, the recommendation was to use verdigris (Bartl *et al.*, p. 223), while in the discussed recipe the colour was altered with the use of saffron.

46. Ad ponendum aurum vel argentum, ut fiat clarum sicut speculum. Tere cretam peroptime cum aqua in lapide. Et fac siccari. Tunc iterum tere et appone modicum de nigro, ut fiat color griseup. Et iterum sicca. Postea pone modicum de czucaro, ut aurum attrahatur et iterum tere per omnia sicut priup. Et habeas bitumen per pannum colatum. Et tempera materiam tritam. Et scribe cum ipsa, quid vip. Et fiat optime sicca per horam vel per duap. Tunc rade cutello aliquantulum et superpone aurum. Et applica bene bombice. Et siccum plana cum dente equino fortiter super aliquam thabulam, donec erit clarum et perspicuum, ut speculum. Et sic intelligendum est de argento. Etc.

On applying gold or silver, for it to be as smooth as a mirror. Grind chalk on the slab with water, as thoroughly as you can. Put it aside to dry. Then grind again adding some black to obtain grey colour. And dry again. After that add some sugar so that it attracts gold, and grind again like before. You need to have glue strained through a piece of cloth. Mix the ground ingredients. Write with it whatever you want. It is best that it dries for an hour or two. Then scrape off the top with a knife and apply gold. Apply it carefully with a silk swab. When dried, smooth it strongly with a horse tooth holding it on a board until it is clean and clear like a mirror. The same has to be done with silver. Etc.

It is the last of the series of recipes to make grey ground for gold or silver. In the three previous ones one of the ingredients was soot (Nos. 27, 32, 33) and in two limewood charcoal was used (Nos. 29, 30). In this case an undefined pigment is added, which in practice could be one of the two above-mentioned blacks. The basic ingredient: chalk, was ground three times; the first time with water alone, the second with black added in the amount necessary for the mixture to become grey, and the third time with sugar. The latter ingredient: *czucaro* was, in the author's view, to cause gold's pasting to the undercoat, while in reality it was the hygroscopic ingredient of the ground, maintaining binder's adequate humidity. At each respective stage the matter was dried. Triple grinding permitted a thorough bonding of the ingredients, an adequately fine grain-ing, while the mixture was mixed with animal glue. An unidentified *bitumen* which could have been an extract of parchment scraps (*bitumen pargameni*) or extract of sturgeon swim bladders (*bitumen esocis*, *bitumen vsiorum*), prior to being mixed with other ingredients, was purified by being strained through a densely-woven piece of fabric. The ground prepared in this way, and applied to the leaf surface, was dried for one to two hours, and later smoothed with a little knife. This tool: *cutellus*, or *cultellus scriptorius*, or *scriptural*, meaning a small knife with an appropriately-shaped blade, was one of the multi-functional scribe's tools, serving mainly to cut feathers, scraping off the uneven undercoat and errors made when writing. In this case it also served to make the ground prepared for silver and gold even as well as to smooth it.

Metal leaf was applied and pasted with the use of a silk swab after a delicate moistening of the ground through breathing onto it, which is not unequivocally pointed to in the recipe, however, seems obvious from the character of the foundation. The decoration gilded with gold or silver on the leaf, placed on a flat board, was polished with a horse tooth to obtain a 'mirror-like' shine. A horse tooth as a tool for polishing appears relatively rarely in sources. It is referred to in the afore-mentioned recipe to obtain 'Fundamentum Gotuicense', which came from the Göttweig Abbey

in Austria; it was also contained in the *Liber Illuministarum* (Bartl *et al.*, No. 282, p. 194), the collection of technological recipes from the Tegernsee Abbey from 1464–1473 (Munich, BSB, Clm 20174, f. 177rv), or the Czech codex from the first half of the 15th century (Praha, NK ČR, Cod. XIV H 16, f. 21v), in which the recipe ‘De assis pro Auro’ shows a distant affinity to the Cracow record.

47. Accipe aurum tabulatum et pone illud in zucararis pomi silvestrip. Et simul horam stare permitte. Et tunc recipe in pennam et scribe. Cum siccum fuerit, polluas cum dente lupino. Etc.

Take gold leaf and place it among sugared-coated forest apples. Leave the whole for an hour. Then scoop onto the pen and write. When it dries, polish it with a wolf tooth. Etc.

It is the second recipe describing how to prepare gold ink for writing, though less precise than the analogical recipe No. 31. Adding gold leaf to sweetened apples seems to be a mental shortcut of the recipe’s author. It is likely that crushed apples were added sugar to stimulate juice extraction from the fruit. In this case the time necessary for an effective digestion of gold leaf with the use of the juice of forest apples was defined. After an hour the ink was ready to be used. This, however, seems to be too short a time in the context of German recipes quoted above where gold leaf was kept in vinegar for 24 hours.

The additive in the form of sugar constituted an additional binder. Similarly as in recipe No. 31, the inscription made with this ink was also polished with a tooth, this time a wolf one.

48. Aurum sic ponitur. Recipe clarum, quando inspissatur et scribe in pargameno. Et cum aliquantulum siccatur, pone aurum et cauda leporis atinge [acinde]. Et polluas dente, et splendebit.

You apply gold like this: take thickening egg white and write on parchment, When it dries slightly, apply gold, and press it with a hare tail. Smooth with a tooth, and it will shine.

The recipe speaks of applying gold leaf without ground, pasted to an almost dry, yet still viscous binder. It was white of egg of broken structure, partially thickened by having been vaporized, which increased its viscosity. Fresh unthickened egg white could unevenly soak into the undercoat and evaporate, which would weaken effective adhesion of gold leaf. Thanks to the increased thickness of the binder it was possible to work at a slower pace when gilding. Having been applied to the binder, the gold was pressed with a hare tale. Having dried, the gilding was polished with an animal tooth. This gilding method ranks among the easier ones, however, the result of the polishing of the gold is not as effective as in the gilding on a smoothed undercoat.

A similar method is described in the treatise *Diversarum artium schedula* by Theophilus where fresh glaire is used, and applying gold had to be conducted fast (*Theophil*, Lib. I, Chapter XXV, p. 30).

The genuine element in the discussed recipe is the use of a hare tail as a tool serving to press and adhere gold leaf. The usual object used for the purpose was a swab of delicate silk or cotton fabric. It is very rare for *cauda leporis* to appear in recipes of the period. The hare tail or paw (*pēs leporis*) served to press the gold in two recipes: ‘De sicco auro’ and ‘Posicio auri super librum vel ymaginem. quomodo fiat’ found in the collection of technological recipes from the Tegernsee Abbey from 1464–1473 (Munich, BSB, Clm 20174, f. 197rv). This is, however, the only element those recipes have in common with the Cracow one, though the fact obviously testifies to the tradition of using similar tools.

49. Si vis facere flaveum colorem, primo habeas fraga vulgariter czirnicze et coque eas in aceto bono. Et pone alumen in quantum sufficit. Et tunc depinge in tela et fac siccare telam depictam, nec in sole nec in vento, sed in camera, vel in aliquo loco secreto. Et postquam siccabitur, tunc polluas dente magno et erit plauaticus.

If you want to make yellow [blue] colour, you first have to have berries colloquially called *czirnicze*, and cook them in good vinegar. Add alum to it, as much as is needed. And paint on canvas, when painted, put aside to dry, not in the sun or in draught, but in a chamber or another quiet place. When it dries, smooth if with a large tooth, and it will turn bluish.

Similarly as in many other recipes, this one, too, speaks of preparing blue (*blavum*) and not yellow (*flavum*). The Old-Polish name ‘czirnicze’ refers to European blueberry. It has retained its conventional name as ‘czernica’. Still in the mid-19th century Gerard Józef Wyżyccki (Wyżyccki I, p. 207) called blackberry: ‘czernica’. Next to elder (*Sambucus nigra* L.) and less so blackberry (*Rubus fruticosus* L.) it was the main plant for centuries used in folk dyeing to dye textiles various shades of red and through violet to navy blue. The fruit of the plant contain anthocyanin dyes (cyanidin glycosides, delphinidines, and malvidins). Depending on pH of the environment these compounds show a different colour. In an acidic environment they yield red, while blue in the alkalic environment. They turn purple with some alum added (Bartl *et al.*, pp. 562-563). In this recipe the berries are cooked with strong vinegar and alum, owing to which the dye itself becomes more reddish-purple. However, what also affects the very process of dyeing is the reaction of the undercoat to which the paint is applied. When the canvas was washed in hard water, the volume of calcium carbonate (CaCO₃) increased in the fabric, raising its pH. The dye applied to such an undercoat took on a blue tint. Anthocyanin dyes are not resistant to light, that is why the recipe’s author recommends drying them at a shaded place or in a room. Polishing canvas dyed in this way makes its surface shine, and boosts the colour.

The range of colours achieved from a blueberry is relatively broad. The *Liber illuministarum* (Bartl *et al.*, p. 563, Nos. 1205, 1254) contains recipes for dyeing leather blue or obtaining green from unripe fruit. Pietro Andrea Mattioli in the Czech edition of his *Herbal* as translated by Tadeáš Hájek (f. 72v) in order to dye fabrics blue recommends a procedure identical with the Cracow recipe, differentiating the colour range by adding vitriol or oak apples (Novák, p. 505). In his manuscript Théodore de Mayerne mentions juice of berries giving red colour and at the same time beautiful crimson (London, BL, Ms.Sloane 2052, f. 23v).

In the chapter ‘Płatkow farbowanie albo chusthek/ w kthorych zachowanie farb bywa/ ku pisaniu y malowaniu’ (Siennik, p. 589)

Marcin Siennik recommended obtaining a brown dye for painting from almost ripe European blueberries. Much later Krzysztof Kluk (Kluk, Vol.3, pp. 144-145) described several ways of preparing the dye in various colours, including crimson paint for painting obtained from *czernica* fresh juice with added calcium, verdigris, and sal ammoniac. Furthermore, he provided ways of preparing a violet dye for wool and linen with alum mixed, or blue with the additive of copper and alum, as well as a navy blue paint additionally seasoned with the oak apples.

<p>50. Si vis facere rubeum colorem, primo habeas fraga, que [habeant] vocantur yezyni. Et tunc fac, ut prius dictum est, de fluveo colore.</p>	<p>If you want to make red colour first you need to have berries called <i>yezyni</i>. Then follow the instructions described for yellow [blue].</p>
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Blackberries (*Rubus caesius L.*; *Rubus fruticosus L.*, *pol.*: *jeżyna*), similarly as the fruit of European blueberry (*Vaccinium myrtillus L.*), were for centuries used mainly in folk dyeing. The fruit of both plants, similarly as that of elder (*Sambucus nigra L.*), contain anthocyanin glycosides in which it is anthocyanins which are coloured aglycones (cyanide, pelargonidin, delphinidin). Depending on the environment's pH these compounds are of a different colour. In acidic environments they are red, and blue in alkaline one. When added alum, they turn purple (Bartl *et al.*, pp. 562-563).

When talking about preparing the dye the author refers to the previous recipe in which fruit was cooked in vinegar, following which alum was added. In that case the obtained colour meant to dye linen was dark red. However, among mediaeval recipes this dye has not been found to serve in illumination.

<p>51. Si vis facere viridem colorem, recipe fraga, que dicuntur psye yagodi et alio modo crussinam, que crescit ad modum crateis [criteis] et pone illa fraga ad</p>	<p>If you want green, take the fruit called <i>psie jagody</i> or <i>kruszyna</i> which grows like a hedge. Put the fruit into a pan or a jug, and pour vinegar over it. Put aside</p>
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unam ollam seu amphoram
et infunde desuper bonum
acetum. Et mitte stare per unam
noctem vel ultra. Tunc effunde
illum acetum de fragis et terge
has fragas manibus in olla et
exprime vulgariter wiszmy per
panniculum. Et recipe succum
et infunde ad vesicam et pende
ad aerem et mitte siccare.
Quando vis temperare tunc
recipe acetum bonum et impone
de illa substancia. Et appone
alumen et grispanum, quantum
vip. Sed hoc fac statim, quando
vis laborare.

for the night or longer. Then
pour the vinegar out, take the
fruit with your hands, and wring
it through a piece of cloth. Take
the juice, pour it into a bladder,
and hang it out in the air to dry.
If you want to dilute it, take
good vinegar and pour over what
has been left after the juice had
dried. Add alum and verdigris, as
much as you want. But do this
directly before you want to work.

In the Middle Ages and later, many plants were used to obtain green of different shades, used widely in dyeing and to make paints for artistic purposes. One of the plants was black nightshade (*Solanum nigrum* L.), whose leaves and black fruit, also called in Polish 'devil' or 'dog' berries, served as the basic source of green and blue dyes. Black nightshade leaves were used in Italy in the Middle Ages to make the paint called *Morella*, in France known under an analogical name *Morelle*. In the dictionary *Herbaria Latino-Polonica* contained in the manuscript *Scripta medica* (Warsaw, BN, Rps BOZ 66, f. 335), which came from the monastery of Canons Regular in Czerwińsk from 1464-1468, the translation of the word 'morella' to 'psyevino' can be found (source: <https://polona.pl/item-view/632d32dc-0f48-4fc7-a73c-901244eabcf1?page=340>). Some tens years later in Murmellius's dictionary from the first decade of the 16th century the word *solanum* was translated to *psynki* (Murmellius, p. 114).

In Europe the fruit of the plants of the Rhamnaceae (*Rhamnus* L.) family, whose species differ slightly depending on the location they grow at, was also widely used. In Poland it was European buck-

thorn (*Rhamnus cathartica* L.), and to a lesser degree also alder buckthorn (*Rhamnus Frangula alnus* Mill), that was used as the source of yellow and green dyes. In the case of the discussed recipe the name 'crussina' refers more to European buckthorn (*szakłak*), since that was the one whose fruit was generally used for a green dye, while alder buckthorn (*kruszyna*) was a source of dye mainly through its bark (Kluk, t.3, p. 13). Here, additional information on the type of the plant is provided by the recipe's author: 'que crescit ad modum crateis [criteis]', speaking of the habit of using this plant for utilitarian and decorative purposes. Still in the 18th century, Krzysztof Kluk (Kluk, Vol.3, p. 13) mentioned that European buckthorn 'can be planted into rows and living fences, dense and beautiful', which points to the century-old tradition of using this plant for growing hedges. In the discussed recipe we possibly come across the oldest name of *kruszyna* (*szakłak?*), though in their Latinized form.

From both trees the fruit as a source of dye at different stages of the ripening process and leaves were used. European buckthorn yielded the dye called *verde di vescica* or *pasta verde* in Italy, *Safftgrün* in Germany (Boltz, f. 30v-31r), while in France the fruit of *Rhamnus infectorius* called *grain d'Avignon* created the dye *stils de grain* (Merrifield I, p. CCXIX). In 16th- and 17th-century Poland the German name of the paint: *Zawgryn* took root (Haur, p. 369). Haur also provided a recipe to prepare yellow paint of unripe European buckthorn fruit and dried in a bladder (*macherzyna*) (Haur, p. 360).

In the discussed recipe the fruit was initially soaked in vinegar, following which juice was pressed, and dried in an animal bladder. The dry dye prepared in this was could be turned to paint if needed by diluting it with vinegar. The paint's colour and its covering power were boosted by adding ground verdigris and alum. Thanks to natural glycosides contained in the fruit, the dye did not require an additional binder.

Mediaeval recipes provide several ways of preparing a dye from the fruit of both plants. In order to extract the pigment the fruit was soaked, like in this case, in vinegar (Munich, BSB, Clm 20174, f. 168v), or in lye, or cooked with no additives. The manner pro-



FIG. 6. Dyes made by use of recipe 51 with fruits of common buckthorn, *Rhamnus cathartica* (left-hand side) and alder buckthorn, *Rhamnus Frangula alnus* (right-hand side). Photo by Agnieszka Kalbarczyk

vided in the *De arte illuminandi* (Lecoy de la Marche, p. 16) involved alum additive together with lye. The dye could be kept either in its liquid form in a glass vessel or dry after evaporating in a beef bladder or soaked into pieces of linen fabric (*folium*). As much as alkaline solution in the form of lye is more frequently used in Italian manuscripts (*Segredi per Colori* - Merrieffeld, pp. 420–421), vinegar or lack of additives are often present in northern and German recipes (Alcherius - Merrieffeld, t. I, p. 86); *Liber illuministarum*, - Bartl *et al.*, No. 1225). Fresh or dried juice on its own with no additives is brownish, and when added alum, it turns green (Bartl *et al.*, pp. 570–571).

Recipes given by Marcin Siennik to dye goatskin with the use of European buckthorn berries cooked in alum water date from a later period (Siennik, p. 588). Also Krzysztof Kluk (p. 12) gives a similar procedure to prepare the dye: *Jagody dojrzałe przed mrozami zebrane, z octem rozarte gotują się: do soku potym wygniecionego przez płatek przyda się nieco Alunu: a wławszy w naczynie szklane zamknięte, w ciepłym miejscu, ale nie na słońcu ususzy się* (Ripe berries picked before the frost, crushed with vinegar, are cooked; for the juice later pressed through a cloth some alum might be needed; having poured it into a closed glass vessel, dry it at a warm spot, though not in the sun).

The drying of a dye in an animal bladder is still mentioned in the mid-19th century by Gerard Józef Wyżycki (Wyżycki I, p. 148).

52. Ut scribas quocumque metallo, recipe limaturam cuiuscumque metalli et tere in marmore cum aceto et sale. Cumque bene tritum fuerit, lava cum aqua. Et serva pulverem in umbra et usui reserva. Et dum scribere volueris, tempera cum claro et scribe. Et siccum polluas cum dente et apparebit in tali colore, quale erat metallum

In order to write with any metal, take filings of this metal, and grind them on marble with vinegar and salt. When well ground, rinse them with water. Keep the dust in the shade, and use guardedly. And if you want it, prepare with glaire, and write. After it has dried, smooth it with a tooth, and the colour the metal was will appear.

This is a recipe telling us how to make an inscription or decoration with a metallic lustre, close to recipe No. 44. It is likely that similarly as in the recipe found in the addenda to Theophilus's manuscript *Diversarum atrium schedula* published by Robert Hendrie 'Si vis facere literas aureas vel argenteas vel cupreas vel ereas aut ferreas' (*Theophilus*, p. 420), in this case various metals can be used, mainly the less noble ones like copper, bronze, or iron. Here, however, metal filings were ground in vinegar with some cooking salt added, as distinct from Theophilus's manuscript where metal particles were crushed in the solution of plum gum in vinegar. The composition of vinegar and salt evidently makes the discussed recipe share the source with recipe No. 44. Similarly as there, the process of grinding was accompanied by a complex chemical reaction in which the organic acid and the hydrochloric acid created as the reaction's results dissolved both metal flecks, but mainly the marble (calcium carbonate) on which the ingredients were ground. Such a reactive chemical composition permitted to avoid calcium impurities in the metallic powder: those were dissolved in the acids, and rinsed in clean water. In the discussed recipe, as distinct from recipe No. 44, and that contained in Theophilus's treatise, the metallic powder was ground with egg white. After the inscription

dried, the surface was polished with an animal tooth, this yielding metallic shine.

53. Radix lili in aqua decocta purificat faciem et maculam delet, si fuerit lota. Probatum est.

Boiled in water lily root cleanses face and removes blotches if there were any. It has been tested.

This is a medical-cosmetic recipe which was placed in the treatise between the recipes for metallic inscriptions and making parchment window films. The rubricator, however, did not separate it with a paragraph marker. This is the only recipe thematically differing from the technological profile of the treatise. Although the whole text of the *Ars de omnibus coloribus* was written down in a homogenous layout, it is thematically unordered and compiled from various sources, which can be seen in the fact that recipes concerning preparation of the same pigments or dyes appear at different places. In his manuscripts, John of Dobra took loose hurried notes on fly leaves with medical recipes which could alternate with recipes of another kind, yet these notes are of a different chronological character, and for obvious reasons they could be thematically mixed (see: BJ rkps 849). In this case placing here the recipe of this character may be regarded as ‘accidental’, and may show that earlier notes were mechanically copied.

54. Ad membranas faciendas pargamencas. Prout iam excidetur de tentorio ponatur per unum diem in urina et sic lava de cemento. Iterum ponatur in forte acetum per unum diem et lavatur bene in aceto. Et postmodum distat in lignis fenestralibus et perfundat eam cum bitumine vel lineat cum sumany melli.

On preparing parchment membranes. Once you cut out a leaf from parchment, put it in urine for the night, thus cleansing it of calcium. Then put it into strong vinegar for a day, and wash it in it. Finally, stretch it on a wooden window frame, saturate it with glue, or smear with *sumany* honey.

Recipes telling us how to prepare parchment membranes instead of glass in windows are relatively rare. We find them in technological and technical treatises, e.g., in the *De Fenestris*, contained in the manuscript *Thesaurus pauperum* from the Bodleian Library (Travaglio 2012, p. 608), in the Bologna manuscript (Merrifield, II, No. 214, 215, p. 493), in the *Liber illuministarum* (Bartl *et al.*, No. 408, p. 250), or in the manuscript from the Tegernsee Abbey from 1464–1473 (Call No. Clm 20174, Munich, BSB, f. 171v–172r).

The recipe speaks about making parchment membranes used in windows instead of glass. In this case parchment is a much more convenient material than crude hide, since the parchment maker has already done a part of the necessary jobs that need to be done to crude hide: he has removed the hair and epidermis, he cleared the flesh side of the skin and has evened out the hide's thickness. Parchment prepared for writing is as a rule opaque and hygroscopic. These properties were to be removed or at least greatly mitigated through appropriate treatments. The methods to achieve the goal included longlasting soaking of the skin in urine, which additionally, thanks to containing urea, softened the parchment, following which soaking in vinegar was to effectively remove particles of calcium carbonate introduced into the parchment structure in the course of producing it. In the case of the discussed recipe the process of soaking and decalcifying of the skin is more laborious than in other recipes where usually clean water was used for the soaking and cleaning of the parchment surface, and optionally wine to remove calcium (*Liber illuministarum*, Bartl *et al.*, No. 408, p. 250).

The elastic and still wet skin was immediately stretched out on the window frame and attached to the wood with nails. When drying, the parchment shrank and straightened up. The recipe's author suggests some saturation of the skin with *bitumine* or *sumany melli*. Neither of the two terms is unequivocal. As for the first, it was most commonly used in the meaning of 'glue'. In the Cracow treatise the word has so far been used twice: for the first time in the meaning of animal glue (No. 27) and in the second meaning

precisely as a solution of cherry gum (No. 29). However, examples of different recipes suggest that the use of the words *bitumine* or *bitumen* refers most often to glue obtained from hides (see: *Liber illuministarum*, Bartl *et al.*, No. 363, 364, p. 238; Clark, I. 38 p. 60). As for the other term: *sumany melli*, Maria Kowalczyk, who submitted the text of the treatise for printing, had doubts as for whether the word *sumany* had been correctly read and as for its meaning, which she marked by putting a question mark by it. As it seems, the meaning of this word is not to be found in Latin but Polish. Before being applied, honey should be cleared of the remains of wax and impurities through so-called *szumowanie* in Polish, meaning scumming. In old-Polish the word *szuminy* signified foam, while *szumowany* or *szymowany* referred to having been cleared of foam and impurities. Hence possibly the word *sumany* in the text, being the 15th-century form of the Polish *szumiony*. This thesis can be confirmed by another recipe to make parchment membranes for windows provided in the Bologna manuscript (Merrifield II, No. 214, p. 493). There, in a slightly different procedure, the honey used was *de mele spumato*, cleared through scumming.

55. Si vis scribere anulo, quod apparebit quasi aurum, recipe cinobrium et tere fortiter cum claro. Post hoc recipe pomicem et tere cum cinobrio simul et parum de vitello, ita quod plus de cinobrio quam pomice. Post hoc pone in pergameno et fac siccare. Et cum siccum fuerit, plana bene cum anulo aureo vel argenteo et apparebit aurealis vel argentealis etc.

If you want to write with a ring so that it looks like gold, take cinnabar and grind it thoroughly with glaire. Then take pumice, and grind it with cinnabar with a bit of yolk, taking more cinnabar than pumice. Then apply it to the parchment and leave to dry. When it has dried, smooth it carefully with a gold or silver ring, and it will look as if gilded with gold or silver. Etc.

In its core, the above recipe almost literally repeats the procedure described in recipe No. 17 in whose comment the specificity of the gilding/metallizing method was characterized. An almost

identical recipe can be found in the manuscript, Call No. M. VIII, from the Library of the Prague Metropolitan Chapter (f. 45v), which has been quoted in extenso above, next to recipe No. 17. The same method is also tackled in recipes Nos. 34 and 43 contained in the Cracow treatise. As much as in all the known recipes there is mention of rubbing the prepared inscription or decoration with ‘metal’, here and in recipe No. 17 there is mention of a definite metal object: *anulo*. A ring being the material for obtaining colour is mentioned twice in the Prague manuscript (Call No. M. VIII, f. 45v, 56v) and in two recipes in the *Liber illuministarum* (Bartl *et al.*, Nos. 19, 337, pp. 66, 224).

56. Si vis scribere, ut fiat roseicus color, recipe albumen ovis et briselium et alumen. Et ista tria comisce simul et pone in ollam novam et mundam. Et sic dimitte stare tribus vel quatuor diebus sub terra. Et postea recipe et cola bene per pannum et cum eo scribe, quid vip. Et erit roseicus color. Probatum est. Etc.

If you want inscriptions to be pink, take egg white, brazil, and alum. Mix the three components, and put them into a new and clean pan. Place it in the ground for three or four days. Then take it out, strain it through a piece of cloth, and write what you want. The colour will be pink. It has been tested. Etc.

It is the fourth recipe speaking of preparing a dye from brazil through cold extraction. The recipe is original, though based on basic principles of preparing dyes in numerous treatises. In the discussed case the author emphasizes what colour can be obtained in such a way. However, the very colour’s name: *roseicus* does not fit the Latin grammar rules, neither is it found in any of the known recipes. The usual word used to describe pink is *rōsēus* (Le Bègue *Tabula de vocabulis sinonimis et equivocis colorum* - Merrifield I, p. 34; Thompson 1926, p. 284). The recipe to produce pink colour with brazil, albumen, and alum as its base can be found in the manuscript *Secretum philosophorum* (Clark, p. 55) or in the *Liber de coloribus illuminatorum* (Thompson 1926, p. 284). Most frequently, however,

in order to obtain pink it was recommended to mix red with white, e.g., minium with ceruse (Thorndike 1960, p. 59, 68; Clark, p. 55).

In the known recipes we have not come across the method of placing the dish with the prepared dye in soil. A similar method was applied only in the case of long-lasting preparation of green, called Spanish green (Petrus de P. Audemaro - Merrifield I, p. 127) or Greek green (Thompson 1926, p. 294) in the winter period, or when preparing 'laurium' in the treatise *Illuminaciones et temperatura colorum* by Johann Boloniensis (Thorndike 1959, p. 18). There is no practical justification for doing so. It is not accounted for either by the necessity to maintain stable temperature or absolute darkness. Contrariwise, in some recipes the mixture of glaire with wood filings was purposefully exposed to light (Silvestre, p. 124).

57. Si vis aurum madidum
supponere, recipe albumen ovi
et bene distempera. Post hoc
recipe crocum et post et clarum
et exprime et appone cretam.
Bene autem omnia simul tere,
ita quod satis spissum fiat. Et
scribe cum eo. Aurum vero |
desuper pone. Cum bene siccum
fuerit, tunc eciam bene debes
polluere cum dente valde bene.
Et sic permanebit pulcrum et
durabile. Etc.

If you want to apply gold on
wet surface, take egg white, and
mix it well. Then take saffron,
mix it with glaire, press out,
and add chalk. Grind everything
thoroughly for it to be quite
thick. And write with it. Apply
gold on top. After it dries,
smooth it well with a tooth.
Thanks to this it will stay
beautiful and durable. Etc.

It is the second recipe (after No. 25) to make yellow gilding ground. The recipe is similar to No. 48 where gold was applied to thickened glaire, without tinting additives. Although it was not clearly specified, the saffron should be initially soaked in the beaten white of egg. Following this, after having pressed it through a densely-woven cloth, chalk was added and all was thoroughly ground on the slab, to obtain a mixture whose consistency would allow to write with a pen. Gold was applied to the still moist ground,

and after it had dried, it was thoroughly polished with an animal tooth. A similar ‘wet’ gilding procedure is provided in Petrus de P. Audemaro’s treatise *De coloribus faciendis* (Merrifield I, No. 192, pp. 154–155). Audemaro, however, recommended tinting glaire with brazil and apply the gilding to the still wet ground without chalk. Other known ‘De madido asse’ recipes on the basis of water binders with some saffron added (*Liber illuministarum* – Bartl *et al.*, No. 8, p. 58; No. 194, p. 150) or oil-based ones (Munich, BSB, Clm 20174, f. 197v–198r), however, differ from the Cracow wording. Meanwhile, a similar recipe is contained in the manuscript from the Library of the Prague Metropolitan Chapter, mentioned above on many occasions (Call No, M. VIII, f. 45v), which reads as follows: *Si vis aurum madidum apponere, accipe albumen ovi et bene distempera. Et crocum pone ad clarum tunc exprime et appone cridam. Bene omnia trita et appone modicum de czukaro, ita quod satis spissum fit. Et fit scribe cum eo. Et aurum desuper in mome[n]to appone et noli nimis aurum exponere. Postquam siccatum fuerit dente bene planabitur.*

58. Glaucus color sic est temperandup. Recipe auripigmentum et tere fortiter cum aqua et fac exsiccari. Et cum bene siccum fuerit, pone in cornu et tunc accipe crocum et desuper funde clarum. Et sic de ilio liquore temperato scribe. Etc.

Tawny/yellow colour is prepared in this way: take orpiment, thoroughly grind it with water, and leave aside to dry. When it has dried well, put it into a horn, add saffron, and pour glaire on top. And write with the liquid prepared in this way. Etc.

This recipe undoubtedly speaks of preparing yellow, which dispels all the doubts as for understanding the word *glaucus* in numerous mediaeval recipes (see No. 6). The author uses here yellow orpiment, and boosts its colour adding saffron to glaire. This is the same understanding of the term *glaucus* as that shown by the author of the mid-13th century’s *Liber colorum secundum magistrum Bernardum quomodo debent distemperari et temperari et confici*, where in the recipe concerning preparation of green he recommended add-

ing *glaucum illud quod dicitur auripigmentum* (Travaglio 2008, p. 131). The colour defined as *glaucus* was most frequently made from chalk with added saffron and a bit of egg yolk ground on a white of egg binder (Praha, NK ČR, Cod. XIV H 16, f. 21v; Munich, BSB, Cgm 824, f. 13r). An almost identical recipe can be found in manuscript M. VIII from the Prague Library: (f. 46r) : *Glaucus color sic temperatur. Recipe auripigmentum et tere fortiter cum aqua et fac exsiccari. Tere in lapide et cum exsiccatum fuit, pone in cornu et tunc accipe crocum et desuper funde clarum. Et cum illo liquore distempera.*

59. De cinobrio temperando.
Recipe cinobrium et pone super lapidem et tere cum claro tam diu, donec clarum per omnia exsiccatur. Et iterum denuo teratur cum claro, in quo crocus per noctem iacuit, tamdiu donec iterum exsiccatur. Et caveas ne aqua demisceatur. Etc.

On preparing cinnabar. Take cinnabar, put it on the slab, and grind it with glaire until the glaire dries. Grind it again, this time with the glaire saffron soaked in, also until it dries. Refrain from adding water. Etc.

Although the author of this concise recipe does not say anything about the purpose of such prepared paint, it has to be supposed that it is cinnabar meant to paint initials rather than for writing. Grinding the pigment twice with glaire is recommended by the author of the *De arte illuminandi* when speaking of preparing paint for painting initials with a brush in the recipe ‘Ad faciendum corpora licterarum de cinobro’ (Lecoy de la Marche, pp. 34-35). The drying of the paint after the second grinding with some egg white permitted storing it for long. In order to prepare cinnabar produced in such a way, it had to be ground with glare once again, avoiding adding water. In fact, the paint prepared in such a way has more binding than when ground only once, which boosts its lustre, however, also increasing brittleness of the paint coat. In order to avoid brittleness it was usual to add a plasticiser to the paint: honey or earwax, the author of the discussed recipe not mentioning it, however (Thompson, Hamilton, pp. 56-57).

Although adding a yellow dye in the form of saffron was not a standard procedure when preparing cinnabar, some recipes where it is used can nevertheless be found. The Bologna manuscript recommends the use of cinnabar rinsed with lye with albumen tinted with saffron added (Merrifield II, No. 224, p. 500). The adding of saffron when grinding the pigment is also mentioned in the Strasbourg recipe ('Wiltu zinober tempereren ze florirende' - Berger, No. 5, p. 154). The way to prepare egg white with some saffron added is also described in the treatise *De Clarea* (Baroni 2016b, p. 308). Adding saffron to ground cinnabar with red wine is recommended much later also by Jakub Haur (Haur, p. 362). We come across the discussed recipe in manuscript M. VIII from the Library of the Prague Metropolitan Chapter, which, importantly, in both manuscripts follows the recipe 'Glaucus color sic est temperandus': *Recipe cinobrium et pone super lapidem et tere cum claro tam diu donec clarum per omnia exsiccat. Et iterum denuo teratur cum claro tamdiu donec iterum exsiccat et tunc denuo teratur cum claro in quo crocus per noctem iacuit, tamdiu donec iterum exsiccat. In lapide denuo imponatur tertia para vitelli ovi et apponantur ad cynobrium et teratur diu donec iterum exsiccat. Et caveas ne aqua admissecatur quia uquam colorem denigrat*. However, although the initial sentences sound identical, in the Cracow manuscript the recipe is simplified. Here the pigment is dried twice, while four times in the version contained in the Prague manuscript; additionally, at the final stage of the process egg yolk is added, serving, as explained above, as a plasticiser. It is not, however, certain whether the Cracow manuscript omitted a part of the procedure, or it may have been the Prague scribe who erroneously added the phrase: 'tamdiu donec iterum exsiccat'.

60. Cinobrium est res mollis
et fit ex sulphure et mercurio.
Recipe mercurii 2 partes et
terciam partem sulphurip. Hec
tere simul cum aqua et pone in

Vermilion is a brittle material
made from sulphur and
mercury. Take two parts
of mercury and one part of
sulphur. Grind it together with

vas vitreum angustum,
habens collum. Et ipsum cum
argilla obstrue exterius ad
spissitudinem unius digiti. Et
desicatum pone super tripodem
et obstrue vap. Et da ignem
lentum fere per medium diem.
Postea vigora ignem magis et sic
assa per integrum diem, donec
videas superius rubeum exire,
et tunc permittite infrigidari. Et
frange vas et invenies cinobrium
bonum. Etc.

water, and place in a glass vessel
with a neck. On the outside
cover it with finger-thick coat
of clay. When it has dried, place
it on a tripod, cover from the
top and start a light fire under
it for half a day. Then increase
the fire and roast it for a whole
day until you see reddish smoke
appear. Lead it to cool. Break
the dish, and you will find good
vermilion. Etc.

It is the only recipe in the treatise to make vermilion, an artificial variety of cinnabar, from the basic ingredients: mercury and sulphur. Called *vermiculum* in the *Mappae Clavicula*, vermilion was one of the major pigments in the palette of not only an illuminator, but also a basic material for a rubricator and a scribe making red initials. That is why it takes a prominent position in all the collections of paint recipes, while sublimation of mercury and sulphur ranked among the basic training exercises of alchemists. In the recipe two parts of mercury were combined with one part of sulphur, and ground with some water added. The mixture was placed in a glass vessel with a narrow neck, subsequently coated with a thick layer of clay. After the protective clay coating had dried, the vessel was placed over fire, and heated for two days, with the fire temperature increased on the second. The herald of the finalization of the process of making vermilion was the appearance of red fumes in the dish. The pigment was reached after breaking the glass vessel. The proportions quoted in the discussed recipe: two parts of mercury and one of sulphur are the most frequently pointed to in 14th-century technological recipes (Kroustalis, Galán, p. 24). In later periods reverse proportions appeared: 1:2 mercury to sulphur. In both cases they are proportions with respect to the volume. Stoichiometric analysis, however, points to the fact that the appropriate proportions in order to obtain ver-

milion are as follows: 1 weight portion of sulphur with 6.2 parts of mercury (Kroustallis, Galán, p. 25). Actually, in both versions the proportions are disturbed, with excessive sulphur involved, which escapes in the course of the mixture's heating, or is rinsed away when the pigment is cleansed. In the discussed recipe the ingredients are initially mixed and ground with some water. The added water facilitated the grinding of the ingredients, in whose course black metacinnabar was created. The additional rinsing with water of the mixture could remove excessive free sulphur. One of the recipes contained in the *Liber Illuministarum* (Bartl *et al.*, No. 335, p. 222) gives a more detailed description of the procedures in which, prior to any further steps, water was evaporated from the mixture of the ingredients ground in this way.

In the Middle Ages, two methods of producing vermilion were practiced. In the first, the older one as it seems, the ingredients were mixed in a dish later heated in order to obtain the pigment. The second method, also embracing the Cracow recipe, was conducted in two stages: initially, metacinnabar was obtained through grinding the ingredients at room temperature, following which the black semiproduct was placed in a glass vessel, in which the appropriate synthesis occurred at high temperature.

In harmony with the recipe, a glass vessel, most likely narrowing towards the top, with a long neck, was coated with clay in a finger-thick layer. Such-shaped vessel could facilitate the reaction, and at the same time prevent evaporation of mercury and sulphur. The layer of clay secured an even spread of temperature on the vessel's surface which levelled differences in glass tensions, preventing its breaking (Kroustallis, Galán, p. 27). Although in the discussed recipe there is only mention of covering the neck's outlet, the vessel was generally sealed with a mixture of clay with horse dung, called *lutum sapience* in alchemical terminology (see No. 21).

A recipe of a very similar linguistic structure can be found in the manuscript Call No. Cgm 824 from the Munich Bayerische Staatsbibliothek (f. 12v). Apart from the first sentence and some minor differences both texts are almost identical: *Item cynobrium sic fit rec-*

ipe mercurium duas partes et sulfur tertiam partem hec tria contere simul cum aqua et pone in vas vitreum angustum habens collum et ipsum cum argilla exterius vndique circunda ad spissitudinem vnus digiti et desiccatum pone super tripodum et obstrue ab vase et da ei ignem lentem fere per medium diem postea maiorem ignem et sic assa per integrum diem donec videbis fumum rubeum tunc infrigidare permitte et frange vas et inuenies cynobrum. A similar formula was also contained in the collection *Iluminaciones et temperature colorum* compiled by Johann Boloniensis (Copenhagen, KB.DK, Call No. Gl.kg1.S.165 - Thorndike 1959, p. 18). All the texts are likely to have come from the same, at least 14th-century, source text.

61. Item lazurium sic fit. Recipe duas partes mercurii et tres partes sulphuris et tres partes salis armoniaci. Et contere simul, ut docui de cinobrio, et pone in vase vitreo et assa per omnia, ut cinobrium. Et cum fumum videbis exire flaveum, tunc satis est. Et mitte infrigidari. Et cum infrigidatum fuerit, inuenies nobilem lazurium et tunc contere in lapide in pulverem sine aqua etc.

Azure is also created in this way. Take two parts of mercury, three parts of sulphur, three parts of sal ammoniac, and grind those together like in the recipe to obtain vermilion. Put it all into a glass vessel and roast precisely like vermilion. And when you see yellow [blue] smoke released, it means that it has been roasted sufficiently. Then cool it. And when it is cooled, you will obtain excellent azure. Grind it on the slab without water. Etc.

The compound of mercury with sulphur is the basis for producing vermilion with some tin, meaning mosaic gold. In this recipe mention is of another compound, this time with sal ammoniac, namely ammonium chloride. The process occurred similarly as in producing vermilion, the fact the author mentions in the previous recipe. The ingredients ground together with some water added (this mentioned in recipe No. 60) were heated in a glass flask until blue smoke appeared, which testified to the completion of the process of pigment creation. Here, however, the smoke's colour

was erroneously defined as *flaveum* and not *blavum*, or less correctly *blaveum*.

Recipes to produce blue based on the combination of mercury, sulphur, and sal ammoniac are found in technological-artistic recipes in Italy (Bologna manuscript - Merrifield II, No. 30, pp. 386–387), where in the 18th century artificial blue produced in this way was called Venetian azure (Merrifield I, p. CCX). Similar recipes were also included in German sources, e.g., in the *Liber Illuministarum* (Bartl *et al.*, No. 325 and 908) and in the manuscript containing the set of recipes from ca 1400 (Munich, BSB, Cgm 824, f, 12v). The latter manuscript contains two recipes to prepare that pigment, of which at least one, the one quoted below, may have come from the same source as the Cracow recipe, possibly an earlier manuscript: *Lasurium sic fit accipe duas partes mercuri et terciam sulfuris et Atam salis armoniaci et contere et pone in vase vitreo et assa per omnia et cum fumum mittes exire flaveum tunc satis est et cum vas in frigidatum fuerit in venies nobilem lasurium et contere in lapidem et puluerem sine aqua Si lasurium sit pendolum Ita quod non vult de penna exire Recipe sal armoniacum et pone cornu vbi est lasurium ad quantitatem pise et moueas simul valet bene tunc in scribendo.*

However, despite the presence of numerous analogical phrases and clear repetitions of whole word sequences, in both recipes there is a visible difference in the proportions of the ingredients used to make the pigment. Such differences may testify to the popularity of similar recipes and their frequent copying at the time, enriched with factual modifications while keeping also the general scheme of the record.

Despite the fact that this recipe to obtain azure is present in many technological-artistic collections, from the chemical point of view the combination of the ingredients under the discussed circumstances does not give a blue pigment. The success the recipe enjoyed in various regions of Europe despite its practical uselessness can suggest a strong influence of alchemical practices in the process of creating coloured substances used in fine arts. (Bartl *et al.*, p. 541). In the course of the described process black mercury

sulphide in the form of metacinnabar (HgS) is created; described as *fumum flaveum* [*blaveum*], it forms a deposit on the walls of the glass flask, which could have a certain blue shine. One of the recipes to produce this pigment in the *Liber illuministarum* (Bartl *et al.*, No. 325, p. 217) compares its colour to ultramarine. Metacinnabar occurring in nature as a mineral is also created in natural cinnabar in the course of processes catalysed by contaminating alkali metals and under the influence of the visible spectrum (*The Pigment Compendium*, p. 266).

62. Ad temperandum lazurium tere cum aqua simplici munda. Et cum bene tritum fuerit, congrega super astulam et permitte bene exsiccare. Et cum bene siccum fuerit, pone in cornu stanneum vel bovinum et desuper funde temperatum clarum apponens modicum de minio vel vitello ovi etc.

In order to prepare azure simply grind it with clean water. When it is thoroughly ground, collect it on a slat, and put aside for it to dry. When it is dried, put it into a tin horn or oxhorn, pouring over prepared glaire with a drop of minium and egg yolk, etc.

This recipe, similarly as Nos. 3 and 20, concerns preparing paint from azurite. The pigment was thoroughly ground with clean water added, and then dried. The dried pigment was mixed in the horn with egg white with little yolk and minium added. What is interesting in the recipe is the use of tin horn or oxhorn as a dish for the paint. According to the anonymous author of the *Liber de coloribus illuminatorum siue pictorum* what mattered was the kind of metal of which the dish for the paint from azurite was made: *Azorium bonum molitur cum aqua, et postea ponitur in cornu argenteo. Talis, enim, nature est ut argentum uelit. Si non habes argenteum, quere stagneum et in illo pone* (Thompson 1926, p. 282). Interestingly, in the manuscript Call No. M. VIII from the Prague Chapter (f. 50v) we find an almost identically formulated recipe, but related to preparing vermilion: *Cynobrium quomodo temperabip*. In that recipe the following phrase is found: *pone in cornu stanneum vel bovinum*. Therefore, did

the kind of metal of which the dish was made matter for the process of preparing and using a definite paint? It seems that the selection of material for the dish is quite accidental, related more to the workshop tradition, or was a mere coincidence. A natural dish for paints and writing liquids used for manuscript making was an animal horn. In the Cracow treatise a horn is the dish for paints in 19 recipes; in one recipe only (No. 14) lead horn is mentioned, and in the discussed recipe tin one is. In treatises there is rare mention of the material for making an ink horn: a glass horn is specified in the recipe to prepare glaire for vermilion in the *De arte illuminandi* (Lecoy de la Marche, Nos. 23, 32, pp. 31, 38); tin horn is specified in the preparation of writing gold in the *Libper illuministarum* (Bartl *et al.*, No. 12, pp. 60–62), where there is also mention of a copper horn which served to store verdigris green (Bartl *et al.*, No. 51, pp. 82–85), while a lead horn is used in the recipe for gold for writing in the Italian *Tractatus aliquorum colorum* (Travaglio 2016, No. 15, p. 252). However, it continues unresolved whether the above was an intentional use of a dish made of a definite material, stemming from the author's knowledge and experience, or whether it simply resulted from what a given workshop was equipped with.

As mentioned above, owing to the coarseness of azurite, it requires a sufficiently strong and elastic binder. In recipe No. 20 the binder was gum arabic with some honey, here it is glaire with a bit of egg yolk. Being a natural water and oil emulsion, yolk strengthened the binder, adding elasticity to the paint layer. The additive in the form of minium, similarly as of brazil in recipe No. 20, was to alter the colour towards purple.

63. Briselium sic fit. Recipe
cimentum et impone in ollam
novam et desuper funde aquam
mundam et fac stare per tres
dies, donec statim fiat pura
aqua et tunc effunde in ollam
novam et mundam et appone lac
pulcherime mulieris, capiens

Brazil is prepared in the
following way. Take lime,
put it in a pan, pour clean
water on top, and leave it for
three days until the water
clarifies, then pour it to a new
pan, and add milk that came
from the breast of a beautiful

eam per mamillam. Et exprime et decoque, postea sume cretam bene tritam et appone lac de lapide calamitaris bene trito. Postea pone in vas purum et superfunde briselium et tere firmiter donec spumescet ampliup. Tunc infunde in lapidem, qui dicitur creta.

woman. Then strain it and boil. Take thoroughly ground chalk and add a suspension of a well-ground calamine stone. Subsequently, put it into a clean dish, pour over brazilwood and mix strongly until it foams. Finally, pour it onto stone which is called chalk.

Although it is not clearly specified, it can be deduced from the context that similarly as in recipe No. 7, *cimentum* has to be understood as quicklime. The recipe speaks about obtaining the dye in the course of a hot extraction of brazilwood in lime lye. In this way an opaque paint defined by the author of the *De arte illuminandi* as *rosecta corporea* (Lecoy de la Marche, p. 17) was obtained. However, as distinct from recipe No. 7, instead of glaire, the additive used was breast milk, while after boiling, instead of alum, ground chalk and calamine *lapis calaminaris*, erroneously written down here as *calamitaris*, were added. All was mixed with shavings of brazilwood and ground on the slab. When being ground, the wood particles lost colour, while the dye was deposited on calcium and zinc compounds. The obtained mixture was then poured onto the surface of a limestone slab, where it was dried. Such a procedure is typical of obtaining lakes, since the absorbent chalk surface allowed to strain the water solution, leaving only solid particles on the surface. In this case it was not only pure lake that was obtained, but its mixture with wood cellulose and tinted chalk. The procedure is not clear, and it did not guarantee obtaining the correctly created material for painting. The reconstruction of the recipe conducted by the author allowed to obtain a whitened claret covering pigment.

Calamine is a mixture of tin compounds, mainly carbonates and silicates with other additives, including iron ore tinting the mineral reddish. In the Middle Ages, it was often present in pharmaceutical and alchemical writings also as *cadmia* (Bartl *et al.*, p. 695).

The mineral was used in metallurgy, mainly in brass production, but in glass making as well (*Theophil*, LXIII, p. 306, LXVI, p. 310), or when purifying silver or gold, whose recipes can be found in the *Mappae Clavicula* (IX, p. 195). In the known artistic and technological sources we do not find recipes with the use of this mineral, actually not just to prepare brazil, but also other dyes and pigments.

The recipe is of a particularly alchemical character. This can be seen not only in the use of calamine, but also of mother's milk. The latter additive is known from the recipe to prepare azurite in the treatise of Petrus de P. Audemaro (Merrifield I, p. 135) and two recipes to prepare burning arrows contained in the *Mappae Clavicula* (ed. T. Phillipps, Nos. CCLXVI and CCLXVIII, p. 57). Interestingly, Ernst Berger (Berger, p. 139, footnote 2) was critical of the translation of Audemaro's treatise by Marie Ph. Merrifield opting for the adjective from the noun mule (*mulus*) instead of the word 'woman's - *mulieris*'. This approach would be understandable, since in treatises the adding of goat milk or milk of other domestic animals was recommended, e.g., in wall painting. The repetition in the *Liber de coloribus* connected with Audemaro's treatise (Thompson 1926, p. 300) does not solve the issue. Instead, the discussed recipe is unequivocal in this respect by putting the word *pulcherime* before *mulieris*.

64. Item hoc modo distempera
briselium. Rade lignum dulciter
et deleta rasura et ipsam
rasuram in vasculum aliquid vel
in cornu mundum plumbeum
et infunde glaream [garram]
novam et parum albi aluminip.
Et mitte maturescere, donec
optime coloratum fiat. Sed
tamen quanto plus aluminis,
tanto nigrior erit briselium et
tenacior. Quanto minus, tanto
rubicundius et minus tenax.

In the similar manner you can
dissolve brazilwood. Scrape
delicately the wood, and put
whatever you scrape off into
a dish or little horn, made of
lead and clean. After that add
fresh glaire and a bit of alum.
Put it aside for it to mature, until
it dyes nicely. The more alum
you give, the darker and more
durable brazil will be. The less of
it you give, the redder and less
durable it will be. You can use

Et de isto colore per tres dies debes temperare, quia nisi uno die vel duobus poterit durare. Quidam intingunt modicum cum lazurio et fit purpurea. Si vero album commiseris, erit roseaceus color pulcherrimus. Quidam in eum mittunt parum de albo et parum de creta et parum aluminis et erit sanguineus. Et si parum in eo verniculum misceris et erit briseliolum optimum pictoris parietis [?]. Tamen omnibus coloribus fere miscunt briseliolum etc. Sequitur.

such dye for three days, since it can last not just one or two days. There are some who mix some brazil with azurite, and crimson is then created. And if you add white, you will get beautiful pink. Some add little white to it, and little chalk, as well as some alum, and it will create blood-red. And if you mix some vermilion with it, the brazil will be excellent for a wall decorator. Because they add brazil to almost all colours. Etc. Further part below.

This is the third recipe speaking about preparing paint from brazilwood in a cold extraction in egg white, repeating the overall procedure contained in other recipe collections. Although it was written down without being separated from the previous recipe, and was not marked by the rubricator as another paragraph, it has to be treated separately, since it is a separate recipe, possibly coming from another source. An analogical formula can be found in the treatise *Illuminaciones et temperature colorum* compiled by Johann Boloniensis (Thorndike 1959, p. 19). However, on the linguistic level the latter recipe differs, which suggests its frequent re-editions. However, since all the most essential elements are present in both recipes, we should quote it at full length: *Item ad idem. Rade presilium, mictre in cornu plumbeum. Infunde novam claretam, parum rubrici aluminise Mictre maturescere donec optime coloratum sit; stet. Parum de alumine, eo splendidior color et levior. Si autem multum, eo nigrius et tenaciup. Parum distempera de isto, quia non datur nisi primo die vel secundo. Quidam cum eo tingunt modicum lazurii. Si autem album cum eo miscueris, erit pulcher color roseup. Si autem parum de albo, parum de croco, parum aluminis, et efit sanguineus color. Si in eo parum vermiculi*

miscueris, erit optimum brunium. Pictores periti cum omnibus fere miscent presilium.

It is characteristic of several recipes contained in the treatise that the paint is kept in a lead horn, which suggests that it is prepared more for writing than for painting. Such a way is quoted in several treatises in the recipes evidently concentrated on adorning manuscripts. Apart from the above-quoted recipe we can find this element in the *Liber de coloribus illuminatorum sive pictorum* (Thompson 1926, pp. 282 300, 306), Theophilus's *Diversarum Artium Schedula* (*Theophil*, pp. 40, 410), in Heraclius (Marrifield I, p. 241), Alcherius (Marrifield I, p. 275), and in Petrus de P. Audemaro (Marrifield I, pp. 135, 143) in the recipes related to preparing red for rubrication, azurite, or gold for writing.

The author enumerates typical combinations with pigments: with azurite to create purple, with white (ceruse) in order to obtain pink, and with white, chalk, and alum to create 'blood-red'. The last composition gains such colour mainly thanks to alum and alkaline chalk, while ceruse only makes the colour lighter.

It remains uncertain what pigment is hidden under the name *verniculum*, or strictly speaking *vermiculum*. According to De Cange (Vol. 8, col. 282b) and also Merrifield (I, p. CLXXIV) such was the name of a red dye (lake) of the kind of kermes (*Kermes vermilio*). Preparation of the mixture of vermilion with the Kermes dye is described in the *Mappae claviculae* (Nos. 175, 176, p. 221), although the name *vermiculum* is used to denominate a colour, both for vermilion (*vermiculum cinnaberin*) and kermes (*vermiculum terrenum*). Meanwhile, in the treatise *De coloribus faciendis* by Petrus de P. Audemaro (Merrifield I, pp. 139-141) under the name *vermiculum* there is a recipe to make vermilion, namely artificial cinnabar. Similarly in Heraclius (Merrifield I, pp. 251-255), in the Bologna manuscript (Merrifield II, p. 449), in the *Liber illuministarum* (Bartl *et al.*, p. 92), or in the *Secretum philosophorum* from around 1300 (Clark, p. 55), there are resembling recipes. In the late Middle Ages, the word *vermiculum* defined more a definite colour, and not the type of pigment or dye, although more often it was applied to de-

fine artificial cinnabar whose colour resembles lake made with *kermes vermilio* (*The Pigment Compendium*, pp. 210–211). Importantly, however, all the additives in the recipe are pigments, therefore it has to be assumed that also in the case of this red we have to do with vermilion. The mixture of brazil with vermilion, depending on the proportions, yields a dark and deep shade. There is no mention of the usefulness of that combination for wall decoration in any of the known treatises. The use of brazil itself *in muro* is mentioned only by Heraclius (Merrifield I, p. 235). Recipe collections focused on miniature painting as a rule do not refer to murals, the only exception being the *Liber de coloribus* where the author speaks of ochre used by painters of murals (Thompson 1926, p. 284). In this case the scribe of the Cracow treatise erroneously wrote down the word *periti*, giving here an abbreviation, therefore the word could be read as *parietis*. Such a transcription can be found in Johann Bionienensis's treatise, which changes the sense of the sentence. Here we have to do not with *pictoris parietis* – 'wall painters', but *pictores periti*, namely 'experienced painters'.

Mentions of making shades in-between, and mixtures of white and azurite with the brazil dye can be found also in Theophilus (p. 415) and made by the author of the treatise *Liber de Coloribus Illuminatorum sine Pictorum* (Thompson 1926, pp. 282, 284), whose text fragment is also found in the 14th-century compendium of paintings from the library of the Church of the Blessed Virgin Mary in Gdańsk (Czartoryski Library, no. 1501 III Rkps; see: Wyrozumski, pp. 663–671).

65. Item superfunde clarum post
hec omnia. Sperge modicum de
alumine et mitte per noctem
stare, quousque spissum fiat.
Tunc cola per pannum et sic
operare cum eo, quid vip. Hoc
probatum est.

Similarly pour in white of
egg after all that. Crush some
alum and leave for the night to
thicken. Then strain through
a piece of cloth, and do with
it what you want. It has been
tested.

This recipe tells us how to prepare a binder from chicken egg white: *clarum ovi* or *glarea ovi* for illumination purposes. The begin-

ning of this brief text suggests that it is only a part of a recipe, and factually it could be connected with the previous one. However, the previous text speaks about colour shades of brazil, and contains no mention of preparing glaire for painting.

The recipe is relatively simple and laconic. Alum was added to the white separated from the yolk, and it was left for the night. On the following day the binder was filtered through a piece of cloth. This aimed to at least partially disrupt the fibrous structure of egg white.

Consistency was the usual challenge when a binder with the use of egg white was prepared. The common recommendation was to beat it with various tools which destroyed the ovomucin (Heracilius - Merrifield I, p. 233, XXXI. [284]). This stage of binder's preparation was particularly pointed to by the author of the treatise *De clarea* (Baroni 2016b, pp. 305-306). The more effectively the white was beaten, the more homogenous the binder was. Breaking down the egg white structure with the use of a sponge or a piece of cloth was regarded as not very effective, owing to which the binder was not sufficiently homogenous, and made writing or painting with the paint with such a binder difficult (Bartl *et al.*, p. 575). Another method for breaking down the fibrous structure of the egg white was through putrefaction for several days. However, the second method applied in gilding techniques weakened the binder's adhesion and reduced the elasticity of the adhesive layer.

In the discussed recipe the additive of alum is recommended, possibly as a means preventing binding's deterioration. We come across no other recipes adding alum to albumen. In the treatise such a binding aged for three days was used to prepare a dye from brazilwood (No. 8) where alum was also added, but mainly to obtain the dye's appropriate colour. Most recipes speak about preparing a binding without additives, and only rarely with some anti-septics, such as realgar, camphor, or cloves (Lecoy de la Marche, p. 25).

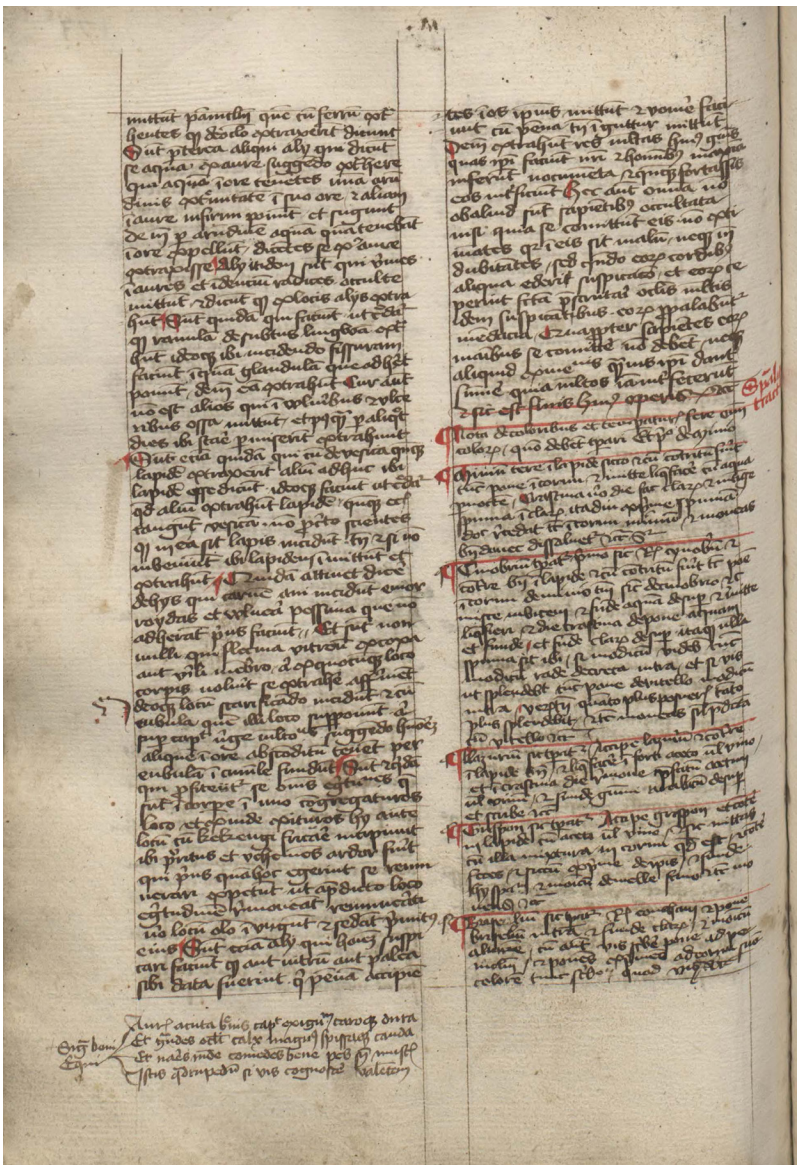


FIG. 7. Folio 174v, beginning of treaty, hand-written at BJ 778 III of the Jagiellonian Library. Source: <https://jbc.bj.uj.edu.pl/dlibra/publication/167666/edition/159341/content> (2024.11.19)

Et sic est finis huius artis
videlicet de omnibus coloribus.
Et quis scite perficere secundum
hec notata, procedat sine rubore,
quia in omnibus particulis est
iam probatus.

Here the treatise on all colours
ends. And whatever you do
precisely according to these
recipes, do it without fear, for
they have been tested in all
detail.

CONCLUSION

A detailed analysis of the recipes contained in the treatise, its structure, and used terminology in the context of other sources of the technology of miniature painting in the late Middle Ages allows us to thoroughly assess the genuine character and factual content of the work. Not only does it permit to underline the outstanding importance of the text within the Polish context, but also to define the directions of cultural and artistic influences, as well as the context of its creation.

In a brief introduction to the first publication of this source Maria Kowalczyk states that the text was most likely edited in Poland, possibly in Cracow, this testified to by many Polish words which can be found in it (Kowalczyk 1977, p. 166). We should agree with such a conclusion, but at the same time it is hard to admit that the treatise was purposefully and finally edited in compliance with the principles applicable to such technological texts. As a rule, in painting treatises recipes were grouped depending on colours or kinds of the pigments used, with a separate group being formed with those concerning gilding and other issues. Such a logical arrangement can be found not only in the major technological treatises such as the *Mappae clavicula*, *Diversarum artium schedula* by Theophilus, Cennini's *Trattato Della pittura*, *De coloribus et artibus Romanorum* by Heraclius, *De coloribus diversis* by Alcherius, *De coloribus faciendis* by Petrus de P. Audemaro, or the anonymous *De arte illuminandi*, and also in numerous minor works. Meanwhile, no such rule is present in the Cracow treatise, while it reveals a somewhat unclear though visible division into three groups of recipes. The first one (Nos. 1-22) contains recipes speaking of pre-

paring the basic pigments and dyes provided chaotically, in which recipes related to minium, cinnabar, azure, verdigris, and brazil are found at different spots. The second group (Nos, 23-48) encompasses mainly recipes concerning gilding techniques. Here, too, lack of a logical arrangement can be found, this additionally undermined with interjections in the form of recipes concerning preparation of some pigments or soap. The last third group (Nos. 49-66) seems the least ordered, containing again recipes speaking of preparing paints (brazil, orpiment, azure) as well as gilding, or preparing egg white. Importantly, in the first three recipes of the group, concerning plant dyes, there are Polish glosses pointing at least to the local reception and provenance of the recipes. The vernacular provenance of this group of recipes can also be seen in the word 'sumany', to-date unrecorded in literature, present in recipe No. 54 speaking about the preparation of window parchment membranes.

The disorderly arrangement of the treatise may suggest a gradual adding subsequent recipes obtained from various sources and on different occasions. Such a compilation may have been created for a longer time until its author decided the set was sufficiently representative, fairly exhaustive, and closed to be written down in a codex. However, lack of any edition, ordering of the content, and material selection is excessively visible, since it contains the cosmetic recipe speaking about a lily root preparation whose presence in such a work is entirely groundless. It, however, testifies to the author of the compilation who may have had something more in common with medicine than book decoration. Furthermore, following Maria Kowalczyk, it seems justified, to associate the treatise with the interest John of Dobra showed in the art of book, all the more so since she has found single recipes related to book painting in another of his manuscripts at the Jagiellonian Library, Call No. BJ 849 (Kowalczyk 1977, p. 166).

Apart from the above remarks, let us also point to relatively frequent strikethroughs and errors in the text, which, however, indicates more the character of the sources from which the trea-

tise was copied than the carelessness or negligence of the scribe: in other texts contained in the manuscript there are not as many of them, this suggesting that the source from which the text was copied must have been challenging for the scribe, e.g., showing little legibility. Such a source may have been in the form of loose or working notes, and not carefully copied in another codex. Naturally, the chaotic arrangement does not suggest that the treatise was a genuine work existing in a single copy only. Equally likely, it may have been copied from another manuscript as a text circulating within the Cracow circles.

The set of pigments and dyes included in the treatise is relatively scarce. It lacks many recipes telling readers how to prepare numerous pigments usually applied in miniature painting, and as a rule present in most of such compilations. The treatise lacks recipes for basic whites, black, indigo, ultramarine, green earth, or brown and yellow earth pigments. The relatively limited set of pigments and dyes presented in the treatise may to a great degree account for the specificity and professional profile of its addressee, e.g., a scribe painting initials or making a modest decoration of manuscripts. An equally symptomatic factor in the discussed set is the lack of expensive and not readily available pigments. Furthermore, the pigment names are not very precise, this visible in the lack of the differentiation of the kinds of copper greens or mineral blues. Such names for green as *viride hispanicum* or *viride grecum*, or blues defined as *azurium ultramarinum*, *lazurium montanum*, or *azurium de Alemania* are to be found not only in the largest treatises, but also in smaller collections of painting recipes. What is more, some names given in the Cracow source are erroneous, as was the case with mosaic gold or purpurin, defined here as orpiment. Such simplifications and errors generally do not happen in 'professional' treatises.

The terminology used in the treatise is noteworthy; it may be pointing to the direction of cultural influences affecting the author of the compilation. As emphasized by Maria Kowalczyk in her edition of the text, the treatise's language is clumsy, and the spell-

ing incorrect (Kowalczyk 1977, p. 166). In this context some more striking examples can be pointed to: they partially result from the author's ineptness to describe untypical procedures, and partially from the terminology consolidated in the technological tradition. Some colour names are given ungrammatically, e.g.: *flaveum* (correctly *flavus*), *brunaticum* (correctly *brunum*), or *roseicus* instead of *roseus*. This, however, not being something exceptional at that time, since, as it is known, many similar sets of recipes were written down in inept and simplified Latin, while within the area of the impact of German also transcriptions combining the two languages were frequent. However, there are no names in the text which would unequivocally testify to the direction of technical influences. Apart from the name *grispon* given to verdigris there are no traces of the language and terminology of German origin in the compilation. In this case, the name may have been a linguistic borrowing widely used in Poland. What is more, the given word in this original transcription is not present in any known treatise either in Germany or any other country. It also seems that the word in this form, in the context of a painting pigment, did not come to Cracow from Bohemia where the most commonly found description in the sources is *viride hispanicum*. Furthermore, what strikes is also the word *briselium*, which has nothing in common with the impact of the German cultural environment visible in Bohemia where, as a rule in various Latin and German versions, the transcription changed the initial letter 'b' to 'p'. The *briselium* variant of the word used in the treatise is unique and not present in other sources.

Another name remaining outside the main impact of the terminology from the German circles is that serving to define ceruse as *cerusa*, present in the Cracow treatise only twice (Nos. 22, 35). This Latin name in the Latin texts in Germany and Bohemia was in the 15th century most frequently replaced with the German *bleyweis* or *playweys*.

Moreover, let us point to a subsequent interesting fact in the context of a cultural or terminological impact, namely the word

fundamentum used in the meaning of undercoat or gilding ground in recipes Nos. 25, 27, 32, 33, and 35. A review of sources shows that this term appears exclusively in German ones. In the remaining texts the words more commonly used are *assis* (*assisa*) or *scisa*.

Furthermore, the name of the blue pigment: *lazurium* used in the treatise to a certain degree also points to the northern cultural and linguistic sphere in which recipes for this pigment were created. The analysis of treatises created or copied in various regions of Europe points to the tendency to use two various versions of the name. When in southern countries the term *azurium* tends to be more frequent, in northern and central Europe: in Germany, Austria, Bohemia, and Poland, what dominates is the name *lazurium*. In France or the Netherlands the names may have alternated, as can be judged from the definition contained in Jehan le Bégue's *Tabula de vocabulis sinonimis et equivocis colorum: Azurium vel lazurium est color; aliter celestis vel celestinus, aliter blauccus, aliter persus, et aliter ethereus dicitur* (Merrifield I, p. 18). The remaining names of pigments and dyes: *minium*, *cinobrium*, *vermiculum* (written as *verniculum*), or *crocus* are in harmony with the terms used across whole Europe.

As a result of the analysis of numerous technological texts created at various places in Europe, it can be concluded that some Latin names or terms were more popular with or characteristic of given regions and traditions. In the Cracow treatise several other Latin terms were used; these referred to materials or auxiliary means used for paint preparation, one of them being quicklime, in the treatise defined as *cimentum inextinctum* (No. 7) or *creta combusta* (No. 33). As much as the first one is not really found in painting recipes, the second comes only in the Munich *Liber illuministarum* (Bartl *et al.*), while the term widely used in treatises is *calx viva*. Similarly, the Latin name for lye (correctly: *lixivium*), most likely owing to the copyist's error written in the treatise as *lixinium* (No. 45), is present in the afore-mentioned Czech manuscript (Praha, NK ČR, Cod. XIV. H. 16) and the frequently-quoted *Liber illuministarum* (Bartl, pp.709, 789). An interesting factor worth pointing to is the untypi-

cal additive in the form of mother's milk, present most commonly in magic and alchemical recipes. The *Lac pulcherime mulieris* (No. 63) is, interestingly, absent in German sources, but mentioned in French treatises, such as the *Liber de coloribus illuminatorum siue pictorum* or the treatise by Petrus de P. Audemaro (Thompson 1926, p. 300; Merrifield I, p. 135).

The Cracow treatise provides a whole set of binders used on various occasions. Generally, the terms used here are widely applied throughout Europe, and they include the basic binders: *gummi arabico, claro ovi, albugine, vitello, bitumen, bitumen pargameni, or bitumine cerusarum*. The term *bitumen* (as distinct from *bitumine*), signifying 'glue' in general, is found in the Anglo-Latin collection of recipes contained in the manuscript *Secretum philosophorum* from the University of Glasgow Library, Call No. MS Hunterian 110, (Clark, p. 60), yet also in numerous recipes in the *Liber illuministarum* (Bartl *et al.*). Interestingly, however, next to the sour cherry gum: *de bitumine cerusarum* mentioned in the collection (No, 29) another name was added in parentheses: *merusarum*, the name found only in the *Liber illuministarum* (Bartl *et al.*, p. 430, Nos. 472-474) in recipes for preserves made from sour cherries. Similarly, two other ingredients: lamb liver bile *iecur agni* (No. 36) used for writing in gold colour (München, BSB, Cgm. 824, f. 57r) and juice of forest apples: *pomum silvestre* (No. 31) applied to dissolve gold, have their equivalents only in German and Czech sources.

In the context of gilding technique let us focus on the tools mentioned in the recipes, and meant to polish the gilt. In 11 recipes animal teeth are recommended as burnishers. Among them the following are mentioned: pig tooth (No. 30), horse tooth (No. 46), and wolf tooth (Nos. 44, 47). Although Maria Kowalczyk suggests the connection of the use of animal teeth for the purpose with magic practices, it is more likely that the variation of the teeth results more from various technical traditions the recipes came from (Kowalczyk 2000, p. 272). In consistently and homogeneously edited treatises for painting the tendency to apply the same tools and methods is visible.

All the examples of the terminology applied in the treatise locate the Cracow text within the influences coming from south-eastern Poland. In the context of that impact it is the recipes to make *gris-seum fundamentum*, namely grey ground for gilding on parchment, which are symptomatic, and which seem to be characteristic of the territory of Germany, Austria, and East-Central European countries. Among six recipes to make such ground in two (Nos. 29, 30) it was recommended to use black from burnt linden tree typical of the moderate climate of Central Europe.

At that time all pigments were ground on a grinding slab (the underneath stone) with the use of a muller, namely the upper stone, made of hard material, such as porphyry or marble. That is why in many recipes in the treatise the phrase *tere in lapide* was translated as 'grind on the slab' (and not in a mortar), in harmony with the Old-Czech inscription from that period: *nakameni trzy* found in one of the recipes from the manuscript of the Library of the Prague Metropolitan Chapter (M. VIII, f. 52v).

Apart from numerous recipes which can be found in collections from the period in an identical or similar wording, some may have been genuine, and if not, they must have been edited in the Polish environment. They are the recipes containing Polish glosses: *popyolu brzostowego* (No. 45), *czirnicze* (No. 49), *yezyni* (No. 50), *psyę yagodi*, *wiszmy*, and *crussina* (words in No. 51) as well as *sumany* (No. 54) in their Latin form. Furthermore, recipe No. 32, containing the Latinized word *czu-crum*, can be ranked among this group. The latter name is also present in Czech sources, taking on the form: *czukercandi* (Praha, NK ČR, Cod. XIV H 16, f. 21v) or *czukaro* (Praha, Library of the Metropolitan Chapter, Call No. M. VIII, f. 45v). According to Maria Kowalczyk, the presence of numerous Polish names of plants and simple medicines as the glosses in the afore-mentioned treatise of *Onomasticon de simplicibus* by Gelasius of St Sophia, written down in the same codex, testifies to John of Dobra's interest in vernacular names and a wide application of herbs in his doctor's practice. It is most likely for a reason that Polish names of dye-yielding plants were incorporated in the above-mentioned recipes for paints (Kowalczyk 2000, p. 269).

A comparison of numerous treatises and collections of painting recipes allowed to identify a direct connection of as many as 18 recipes from the Cracow treatise with recipes in other sources (Table 1 a). These records constituting almost 30 per cent of the whole treatise have in part their literal or linguistically and content-wise close equivalents in other treatises. As for the further 13 recipes significant analogies and an indirect connection with other texts can be found, testifying to the common source (Table 1 b). However, despite such numerous analogies it is impossible to point to one source from which they are derived. The recipes which have their analogical versions in other texts are dispersed throughout the whole text of the Cracow treatise. Even when they occur in a certain sequence (10-12, 36-37, 57-61), their order in analogical sources is entirely different. This may suggest that either all those collections drew from another, to-date unidentified as yet source, or were independent compilations of single recipes circulating among copyists, scribes, or illuminators in various configurations

TABLE 1. LIST OF RECIPES CONTAINED IN THE TREATISE AND THEIR CONNECTION WITH RECORDS INCLUDED IN OTHER SOURCES.

a - directly connected with the recipes contained in the treatise; b - significant analogies and indirect connection with the treatise; c - a more distant relation with the treatise resulting from technical traditions.

Abbreviations: BnF - Bibliothèque nationale de France; SBB - Berlin, Staatsbibliothek; CUL - Cambridge, University Library, GNM - Nürnberg, Germanisches Nationalmuseum; KB.DK - Copenhagen, Kongelige Bibliotek; BL - London, British Library; BSB - Munich, Bayerische Staatsbibliothek; BodL - Oxford, Bodleian Library; KPMK - Praha, Knihovna pražské metropolitní kapituly; NK ČR - Praha, Národní knihovna České republiky; ULBT - Innsbruck, Universitäts- und Landesbibliothek Tirol; BnM - Venice, Biblioteca nazionale Marciana

No.	Pigment/ dye	A	b	C
1.	Et primo de minio			BL Sloane 1754 BSB Clm 20174 Alcherius
2.	Cinobrium temperatur primo sic			<i>Liber illuministarum</i> Alcherius
3.	Lazurium sic temperature			<i>Liber illuministarum</i>
4.	Grispon sic temperatur			<i>Liber illuministarum</i>
5.	Briselium sic temperatur			
6.	Glaucum, quod venditur			
7.	Briselium sic temperature			Rekopis boloński BSB Clm 20174
8.	Briselium sic temperabis	KPMK M. VIII		<i>Theophil</i>

No.	Pigment/ dye	A	b	C
9.	Crocus autem sic temperatur		Recette...di colori	<i>Liber illumini- starum</i> BSB Clm 20174 NK ČR Cod. XIV H 16
10.	Si vis habere viridem colorem		BSB Cgm 824	Audemar BL Sloane 1754
11.	Si vis habere viridem colorem			BSB Cgm 824
12.	Item si viridem colorem	BSB Cgm 824		
13.	Si vis facere de cupro viridem colorem			
14.	Si vis temperare pulcrum flaveum colorem	KPMK M. VIII		<i>Liber illumini- starum</i> BSB Cgm 824
15.	Item aliter tempera flaveum colorem			<i>Liber illumini- starum</i>
16.	Cinobrium temperabis sic			
17.	Item accipe cinobrium	KPMK M. VIII		
18.	Item minium			BSB Cgm 824
19.	Item si vis habere griseum colorem	BSB Cgm 822		BSB Cgm 824
20.	Item si vis temperare lazurium	KPMK M. VIII		<i>De arte illumini- nandi</i> <i>Compendium artis</i> <i>Picture</i> <i>Liber illumini- starum</i>
21.	Item ad faciendum auripigmento			
22.	Si vis scribere cum albo super nigrum			SBB Germ. Quart. 417 <i>Illuminierbuch</i> (Boltz) Siennik
23.	Si vis deaurare columbam			
24.	Si vis cum auro de penna scribere			Alcherius BnF Mp. latin 6749b CUL Ms II.3.17
25.	Nota ad ponendum aurum super capitalia	BSB Cgm 824	GNM 3227a	Månssons
26.	Item si vis habere colorem brunaticum			NK ČR Cod. VI. F. 19
27.	Fundamentum auri			<i>Liber illumini- starum</i> BSB Cgm 824
28.	Item fac farnisium			BnM sygn. IT.III.10
29.	Item si vis cum auro scribere		Liber illumini- starum	
30.	Item si vis bene aurum apponere			Rękopis boloński

No.	Pigment/ dye	A	b	C
31.	Item si vis cum auro de penna scribere			<i>Liber illuministarum</i> BSB Cgm 822 BSB Cgm 824 GNM sygn. 3227a
32.	Item fundamentum ad ponendum aurum vel argentum			<i>Liber illuministarum</i>
33.	Alia informacio ad fundamentum			<i>De arte illuminandi</i> <i>Liber illuministarum</i>
34.	Ad scribendas litteras aureas, argenteas vel cupreas			BnF Mp. latin 6749b
35.	Si vis scribere flores aureos vel argenteos,			Alcherius <i>Liber Illuministarum</i> BSB Cgm 822
36.	Si vis cum auro scribere	BSB Cgm 824	GNM Call No. 3227a	
37.	Item si vis grispon temperare	BSB Cgm 824		
38.	Si vis briselium temperare		Bologna manuscript	KB.DK sygn. 1656 <i>Liber illuministarum</i>
39.	Si vis aurum ponere super vitrum			<i>Liber illuministarum</i> <i>De Fenestris</i>
40.	Item aliter sic			Rekopis boloński
41.	Si vis aurum super nucem vel pomum vel muscatum		BSB Cgm 824	<i>Tractatus Alkimie</i> ULBT Cod. 422 <i>Qualiter Quilibet Artificialis</i>
42.	Si vis colorem facere et tamquam aureum	BSB Cgm 824		<i>Mappae clavicula</i> Månssons
43.	Tere cristallum subtilissime in marmore	KPMK M. VIII	<i>Liber illuministarum</i>	<i>Secretum philosophorum</i> <i>Experimenta de coloribus</i> <i>Compendium artis picturae</i>
44.	Alius modus			Alcherius CUL Ms II.3.17
45.	Smigma sic paratur			<i>Liber illuministarum</i> BL mp. Canon. Misc. 128
46.	Ad ponendum aurum vel argentum		NK ČR Cod. XIV H 16	
47.	Accipe aurum tabulatum			BSB Cgm 822 BSB Cgm 824 GNM sygn. 3227a
48.	Aurum sic ponitur		Teofil	BSB Clm 20174

No.	Pigment/ dye	A	b	C
49.	Si vis facere flaveum colorem			Mattioli <i>Liber illuministarum</i> Siennik
50.	Si vis facere rubeum colorem			
51.	Si vis facere viridem colorem,		BSB Clm 20174	Alcherius <i>Liber illuministarum</i>
52.	Ut scribas quocumque metallo			Theophilus
53.	Radix lili			
54.	Ad membranas faciendas pargamicas			<i>Liber illuministarum</i> Bologna manuscript <i>De Fenestris</i>
55.	Si vis scribere anulo	KPMK M. VIII		<i>Liber illuministarum</i>
56.	Si vis scribere, ut fiat roseicus color			<i>Illuminaciones et temperature colorum</i>
57.	Si vis aurum madidum supponere	KPMK M. VIII		Audemaro <i>Liber illuministarum</i>
58.	Glaucus color sic est temperandus	KPMK M. VIII		
59.	De cinobrio temperando	KPMK M. VIII		<i>De arte illuminandi</i> Bologna manuscript
60.	Cinobrium est res mollis	BSB Cgm 824	<i>Illuminaciones et temperature colorum</i>	
61.	Item lazurium sic fit	BSB Cgm 824		Bologna manuscript <i>Liber illuministarum</i>
62.	Ad temperandum lazurium	KPMK M. VIII		
63.	Briselium sic fit			<i>De arte illuminandi</i>
64.	Item hoc modo distempera briselium		<i>Illuminaciones et temperature colorum</i>	<i>Liber de coloribus</i> Theophilus Heraclius Alcherius, Theophilus <i>Liber de Coloribus</i>
65.	Item superfunde clarum post hec omnia			

Among the numerous sources in which we find some of the recipes contained in the treatise *Ars de omnibus coloribus* particularly two codices of Czech-German provenance draw our attention. The

first of them is the unpublished yet manuscript from the Library of the Prague Metropolitan Chapter, Call No. M. VIII, (No. 1361) from the first half of the 15th century (Podlaha, pp. 264–268). The codex contains a collection of predominantly medical treatises, including two sets of painting recipes written down on leaves: 43r–52v and 55v–56v. Two groups of recipes are separated with texts of other content, and although they were composed in a similar editing format, they feature additions testifying to a more makeshift character of the record. Similarly as in the Cracow treatise, respective recipes are separated with paragraph markers and red lines. This collection contains as many as nine recipes of an almost identical wording.

The second source is the manuscript kept at the Munich Bayerische Staatsbibliothek, Call No. Cgm 824, on leaves 12r–14v, 66r–69r, and 74v–75v containing recipes written mainly in German and Latin, and in a Czech dialect. The manuscript from ca 1400 created in Bohemia, used also in the Benedictine Abbey of St Ulrich and St Afra in Augsburg (Bartl *et al.*, p. 30), contains mainly pharmacological, technical, and domestic recipes (Schneider, pp. 486–491; Ploss, p. 156). This manuscript encompasses six recipes clearly connected with those in the Cracow treatise.

Echoes of some of the recipes can be found in two more sources. One of them is the manuscript, Call No. is Cod. XIV H 16, kept at the National Library in Prague, and containing theological and astrological texts (Truhlář, p. 345–346). On leaves 66v–68v the manuscript from the first half of the 15th century, written down in Latin ad German, contains the *Formulae componendorum colorum* copied by different hands. The other source is the codex, mainly of alchemical content, from ca 1390 (currently at the Germanisches Nationalmuseum in Nuremberg, Call No. GNM 3227a), containing, among other texts numerous painting and household recipes (*Katalog der deutschsprachigen illustrierten Handschriften*, pp. 16–18 (Nos. 38.1.4). In those two manuscripts single recipes to a bigger or lesser extent linked with those contained in the *Ars de omnibus coloribus* can be found.

A more distant affinity to the Cracow treatise, more within the illumination tradition or terminology than in the actual record, can be found in the manuscripts from the Tegernsee Abbey kept at the Munich Bayerische Staatsbibliothek, including one from the first half of the 15th century, Call No. Cgm 822, (Schneider, pp. 471–478), the second (Call No. Clm 20174) containing *Praecepta de cera et plurima de coloribus faciendis et de codicibus scribendis* from 1473 (Halm, p. 287 (No. 2341), and the third being an extensive collection of recipes from ca 1500: *Liber Illuministarum*, Call No. Cmg 821 (Schneider, pp. 461–470). Some similarities can also be found in the treatise *Illuminaciones et temperature colorum* compiled by Johannes Bolonienensis, and contained in the manuscript of Call No. Gl.kg1.S.165 kept at the Det Kongelige Bibliotek in Copenhagen. Interestingly, as can be read in the explicit to the treatise, Johannes wrote it down in ‘Gorlicz’ (Zgorzelec), on the border between Bohemia and the Kingdom of Germany (Thorndike 1959, pp. 16–21).

The above remarks concerning the provenance and character of the treatise *Ars de omnibus coloribus* allow us to suggest that it was compiled within the Jagiellonian University circles, and the fact that it was written down in the codex of Call No. BJ 778 may have been inspired by John of Dobra. The manuscript is dated to around 1425, when the future doctor, having been conferred the Master’s degree at the *artium* faculty, was beginning medical studies at the Cracow university, while intensively amassing specialist literature. It has also been confirmed that, among others, in 1426–1427, he copied medical treatises from the manuscript now at the Jagiellonian Library, Call No. BJ 2027 (Kowalczyk 2000, p. 261; Potkowski, p. 86). Furthermore, it is known, too, that not only did John of Dobra collect medical recipes, but he was also interested in the questions related to writing and painting techniques. In his manuscripts single recipes to make paints can be found; he was also familiar with Theophilus’s treatise (Kowalczyk 1977, p. 166). The fact that his handwriting was identified in manuscript BJ 1962 allowed to identify several other books from his library, including the manuscripts of Call Nos. BJ 758, 787, 802, 828, 837, and

849, in which the medic wrote some marginalia or added extensive comments (Kowalczyk 2000, p. 278). Several of those manuscripts, particularly the earlier ones, evidently copied abroad, may have reached his book collection as a purchase, and some were copied for his use. A similar editing scheme, decoration, and the same hand of the scribe who copied the technological treatise in BJ 778 may be identified in at least two more manuscripts as well: BJ 785 and 787. This shows that, while collecting various works, John of Dobra also resorted to the services of professional scribes whom he commissioned to copy respective texts. This, in turn, can lead to the conclusion that the treatise in manuscript BJ 778 was also copied on John of Dobra's commission.

What matters for the context of the genesis of the treatise is the overview of the historical backdrop to the creation of the *Ars de omnibus coloribus*. As mentioned above, the manuscript was written down around the period when John of Dobra was intensively collecting texts in relation to his medical studies. He may have had the manuscripts copied in the University environment where many manuscripts were imported from other university centres in Europe. The recipes in the treatise are most often connected with the manuscripts of Czech provenance. The last decades of the 14th and the first quarter of the 15th century exceptionally favoured Polish-Czech contacts in the sphere of culture and science, as well the migration of ideas and the transfer of current artistic styles. Under the Luxembourg rulers: Charles IV and Wenceslaus IV Prague turned into an important centre focusing cultural trends coming from different directions. Thanks to the oldest university in this part of Europe (from 1348), it also constituted an important centre of intellectual life, and, at the same time, an important centre of manuscript copying.

The years 1380-1430 were the heyday of Czech illumination focused around the Prague court and cathedral, radiating not only to neighbouring countries, but with its impact reaching also Rhineland, France, or England (Dostál, p. 57; Miodońska 1960, p. 154; Miodońska 1993, pp. 121-122). The artistic tendencies arrived

in Lesser Poland mainly through Silesia or Slovakia (Miodońska 1993, p. 122). That was the period when contacts between Prague and Cracow intensified, not only through those of the court, university, and intellectual circles, but also Church ones. They were particularly intense in the communication of Charles University with the recently-founded Cracow one (Miodońska 1960, p. 155). The necessity to copy manuscripts from Prague libraries by Polish students and professors for their own use may have favoured the enriching and perfecting of the writing techniques, not only inspiring interest, but also a need to become acquainted with the illumination techniques and materials. The general enlivening of contacts between the neighbouring countries led to the migration of numerous artists dealing with book decoration and Czech artists to Poland, this helping the penetration of painting styles and reception of the secrets of illuminator's technique (Miodońska 1960, p. 169). It goes without saying that for authors of manuscript decoration the arcane knowledge of the technique was of major importance. That is why, most likely, they collected painting recipes meant to boost their career potential. Recipes of the kind might have migrated to Poland along different channels: as a result of personal contacts between the Cracow and Prague university centres, through the contacts of monasteries of the same rule producing manuscripts, or directly, thanks to Czech artists active at the time in Poland. It seems that in the case of the treatise *Ars de omnibus coloribus* the most likely hypothesis is the interpenetration of the recipes through university contacts.

Addressees of such a compilation of painting recipes could be professional scribes, notaries, or text copiers focused on making additional rubrication, or on a more modest initial or marginal decoration. Such recipes may have been most commonly helpful when learning the basics of manuscript ornamentation, although in the case of the discussed manuscript we come across more advanced gilding techniques (Nos. 25, 35). In such a situation the usual thing was to systematically conduct the teaching of illumination art, as was the case in the later period (1482) when Bartłomiej,

an altaris at St Mary's Church in Cracow, began teaching Jacob of Bystrzyca the *illuminati libros cum auro et cum floribus* (Cracovia artificum, p. 249, No. 816; Miodońska 1993, p. 88).

When analysing the colour range of the decoration of manuscripts from the late 14th and the first decades of the 15th century, Barbara Miodyńska points to a more modest colour range of the works created in Poland than that which were products of Czech illuminators. What dominates in that painting is verdigris green, cool blue (in the shade of ultramarine), pinks, claret shades (interpreted by Miodyńska as a mixture of alizarin), vermilion red, cool greys, and light ochre. Among the colour selection it is more rarely that we come across pinks bordering on purple, cold violet, orange and a lemon yellow, as well as shades of reddish-grey. At the same time it is a light mat tone, obtained through softening the colours with white, that is characteristic of both Bohemia and Poland. In the second quarter of the 15th century the intense colour of the initial dominates over the pale green of foliated scrolls and flowers in the colour range of light grey, ochre, broken blue, and brownish pink (Miodońska 1960, pp. 197-198). These observations coincide with the colour scale of pigments and dyes presented in the *Ars de omnibus coloribus*.

Interestingly, let us also point to the character of paints generally applied in mediaeval book painting in the context of the terminology currently used in studies in art history. Names like 'water colour', 'gouache', or 'distemper' seem not to be historically adequate or too simplified versus the richness of painting methods applied in illumination. All the above terms refer to painting techniques based on definite binders or additives, as in the case of gouache. However, the illumination painting technique is far more complex, containing in it elements of all the above ones. It is water painting, using, nevertheless, various binders and their combinations, depending on the colour factor, or even on a century-long technique tradition. Next to the most commonly applied binders in the form of egg white or gum solutions, also animal glues obtained from different sources were used, but so were water-and-oil

emulsions in the form of egg yolk. The sources of colourants are an equally complex issue. In the palette of a painter-illuminator the same prominence as to mineral and earth pigments was given to lakes and dyes. The illumination technique combines elements of all the above variants of water painting, containing opaque or transparent paints, giving them an appropriate character through the application of various binders or additives.

The treatise *Ars de omnibus coloribus* contained in the manuscript of John of Dobra has to-date constituted a unique source related to the late-mediaeval illumination technique, and also a testimony to the migration and assimilation of Central-European artistic and technological influences in Poland. It is likely that further archival research can yield new discoveries of other technological texts, enriching our so-far knowledge of the secrets of the art of book and of the penetration of artistic traditions in the technological context.

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Translated by Magdalena Iwińska