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Foreword

Dear Reader,

We are very happy to share with you this second issue of Conservation Update from 2021. This brief foreword aims to acknowledge and recognise the work done from those involved in this issue over the last months.

The European Research Centre for Book and Paper Conservation - Restoration and its periodical, Conservation Update are thankful to everyone involved in the process of disseminating the journal. First, we would like to thank the Chief Editors who process authors' submissions and manage them through a process following the standards for a peer reviewed journal with this publication as the product.

We would like to express our gratitude to all the peer-reviewers involved, for their valuable commentaries, which helped shape the final content of the articles. Thanks to Anja Props, our new layout designer, who took over in this new issue and put every bit together, materialising it as a whole.

We would like to make a special mention to Zoe Reid and Maja Kostadinovska , who leave their positions as Chief Editor and Layout Designer, for their wonderful altruistic work in the journal during these last years.

You will find some differences in this new issue of Conservation Update from previous ones. New names, new design and, most importantly, a new format. In contrast with previous issues, this one and the next to come will only include academic articles. As a consequence, we are leaving aside other relevant information related to the ERC. But do not worry! It will continue to be available on our social media and the ERC webpage. From here we encourage you to engage with us and follow our news and activities on our Facebook and webpage.

We are working to make Conservation Update a journal that is more accessible and available to a bigger public and to offer our readers a better structured publication. Our commitment will continue to be resolute and maintain our focus on the divulgation the Book and Paper Conservation - Restoration research and to offer a reliable space for publication for academic professionals and researchers.

And last, but not least, thank you to the authors and readers, because without your work and your attention our purpose would be meaningless. It just remains for me to wish that the articles we gather here will bring you a refreshing perspective on the topics discussed and welcome you to continue giving us your support in future publications.

Pascual **Ruiz Segura**

Bleaching of Paper with the Help of Blue Light Emitting Diodes (LED): Experiments and Results

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ABSTRACT

The authors reviewed the results of experiments on light bleaching of paper objects with the use of blue light emitting diodes (LED) that were carried out and published by them in Russian from 2009 up to 2017. Two light devices with LED emitting blue light at a wave-length of 455–475 nm were used: a spotlight with 180 LED and a special installation with 1200 LED both constructed by Russian LLC “Folga” (St. Petersburg). Paper objects were placed in filtered water containing Ca^{++} and Mg^{++} ions at neutral pH at a distance of 7 cm from the light source, which is considered to be optimal for homogenous illumination. Water-ethanol mixture (1:1) was used as well. The light of chosen wave-length excludes the necessity for UV filters and does not raise the temperature of immersion baths. Objects of different paper composition and age, among them samples with printed and written texts, postcards, engravings and photographs were treated. The treatment’s efficiency was evaluated by changes in paper brightness and paper pH values, as well as by paper appearance before and after treatment. LED radiation for 4 hours was found optimal. The results of artificial humid thermal ageing by indices of brightness, pH, folding endurance of paper and the average degree of cellulose polymerization did not show negative action of the selected bleaching method on the long term stability of chromatographic cotton paper and newsprint paper containing lignin. The method is supposed to be useful in restoration practice.

1 Introduction

The idea of applying blue LED occurred to the authors as a result of studying the light bleaching of paper with fluorescent lamps[1, 2, 3] and in connection with the invention and successful development of LED lighting with its advantages[4]. The authors began with knowledge that short-wave blue light's energy is able to initiate the destruction of chromophores of paper discoloration products, i.e., to bleach paper. So, newsprint paper containing considerable amounts of lignin was bleached at a wave-length between 420 and 510 nm[5,6]. The chemistry of light bleaching can be attributed to the peroxide type, resulting from formation of hydroperoxide ions and radicals in water affected by light and oxygen.

LED emitting light at a wave-length of 455–475 nm was used in our work. The absence of ultraviolet (UV) and infrared rays in this irradiation eliminated the need for an UV light filter and cooling fans for the water bath used, when bleaching paper objects under fluorescent lamps.

Experiments with blue LED have been carried out since 2009 and limited to treatments of objects immersed in aqueous medium. The results of the experiments are described in numerous articles[7, 8, 9, 10, 11]. They are reviewed here in aggregate.

1 Gerasimova et al. (2006), p. 151
2 Gerasimova et al. (2009), p. 28
3 Dobrusina et al. (2011), p. 50
4 Yunovich (2011)
5 Leary (1967), p. 17
6 Feller et al. (1982), p. 65
7 Gerasimova et al. (2011), p. 139
8 Gerasimova et al. (2015), p. 61
9 Gerasimova et al. (2017), p. 268

2 Methods of Treatment and Results Estimation

2.1 Bleaching Devices with Blue LEDs

Initially, a blue SP-S 180-20-220 LED spotlight, provided by St. Petersburg-based LLC "Folga", was used. The area of illumination is 160 x 120 mm. It contains 180 470-R5-A15 blue LED with a radiation wave-length of 455–475 nm and an illumination angle of 20°. The spotlight power supply voltage is 220 V, with a current consumption of no more than 50 mA and an operational life of at least 100.000 hours (manufacturer data).

The spotlight was suspended upright so that the distance between LED and paper surface was about 7 cm, which is considered optimal for obtaining homogeneous illumination (Fig. 1).

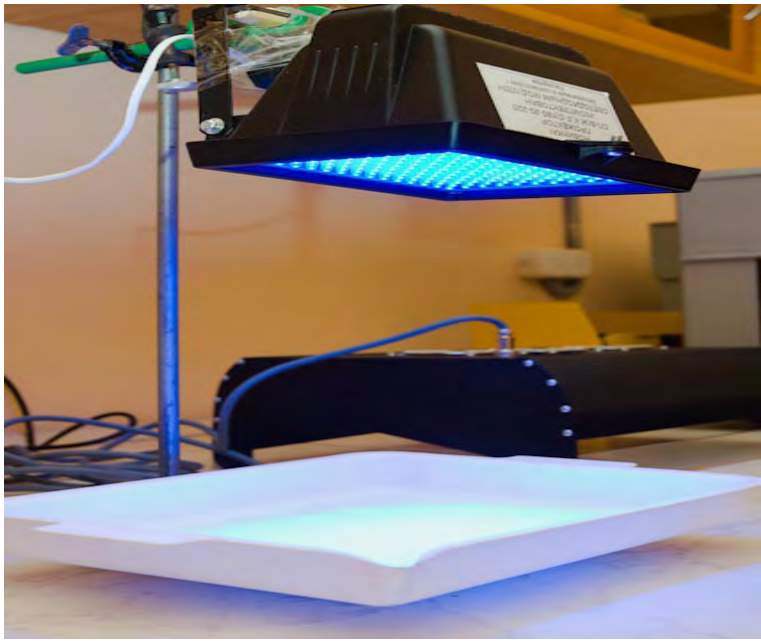


Fig. 1: *Spotlight SP–S 180-20-220 with 180 blue LEDs*

For further research the authors a special LED installation with a maximum area of illumination 300 x 400 mm was designed and constructed in LLC "Folga" according to the

authors technical order (Fig. 2). The installation consists of a metal table with legs which height ensuring an optimal distance from the light source to the surface of the samples (7 cm). 1200 blue LED with the same characteristics as in the spotlight are placed on the lower surface of the table plate. The upper surface is supplied with cooling fans. Underneath is placed uncovered plexiglass tray.

Fig. 2: *Installation for light bleaching of paper with 1200 blue LEDs*

2.2 Medium for Bleaching and the Treatment Mode

Water with a neutral pH value was used as a medium for bleaching, specifically tap water filtered through an "Akvafor jug" purifier with an Akvafor V100–1 replaceable filter module produced by LLC "Akvafor"(St. Petersburg), using its own technology. According to the manufacturer, the module provides deep water purification of chlorine, organic impurities, heavy metals. The content of iron ions in filtered water is no more than 0.1 mg/l and no more than 0.001 mg/l of copper ions. Filtered water contains Ca^{++} and Mg^{++} ions, its pH value is within 7.0 – 8.0.

The initial pH value of filtered water in our experiments with blue LED was in the range of 6.8 – 7.6. In part of the experiments, a mixture of filtered water with ethanol in a volume ratio 1:1 was also used as a bleaching medium.

Since the immersed samples were irradiated on one side, they were turned over in the middle of the bleaching period. Various options were considered for the duration of treatment. 4 hours (2 hours on each side) was decided as optimal. In all cases, the treatment began and ended with washing for half an hour in a medium similar to that in which the bleaching was carried out. Thus, the samples passed through three changes of water or water-ethanol. All operations were performed at room temperature.

2.3 Methods of Evaluation of Treatment Results

2.3.1 Physical, chemical and mechanical methods

The results of the treatment were evaluated according to changes in sample brightness, the pH values of their aqueous extracts, and visually through scanning.

Paper brightness was determined by the reflection coefficient of light at a wavelength of 457 nm using an Elrepho 070/071 spectrophotometer, illuminant D65/10°, in accordance with GOST RISO 11475-2010 "Paper and board method for determination of CIE whiteness, D65/10° illuminant (outdoor

daylight)". As a rule, measurements were carried out with apertures of 34 or 9 mm, in places without text, images or inscriptions. The results obtained were averaged. Since the method was non-destructive, it could be applied to the same samples before and after treatment or after its definite stage.

The effect of treatment was evaluated by a change of paper brightness $\Delta R=R_t - R_0$, where R_0 and R_t - paper brightness before and after treatment correspondently (%).

The pH value of paper aqueous extract (cold extraction) was determined according to GOST 12523-77 "Cellulose, paper, board method for determination of pH value of aqueous extract" using pH-meters with surface pH electrodes[10].

The influence of treatment on paper mechanical strength was estimated by changes in paper folding endurance measured on a Folding Endurance Tester: at a load of 9.8 N for cotton chromatographic paper and 4.9 N for newsprint paper high in lignin. Before measurements were taken, the samples were preconditioned to 50% RH and a temperature of 18° C in accordance with ISO 5626: 1993 "Paper Determination of Folding Endurance". The change in paper folding endurance as a result of treatment expressed in per cents to the index value before treatment.

For chromatographic paper consisting of pure cotton cellulose, the average degree of cellulose polymerization was determined by measuring the intrinsic viscosity of its solutions in cadoxen[11].

2.3.2 Ageing procedures

The stability of the treatment's effects was estimated by checking the same properties after humid thermal accelerated ageing and light ageing. Humid thermal ageing was carried out at 80° C and 65% RH in a TABAI chamber up to 288 hours.

Light ageing was conducted in the installation with OSRAM DU LUXE 11-860 LUMILUX and PHILIPS PL-L CLEO 3B lamps at 30000 lx illumination at 27° C and the distance 24 cm for 12 hours.

3 The results of the experiments

3.1 Experiments with the blue spotlight

For the first experiments, the following kinds of paper without text were taken:

- rag paper (19th century) made of flax fibers, sized;
- chromatographic paper of M grade (1962) made of cotton fibers without sizing and fillers;
- newsprint paper (1975) made of wood pulp (75%) and unbleached sulfite cellulose (25%);
- paper made of 100% cotton cellulose of experimental production (end of 20th century), hereinafter referred to as cotton paper;
- paper made of 100% sulfite cellulose (end of 20th century), hereinafter referred to as sulfite paper.

4x4 cm paper samples were bleached by the method described above in filtered water irradiated with the blue spotlight for 4 hours, 2 hours on each side. Simultaneously, other samples of the same paper were washed by keeping them in filtered water for 4 hours under ambient light.

Table 1 presents data on the brightness of untreated (control), washed and bleached

10 Mamaeva, Velikova (2016), p. 213
11 Shul´gina (1986), p. 10

samples before and after two types of accelerated ageing: humid thermal for 288 hours and light for 12 hours; Table 2 shows data on the aqueous extract pH of the same samples.

Table 1

Brightness (%) of untreated and treated paper before and after accelerated ageing

Paper	Treatment	Before ageing	Humid thermal ageing 288 h	Light ageing 12 h
Rag	Control	53.0	46.2	56.5
	Washing	55.9	50.8	59.5
	Bleaching	61.6	53.5	63.4
Chromatographic	Control	71.5	56.3	75.3
	Washing	79.7	74.0	82.7
	Bleaching	82.5	76.2	82.2
Newsprint	Control	49.7	39.3	45.9
	Washing	51.8	43.6	47.5
	Bleaching	53.7	42.8	46.6
Cotton	Control	87.6	82.5	87.9
	Washing	88.1	83.7	88.4
	Bleaching	88.6	83.5	88.7
Sulfite	Control	77.9	58.8	76.9
	Washing	80.8	65.4	79.9
	Bleaching	83.9	66.0	80.6

Table 2

Aqueous extract pH value of untreated and treated paper before and after accelerated ageing

Paper	Treatment	Before ageing	Humid thermal ageing 288 h	Light ageing 12 h
Rag	Control	5.7	5.8	5.7
	Washing	6.2	6.3	6.1
	Bleaching	6.4	6.3	6.2
Chromatographic	Control	6.3	6.3	6.3
	Washing	6.8	6.7	6.8
	Bleaching	6.8	6.7	6.8
Newsprint	Control	5.4	5.4	5.1
	Washing	6.5	6.1	5.9
	Bleaching	6.7	6.4	6.0
Cotton	Control	6.6	6.4	6.5
	Washing	6.7	6.4	6.6
	Bleaching	6.7	6.5	6.7
Sulfite	Control	6.0	5.6	5.9
	Washing	6.2	5.8	6.1
	Bleaching	6.5	5.9	6.3

As follows from the data in Table 1 (see "Before ageing"), the effect of brightness increase obtained by washing in filtered water was enhanced by blue irradiation on paper of all kinds. The lowest result was obtained for cotton paper with the highest initial brightness (87.6%): the brightness increase as a result of irradiation was only 0.5%. Light bleaching appeared to be most effective for rag paper with a fairly low initial brightness value (53.0%): the difference in brightness of bleached and washed samples was 5.7%. The brightness of the chromatographic paper after light bleaching increased by 11% (the initial value was 71.5%), the contribution of irradiation being only 2.8%, the rest being the result of washing. Almost the same contribution was made by irradiation in the increase of sulfite paper brightness, but in this case the role of washing was much less. A positive effect was obtained after light bleaching of newsprint paper: its brightness increased by 4% (from 49.7% up to 53.7%), but it was only by 1.9% higher than the result of washing (from 49.7% up to 51.8%).

Humid thermal ageing for 288 hours decreased the brightness of all the tested papers by varying degrees (Table 1), most of all that of untreated sulfite paper, which decreased in brightness by 19.1%. The smallest decrease was seen in cotton paper: 4.4% in the washed sample, 5.1% in untreated and bleached ones. The brightness of untreated chromatographic paper decreased by 15.2%, washed and bleached samples appeared to be significantly more stable, with brightness decreased by 5.6% and 6.3%, respectively. Among the samples of rag paper, the bleached one showed the greatest decrease of brightness (8.1%) and the washed one the least (5.1%). Brightness of untreated newsprint paper after humid thermal ageing decreased by 10.4%, the bleached one by 10.9% and the washed one by 8.2%.

Judging by the index changes in all five types of paper, the washed samples were more resistant to humid thermal ageing than the untreated and bleached ones.

After 12 hours of light ageing, the brightness of all rag paper samples increased: the untreated sample by 3.5%, the washed one by 3.6% and the bleached one by 1.8%; the untreated and washed chromatographic paper samples increased by 3.8 and 3.0%, respectively.

The bleached chromatographic paper sample and all cotton paper samples, which had high brightness values before ageing, were practically unchanged as a result of light ageing. Decrease in brightness was observed in samples of sulfite paper, by 1% in the untreated sample, by 0.9% in the washed one and by 3.3% in the bleached one. Light ageing had the greatest influence on newsprint paper, causing a decrease in the brightness of the bleached sample by 7.1%, that of the washed one by 4.3% and that of the untreated one by 3.8%. It should be noted that at the end of the selected periods of humid thermal and light ageing, bleached samples of all types of paper retained their superiority in brightness over the untreated ones. As Table 2 shows, changes in the paper pH value after the treatments were mainly determined by the influence of filtered water; blue light had little to no effect. In all five kinds of paper which had lower pH in their aqueous extracts than filtered water, the values of the index increased and became closer to neutral.

Both types of accelerated ageing had little effect on the pH values of treated and untreated samples of rag, chromatographic

and cotton papers. Sulfite paper showed resistance only to light ageing; after humid thermal ageing, the pH value of the control and washed samples decreased by 0.4 pH units, while that of the bleached one decreased by 0.6. The relatively low pH of untreated newsprint paper (5.4) did not change after humid thermal ageing, but after light ageing decreased by 0.3 units. The pH value of washed and bleached newsprint paper decreased after humid thermal ageing by 0.3 – 0.4 and after light ageing by 0.6 – 0.7 units, but remained 0.7-1.0 pH units higher than that of control samples subjected to similar ageing.

At the next stage, the scope of objects under study was widened, as seen in Table 3. Two bleaching media were compared: filtered water (pH 6.8–7.0) and a mixture of water and ethanol (1:1).

Table 3

Experimental paper material characteristics

№	Paper, dating	Fiber composition	Sizing	Thickness, mm	Text material	Note
1	strong rag paper, 19th century	flax, hemp	gelatin	0.28	without text	light brown stains (tide lines)
2	loose rag paper, 19th century	flax	gelatin	0.29	without text	Reddish foxing
3	grey rag paper, 19th century	flax	starch, gelatin	0.15	without text	brownish foxing
4	rag paper, 1852	flax	gelatin	0.13	iron gall ink	yellowness
4a	the same	flax	gelatin	0.13	black printing ink	the same
5	rag paper 19th century	flax	gelatin	0.13	campesian ink, red-brown pencil	the same
6	chromato-graphic paper, 1962	cotton	-	0.16	without text	the same
7	newsprint paper, 1975	bleached wood pulp — 75%, sulfite cellulose — 25%	-	0.09	without text	the same
8	book paper, 1915	wood pulp — 70%, softwood cellulose — 15%, flax — 15%	gelatin	0.09	black printing, campesian ink	the same
9	newsprint paper, 1954	wood pulp — 70%, softwood cellulose — 30%	-	0.10	black printing ink	the same

The experiments were carried out with 4 x 4 cm samples. Side views of the samples are shown in Figures 3 and 4, where the first sample in each row was not treated (control), the second one was washed in water, the third one was bleached in water, the fourth one was bleached in a mixture of equal volumes of water and ethanol. Bleaching and washing methods were the same as described previously. In this case brightness was measured all over sample surface for both sides of each sample before and after treatment. The brightness values obtained for the samples side shown in Figures 3 and 4 are given in Table 4.

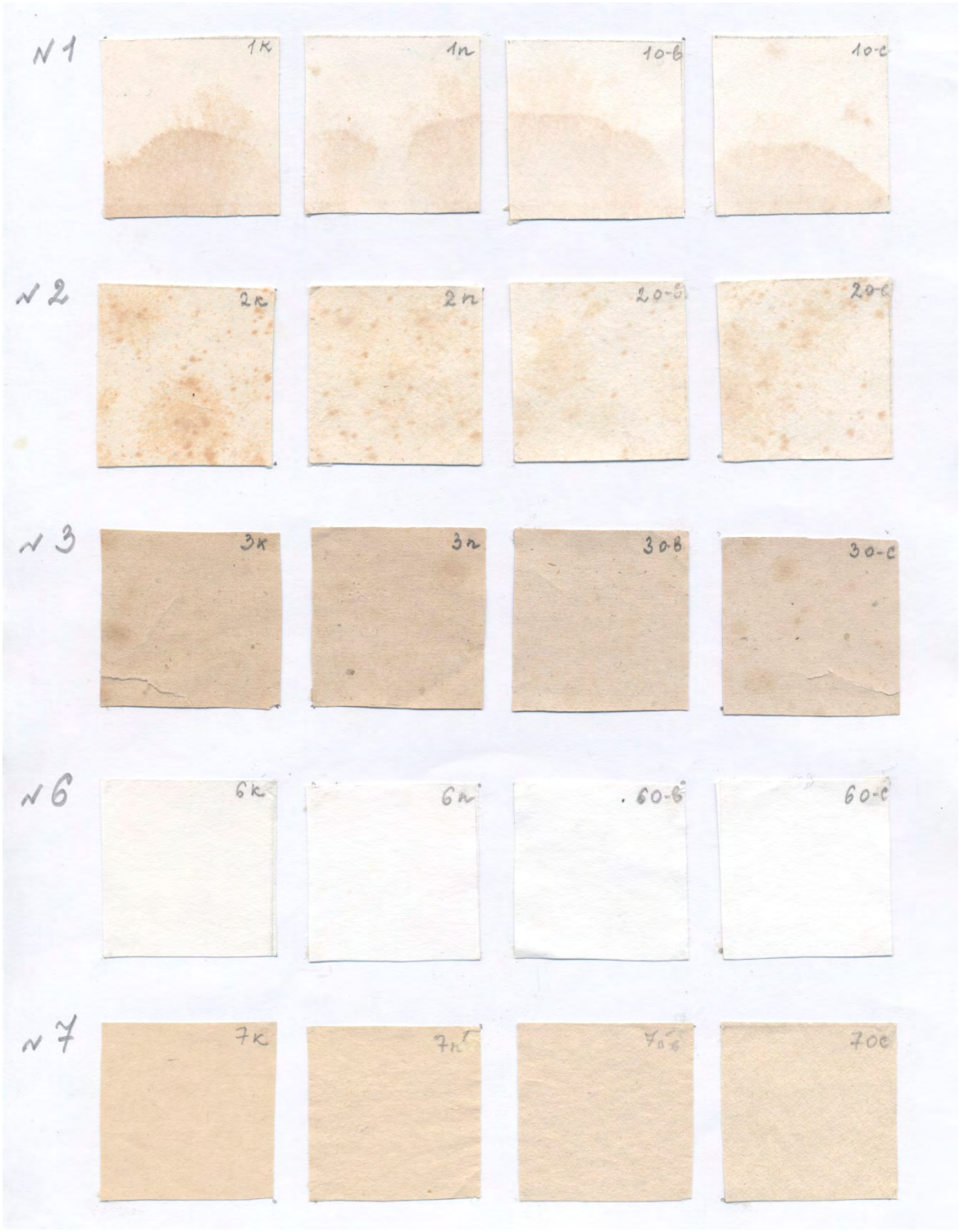


Fig. 3: *Samples without text: column 1 – control, 2 – washed, 3 – bleached in filtered water, 4 – bleached in water-ethanol mixture*

Fig. 4: *Samples with text: column 1 – control, 2 – washed, 3 – bleached in filtered water, 4 – bleached in water-ethanol mixture*

Brightness increase (ΔR_{457}) after treatment (washing or bleaching) was calculated for each side and averaged for the whole sample. In Table 5, average values of ΔR_{457} for washed and bleached samples are presented. The data on pH of samples aqueous extracts are shown in Table 6.

These experiments confirmed earlier findings on the effectiveness of blue LED for light bleaching of various papers and the neutralizing action of filtered water. Comparison of brightness increase (Table 5) after bleaching in water and water–ethanol mixture showed the advantage of the latter for seven kinds of samples out of ten, including all kinds of paper containing wood pulp (№ № 7 – 9).

Table 4

The samples brightness (%) on the side represented in Figures 3 and 4 (for № meaning see Table 3)

№	Control	Washing	Bleaching in water	Bleaching in water – ethanol
1	59.0	67.0	67.2	71.1
2	52.3	56.0	69.5	61.4
3	38.0	40.4	45.7	46.0
4	44.2	46.3	50.4	54.9
4a	46.5	46.7	50.9	55.9
5	51.2	55.0	54.5	57.3
6	81.5	85.4	87.2	87.2
7	47.9	49.2	52.5	54.9
8	36.3	39.8	41.5	43.1
9	34.6	35.0	37.3	40.0

Table 5

The samples brightness increase (ΔR457 , %) as the result of treatments (for № meaning see Table 3)

№	Washing	Bleaching in water	Bleaching in water – ethanol
1	5.9	8.7	11.0
2	3.3	12.0	9.3
3	2.5	7.7	8.5
4	1.9	5.5	9.6
4a	1.8	6.0	8.8
5	1.1	1.0	1.0
6	2.8	4.1	4.1
7	1.5	5.0	6.6
8	3.3	4.1	7.4
9	0.2	3.2	5.9

Table 6

pH of paper samples before and after treatments (for № meaning see Table 3)

№	Control	Washing	Bleaching in water	Bleaching in water – ethanol
1	6.1	6.5	6.6	6.5
2	6.0	6.6	6.6	6.6
3	6.3	6.6	6.7	6.6
4	5.2	6.5	6.5	6.4
4a	5.1	6.3	6.3	6.3
5	4.9	6.4	6.4	6.3
6	6.0	6.6	6.6	6.5
7	5.0	6.5	6.5	6.4
8	5.5	6.5	6.6	6.6
9	5.0	6.3	6.3	6.3

The experiments made it possible also to draw some conclusions about the influence of the treatments on certain writing and printing materials.

Judging by the visual observation, (Figure 4) the colour intensity of iron gall ink and black printing ink on rag paper (samples №№ 4 and 4A) did not change after water treatments and faded only slightly after water-ethanol treatments. None of the treatment types affected the campesian ink or red–brown pencil on rag paper (sample № 5). The campesian ink on 1915 book paper (sample № 8) did not change after treatments, while printed text on the same sample got noticeably diffused after water treatments and did not change after water-ethanol bleaching. The printed text of a 1954 newspaper (sample № 9) got partially diffused after all treatments.

The results showed the need for further studies on larger samples and documents. In this regard, a special LED installation was made.

3.2 Experiments with LED Installation

The effectiveness, influence on the properties of paper and potential practical use in restoration of bleaching using LED installation was examined. The objects of the study were samples of chromatographic and newsprint paper, (Table 3, №№ 6 and 7) as well as some printed materials and photographs (Table 8).

Table 7

Indices values of untreated and bleached paper properties before and after humid thermal ageing for 216 hours

Paper	Brightness, %	N, double folds	pH	DP
Chromotographic: Untreated	81.8	54	6.0	883
Untreated, aged	74.2	37	5.9	872
Bleached	86.8	51	6.5	892
Bleached, aged	82.8	38	6.3	872
Newsprint: Untreated	50.0	125	5.3	-
Untreated, aged	39.8	54	5.1	-
Bleached	54.0	220	6.0	-
Bleached, aged	46.5	96	5.5	-

Table 8

Data on the document bleached in the LED installation

№	Name/type of a document	Size, mm	Fiber composition of paper	Notes
1	Engraving A Bookplate “Shield”	230x146x0.16	flax	Yellowing, tidelines
2	Engraving B Bookplate “Eagle”	245x157x0.13	flax	Yellowing, stains
3	Leaflet "Alisher Navoi", Tashkent, 1941	297x209x0.15	wood cellulose	Yellowing, localized yellow stains
4	«Builder Solness» - scene from V.F. Komissarzhevskaya theatre play – Postcard, Moscow, 1905	87x137x0.32	wood cellulose with admixture of textile fibers (~2%)	Slight yellowing
5	V.F. Komissarzhevskaya portrait. Postcard, Moscow, 1922	136x85x0.23	wood cellulose	Significant yellowing, separate yellow stains
6	A portrait of a woman. Photograph, Leningrad, near 1940	191x131x0.26	wood cellulose	Yellowing, tidelines, the sheet corrugation remains of wood pulp carboard mounting
7	A carpet fragment. Photograph, Leningrad, 1937-1939	151x236x0.17	wood cellulose	Yellowing, yellow stains. Violet stamp, violet ballpoint pen ink

3.2.1 Effect of Treatment on Paper Properties

Samples of chromatographic and newsprint paper were immersed in filtered water (pH 7.1) and irradiated in the LED installation for 4 h (2 h on each side) being washed in filtered water for 30 min before and after irradiation. Half of the untreated and bleached samples were subjected to humid thermal ageing for 216 hours. The values of brightness, folding endurance (N, double folds) and pH of paper aqueous extract of all samples were determined. For the samples of chromatographic paper consisting of cotton cellulose without sizing agents and fillers, the average degree of cellulose polymerization (DP) was also determined. The results are given in Table 7.

As Table 7 shows, the brightness of chromatographic paper increased after bleaching by 5% and reached 86.8%. Humid thermal ageing reduced the brightness of untreated paper by 7.6% and that of bleached paper by only 4%.

Bleaching did little to change chromatographic paper folding endurance, its decrease was within the measurement error. After ageing, both unbleached and bleached samples had approximately equal folding endurances, which was less than 25–30% for those before ageing. The pH value of the aqueous extract of chromatographic paper rose as a result of bleaching from 6.0 to 6.5. Humid thermal ageing increased the acidity of its untreated and treated samples slightly, by 0.1–0.2 pH units. Bleaching did not affect the average degree of polymerization of chromatographic paper cellulose or its resistance to humid thermal ageing. After ageing, the degree of polymerization of untreated and bleached paper was the same, which was in accordance with the values of their folding endurance.

As for newsprint paper, its brightness increased by 4% and reached 54%. Accelerated ageing reduced the brightness of untreated paper by 10.2% and bleached paper by only 7.5%. Bleaching significantly increased the folding endurance of newsprint paper. After accelerated ageing, bleached and unbleached samples showed the same decrease of the folding endurance, i.e., even after ageing bleached paper retained its superiority in strength over unbleached paper. The pH value of the newsprint paper aqueous extract after bleaching increased by 0.7 pH units, reaching 6.0, and after ageing it was 0.4 pH units higher than that of untreated paper.

Thus, bleaching with blue light in the LED installation increased the brightness and reduced the acidity of both cotton fiber paper (chromatographic) and paper with a high content of lignin (newsprint paper). The degree of polymerization and folding endurance of chromatographic paper did not change, while the strength of newsprint paper increased significantly. After humid thermal ageing for 216 hours, the bleached samples of both papers retained superiority over unbleached ones in terms of brightness, pH values, and in the case of newsprint paper, folding endurance. Besides, the bleached paper showed better stability of brightness under humid thermal ageing.

3.2.2 Experimental Bleaching of Documents

Information on the documents bleached in the LED installation is given in Table 8. These are engravings, printed editions with text, postcards and photographs, dated from 1901-1941, all of which are the property of the authors. Bleaching was intended to improve the appearance of the objects and to check

the changes. The appearance was recorded by scanning before treatment and after each stage. Brightness and pH were measured.

Two engravings printed on paper made of flax fiber with a weak gelatin sizing (Table 8, №№ 1 and 2, Fig. 5) were bleached first.

After pre-washing for 30 min, the engravings were bleached 6 times in filtered water. Each of the six bleaching procedures was carried out for 4 hours (2 hours on each side of the engraving), followed by washing in fresh filtered water and drying between sheets of filter paper for two days and nights. Brightness was measured before the treatment and after each stage in the five areas selected on the reverse side of the engraving, the results being averaged (Table 9).

Table 9

Brightness of the engravings paper before and after the treatment stages

Treatment	Brightness, %	
	Engraving A	Engraving B
Before treatment	38.9	54.4
Pre-washing (30 min)	42.2	59.1
Bleaching duration, hour:		
4	51.6	69.5
8	55.8	73.1
12	59.2	74.6
16	62.2	76.0
20	63.1	76.6
24	64.5	77.3

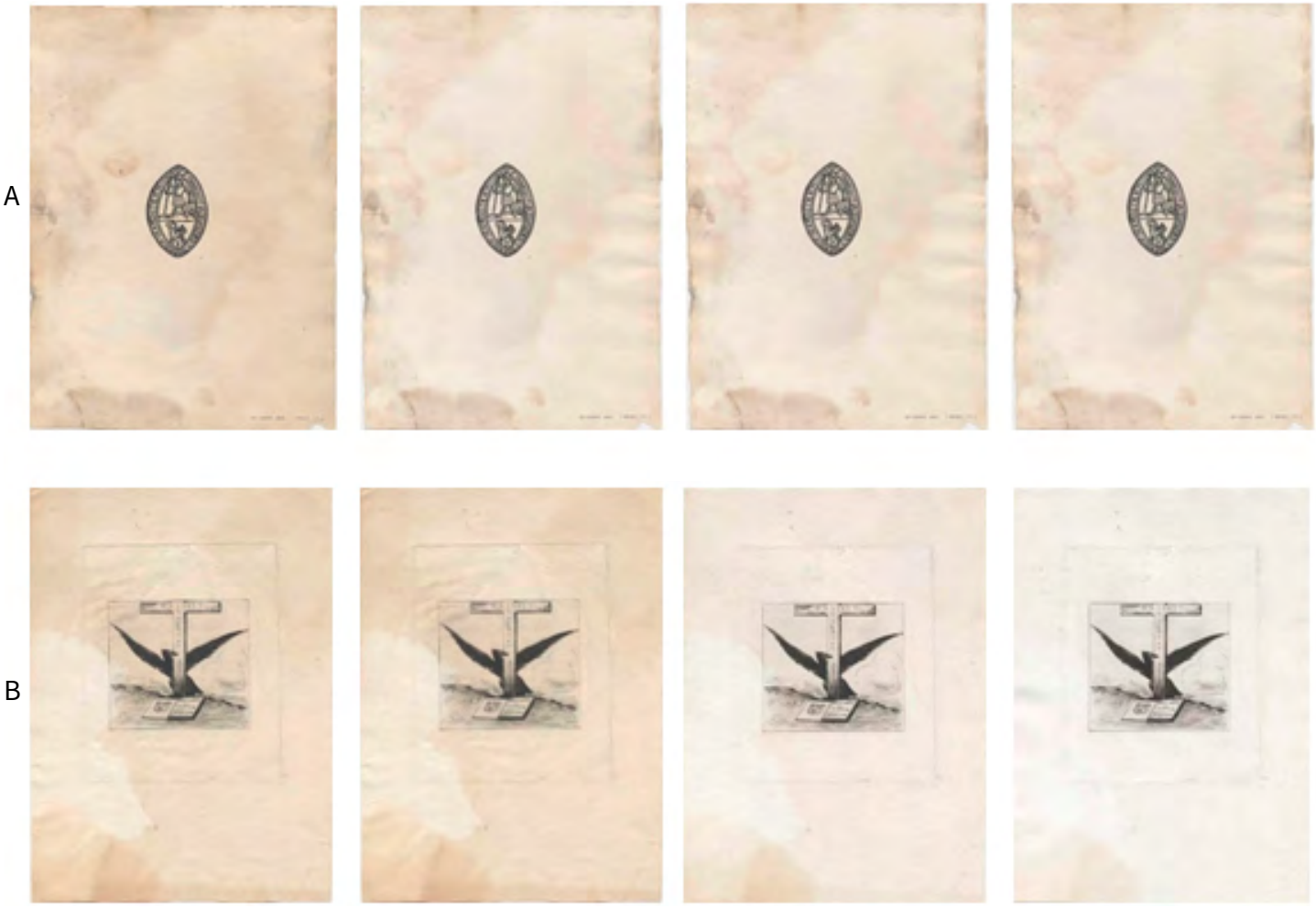


Fig. 5: *Engravings A and B before and after treatments*

Washing in filtered water for half an hour increased the brightness of the paper support of engraving A by 3.3% and that of engraving B by 4.7%. Bleaching for 4 hours led to an increase in the brightness of engraving A by 9.4% and for engraving B by 10.4% when compared with pre-washing levels. With further exposure to light up to 24 hours, the brightness continued to increase while gradually slowing down.

Figure 5 represent the appearance of the engravings A and B, recorded by scanning, before treatment, after washing and after bleaching for 4 hours and for 24 hours.

The influence of the treatment on the engravings printing ink was not noticed.

Sheets of printed publications (Table 8, № 3, Fig. 6) and postcards (Table 8, №№ 4 and 5, Fig. 7 and 8) were treated in a similar manner. The only difference was the duration of LED bleaching, which was limited to 4 hours.

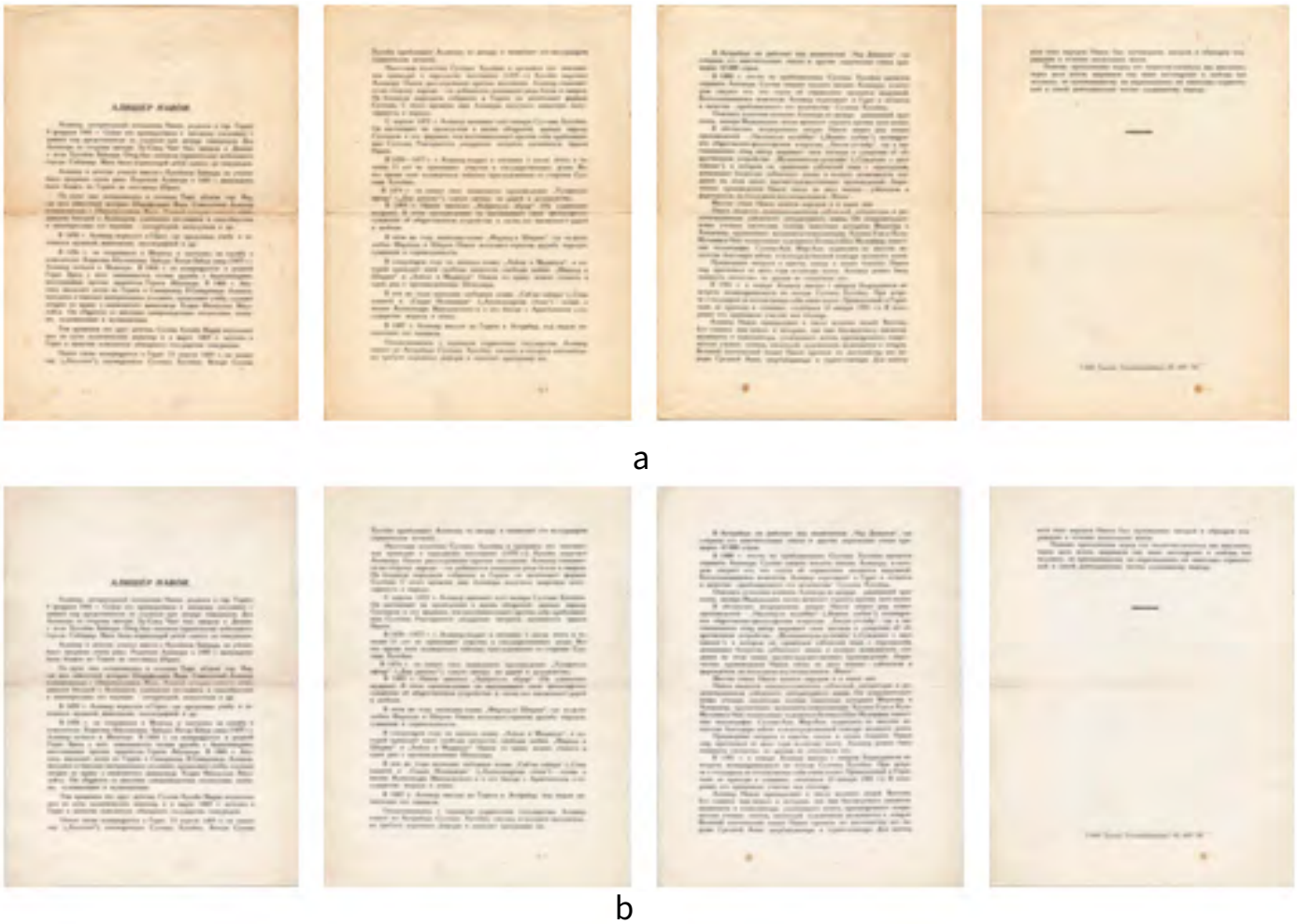
The obtained data on paper brightness and pH values of the objects paper of this group are shown in Table 10.

Table 10

The effect of bleaching treatment on the paper brightness and pH value of the paper aqueous extract

Object №	Brightness, %		pH	
	Before treatment	After treatment	Before treatment	After treatment
3	49.5*	59.0*	4.5*	5.2*
4	50.0	55.5	5.0	5.7
5	30.0	45.5	4.2	5.0

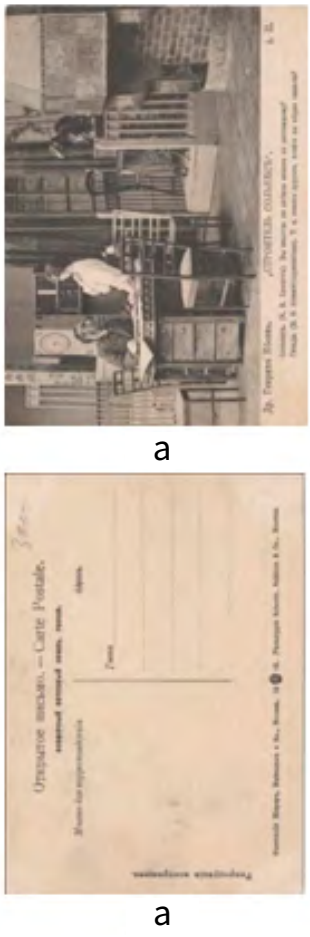
Note: * average value for two sheets.



a

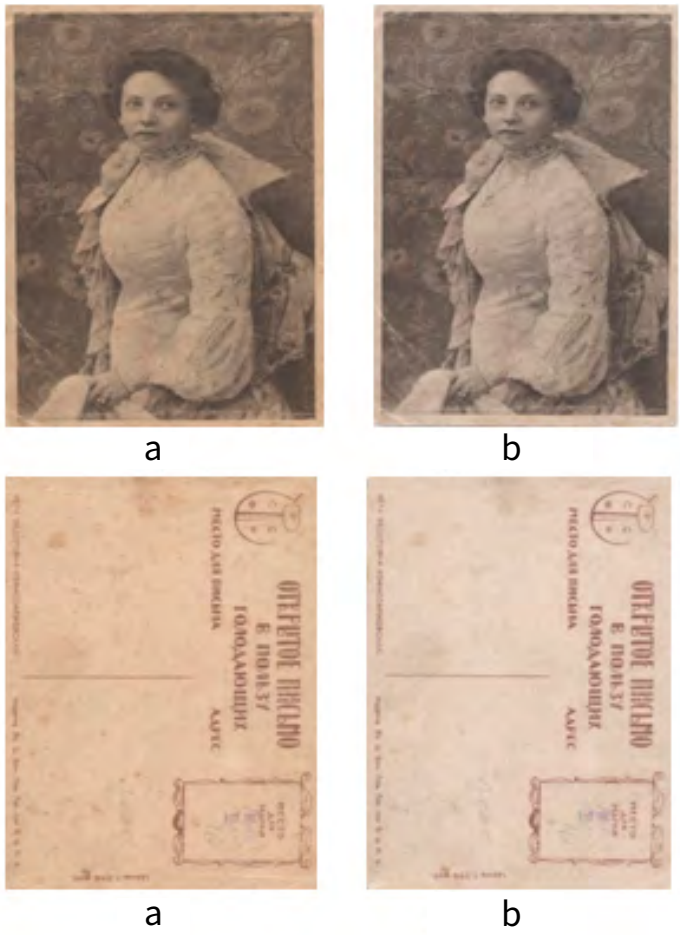
b

Fig. 6: *Leflet "Alisher Navoi": a – before treatment, b – after bleaching (4 h)*



a b

Fig. 7: *Postcard "Builder Solness" – a scene from the performance of the V. F. Komissarzhevskaya theater: a – before treatment, b – after bleaching (4 h)*



a b

Fig. 8: *Postcard "Portrait of V. F. Komissarzhevskaya»: a – before treatment, b – after bleaching (4 h)*

"Alisher Navoi" (№ 3) leaflet pages, before and after treatment, are presented in Figure 6. The treatment resulted in yellowness removal, the increase in brightness was about 10%, printing ink was well preserved.

The increase in paper brightness of a postcard with a scene from the play "Builder Solness" (№ 4), which had no significant yellowness and stains, was small (5.5%), but the result obtained was quite satisfactory (Fig. 7). On the contrary, the brightness of the postcard paper with a portrait of V. F. Komissarzhevskaya (№ 5), strongly yellowed and with numerous stains, increased significantly after bleaching (by 15.5 %). The appearance of the card improved and the print was not affected (Figure 8).

The paper of all four objects of this group had high acidity, ranging from 4.2 (№ 3) to 5.0 (№ 4). As a result of treatment in all cases, a decrease in acidity (an increase in the pH value) by 0.7 – 0.8 pH units was achieved.

Work with this group of objects confirmed the effectiveness of the applied mode of LED bleaching as a way to increase paper brightness and reduce its acidity, without affecting texts and images made with printing ink and graphite pencil.

The photographs (Table 8, №№ 6, 7) were treated in the same manner, the only difference being that when drying in a press between sheets of filter paper, the photo was covered with a sheet material of Parafil KT 30 on the face side to prevent the adhesion of the wet photo layer to the filter paper.

The woman's portrait (Fig. 9), which had background yellowing, sheet deformation, tide line and significant discolouration in the lower part with cardboard remains from the mounting, had been bleached for 4 hours (similar to objects № 3 – 5). The brightness values of the face and reverse sides of the photograph before treatment, after washing and after bleaching are given in Table 11.

Fig. 9: *A woman portrait. Photograph: a – before treatment, b – after washing (0.5 h), c – after bleaching (4 h)*

Table 11
The effect of bleaching treatment on the paper brightness and pH value of the paper aqueous extract

Object №	Brightness, %		pH	
	Before treatment	After treatment	Before treatment	After treatment
3	49.5*	59.0*	4.5*	5.2*
4	50.0	55.5	5.0	5.7
5	30.0	45.5	4.2	5.0

Note: * average value for two sheets.

The treatment resulted in a brightness increase on the face side by 9% and that of the reverse side by 9.5%. The discolouration and the tide line were significantly diminished. The deformation was eliminated in the process of drying in a press; the photo image remained unchanged.

The photograph of a carpet fragment (Fig. 10) had slight yellowing of the paper, a large yellow stain and small stains on the reverse side, which were almost not reflected in the image on the face side. This photo was bleached in two stages, 30 min each, with the face and reverse sides being irradiated for 15 min at each stage. Data on the brightness values of the reverse side measured before and after treatment are shown in Table 12. In this case, a satisfactory result was achieved as soon as half an hour after bleaching with preliminary washing. Paper brightness increased by 6.5% and in the area of the stain by 9%. The next 30 min of bleaching led to a further increase in brightness, but only by 1 – 1.5%. The photo image remained well preserved.

The experiments with black-and-white photographs showed the possibility of using the LED installation for bleaching the paper

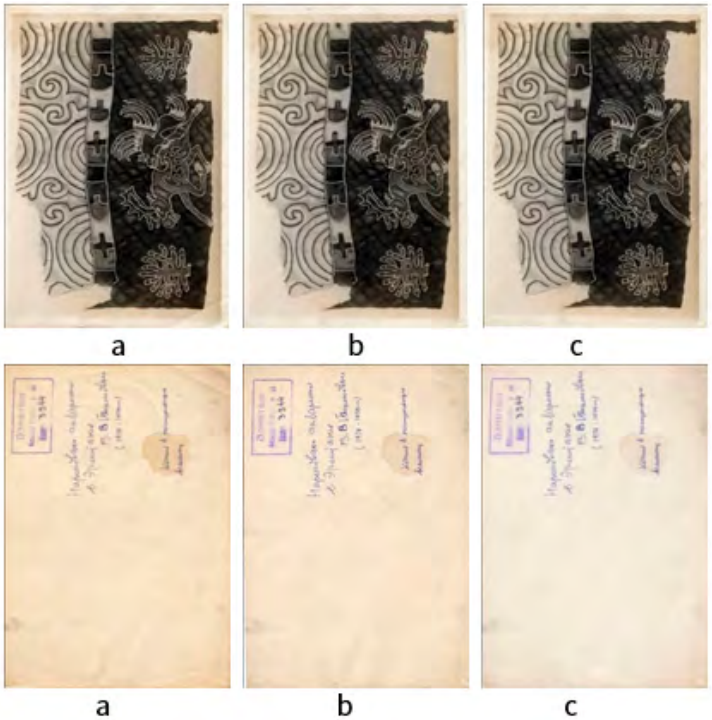


Fig. 10: *Photograph of a carpet fragment: a – before treatment, b – after washing (30 min), c – after bleaching (60 min)*

Table 12
The effect of bleaching treatment on the paper brightness and pH value of the paper aqueous extract

Treatment type	Treatment duration, min	Brightness, %	
		Area without stain	Area with stain
Before treatment		48.5	37.0
Washing	30	51.5	42.0
Bleaching:			
1 stage	30	55.0	46.0
2 stage	30	56.0	47.5

support of such objects without affecting the photo image. The presence of inscriptions with a ballpoint pen and a stamp on the reverse side of one of the photos (Fig. 10) made it possible to note the stability of violet ball point ink during pre-washing and light bleaching for 60 minutes and the blurring of violet stamp ink around its contours, which occurred in the very process of pre-washing.

4 Conclusion

It was experimentally shown that light bleaching of paper objects through irradiation with a wave-length of 455–475 nm obtained from blue 470–R5–A15 LEDs could be used. For the experiments, a lighting device (spotlight) with an illuminating area of 160 x 120 mm, containing 180 LEDs, and a specially designed installation with 1200 LEDs with a maximum illuminating area of 300 x 400 mm were used. The absence of UV and IR rays in the irradiation allows the process to be carried out at room temperature and without UV filters.

Irradiation for 4 hours (2 hours on each side of the object) in tap water, purified by an "Akvafor Jug" filter, with pre- and post-washing for 30 min, was chosen as an optimum mode. Filtered water with pH 7–8, containing ions Ca^{2+} and Mg^{2+}, gives paper a neutralizing effect and increases paper resistance to ageing. In some experiments, a mixture of this water and ethanol (1:1) was used.

The efficiency of the chosen method was shown on various papers made of flax, cotton, sulfite cellulose, wood pulp, as well as on samples and separate sheets with printed and handwritten texts, engravings, postcards and black-and-white photographs. The treatment efficiency was evaluated mainly by increases in paper brightness and pH values. Comparison of two bleaching media, water and water-ethanol mixture (1:1), showed the greater efficiency of the latter in most cases.

The results of humid thermal ageing by indices of brightness, pH, folding endurance of paper and the average degree of cellulose polymerization indicated the absence of negative influence of the selected method of bleaching on the durability of chromatographic paper made of cotton fibers and newsprint paper with high content of lignin.

Observations on the behavior of some printing and writing materials in the washing and bleaching processes showed that campesian ink, graphite and color (red–brown) pencils withstood water and water-ethanol mediums. Black printer's ink and iron gall ink on rag paper did not change after treatments in water and slightly faded after bleaching in water- ethanol mixture, while printed text on 20th century newspaper showed a tendency to diffuse in both mediums. After water treatments violet stamp ink diffused a little around the stamp contour and violet ballpoint pen paste did not change.

The results of the experiments suggest that the proposed method of paper bleaching with blue LED will probably find its place in restoration practice.

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Deletions in Manuscripts and Conservators´ Decision-Making Depicted in SKOS

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ABSTRACT

Deletions found in manuscripts may, on the one hand, give us valuable information about the history of the individual manuscript or handling practices of the particular time; on the other hand, they are a challenge for conservators because they may require some particular action.

The paper seeks to

- Draw attention to the topic “deletions in manuscripts” and the types of information that their proper interpretation should contain
- Give tools to identify deletions in manuscripts
- Conclude with some introductory points towards a discussion on how conservation theory can address deletions.

SKOS stands for Simple Knowledge Organization System and is an area of work developing specifications and standards to support the use of knowledge organization systems (KOS) such as thesauri, classification schemes, subject heading lists and taxonomies within the framework of the Semantic Web.[1]

1 https://www.w3.org/2004/02/skos/ (31st Aug. 2021)

1 Introduction

In the framework of "Digitale und soziale Transformation in der Hochschulbildung" (DITAH), an inner Austrian joint project of a number of Austrian universities: Akademie der bildenden Künste Wien, Donau-Universität Krems, Österreichische Akademie der Wissenschaften, Österreichische Nationalbibliothek, Paris-Lodron-Universität Salzburg, Universität Graz, Universität Innsbruck, Universität Wien, Technische Universität Wien (lead Graz University), funded by the Austrian Federal Ministry for Education, Science and Research, the author´s task was to describe various conservation aspects in a way that would allow entry of that description in SKOS[1] online structure, making it accessible to the general public.

In this publication the author describes the information brought together, focusing on the topic of text and image deletion, i.e. making a text or picture invisible. The topic is relevant for conservation, as deletions constitute one of the aspects of the heritage items. They may provide information on their history and must be detected, interpreted and preserved accordingly. Therefore, they need to be dealt with in an appropriate manner in the course of developing a conservation concept.

The advantage of entering information in SKOS is dual:

- The open access mode allows for adding further research results
- The SKOS structure may be entered at any point and can be followed in either direction, i.e. towards the starting point (which is the topic "Deletions" in this case) or to the end-branches of the structural "tree"

The author, being a conservator, understands and describes the topic from the perspective of a conservator, however the topic is also interesting for philologists, historians and other experts in book-related fields.

As the target of the survey was the SKOS, the text of the contribution has to follow the "layers" of that description structure and the headlines are therefore somewhat unusual for a publication in a journal. With "layers" the tree structure of a thinking procedure or a computer structure is meant.

1. First layer - Definition and first division

Deletions are in principle alteration of material of manuscripts – text or image – which were done deliberately.

The difference between deletions and damage will be described later, in the context of developing the conservation strategy. The appearance may be the same, but the cause is different and the objective is to identify the actual cause on the basis of physical evidence.

While the main focus of this survey is on parchment as a text carrier, we also include papyrus or paper. One reason for that decision is that it would feel as a loss to have studied the source material and not provide it here; in particular in the context of a SKOS system, where more content can be added any time later. The second reason is that in some of the recipes the text carrier is not explicitly named.[2]

1 Simple Knowledge Organisation System

2 The material was brought together in the author´s dissertation work at the University of Fine Arts in Warsaw and in parts published in Patricia Engel, "Deletions in manuscripts: Historical sources and physical traces"

2. Second layer –distinguishing between deleting during and after writing

The reason why deletions were done might be different and here we have already the first fork in the logical path, because they appear differently depending on when they were made:

- During writing
- After the manuscript was finished.

2.1 During writing the scribe will not only delete letters or words immediately after he had made the mistake, using the most practical method, in most cases deleting with a knife, but he will also overwrite the area immediately. Other so-called “dry deleting” methods are also witnessed, such as using sandstone and dry bread. Therefore the indicators for such deletions during writing are:

- letters or words are deleted (very locally)
- the ink of the text and the overwriting are the same
- the tools used are knife, sandstone, etc., any dry and locally applied tool, which allowed for immediate overwriting and thus did not particularly interrupt the process of writing

The various methods used for deleting text will be the theme of the next SKOS layer and must be connected to the layer following that, dedicated to our sources . This is valuable information, as it allows dating post quem (limit after which), in particular, the mixes of liquids we encounter in the time periods shortly before 1500[3]. Further layers are the description of the traces left by dry deleting methods in the material, the description about how we can identify them (next layer) and, finally, how to interpret them and how a conservator should respond to them.

After the structure has been laid out using the dry local deletion methods as an example, we now continue with the content to be filled into the SKOS. The chapter numbers represent the depth of the tree.

2.2. Correction after the text is finished may have happened immediately, by corrector a proof reader or later. In any case,

- the corrections are made in a fully finished text. In contrast to deleting in the flow of writing,
- there is no extra space to fit words than there was originally. So if not crossed out and written above in smaller letters, which also was done in case the wrong text was taken away, the new word must be fit into the space, whether it is shorter or longer than the original one.
- While the scribe will have used his ink for overwriting deleted words during writing procedure (2.1), a different ink should have been used for corrections made later (Here we need a link to ink survey methods in SKOS. – being able to interlink the particular entries of such a chapter with other chapters´ entries is another advantage of SKOS and this paper describing the chapter

in Care and Conservation of manuscripts, Copenhagen 2012, pp. 109-135 and the applied use of such findings proven in Patricia Engel, "Die Tilgungen im Ratmann Sakramentar – Hinweise auf die Traditionspflege im Kloster St. Michael um 1400„ in: 1000 Jahre St. Michael in Hildesheim – Kirche – Kloster – Stifter. Gerhard Lutz, Angela Weyer (Ed.) Michael Imhof Verlag, 2012, pp.242-248

3 The period of survey is from 0-1500, see also Fig. 1

deletions in SKOS consequently also must be mentioned). (These first assumptions of what deleting method was applied and why will finally be part of the layer where we identify the deleting method.)

For later corrections dry deleting methods were used, but also overpainting, over pasting and over sewing (link there)

The common feature of 2.1. and 2.2 is that the deletions are restricted to relatively small areas.

2.3 Outdating of text due to change of language or rite can be the third reason for deletions. Books were sorted out and often used as book binding material to strengthen the binding structure, however in many cases the parchment, which was considered valuable, was used again, for a second or even a third time, with the entire text deleted. To produce the so called **palimpsests**, deletion methods had to be efficient and good enough to take away text on a large scale. There were particular dry scraping methods available, such as the use of pumice and sepiolite, but also physico-chemical methods, such as washing off the text with various liquids, starting from water, making use of pH change, for example by using wine, loosening the parchments structure with milk, etc., and finally combinations of different methods.

A finding of a deletion might indicate a certain reason for it, which might suit to support already existing hypothesis about the history of the manuscript, but it might also be that knowing the history of the manuscript helps understand the deletion. Therefore, a SKOS link to the history of a manuscript is needed here.

3. The deleting methods

The choice of deleting method does not only relate to the moment of deletion and the situation the scribe or corrector or palimpsestor was in when the deletion action was made, but also with the material of the text (particular the ink, etc.) and the support (parchment, etc.). In our case, however, we focus on parchment, as explained above. Still, papyrus and paper must be considered when a full picture is given, and in SKOS we should provide links to the relevant material, which may be various sorts of ink, parchment or paper.

It furthermore shall be stressed that we have available – according to our knowledge – a certain date *post quem* for the various methods which is taken from old texts, i.e. scribes' manuals, etc.

The dating *post quem* may be also used for the particular sort of writing material. However, with writing material we also have local dissemination, which means we also must provide a link to a map in SKOS and indicate local use of material by scribes.

3.1 Dry

The dry deleting methods either rely on the abrasion of the inks plus the uppermost layer of the parchment, which can be performed with a knife, a piece of pumice, sepiolite, deletion bread or sand stone; a second technique is by dusting off writing material with feathers. The latter can be done in the case of charcoal, which is not fixed strongly to the parchment but held by weak electric forces and its trapping in the rough surface.

Further the author presents each and every deleting method by first giving the sources and then providing all contents need-

ed to fill up the SKOS structure, specifically:

- the material on which the particular deletion method would work well and therefore was applied,
- the date we found with the publication of the source, which allows for dating post quem,
- the quotation of the source,
- the description of traces left on the manuscript after the particular deletion method was applied,
- the means of the detection of the traces, and
- the difficulties which might occur in their interpretation.

3.1.1 Knife features on numerous depictions of scribes including the evangelists in gospels. At the same time it is mentioned already in the Bible (Jeremias 36,23)[4]. In the scribes´ manuals we do not find knife mentioned as a deleting tool and the reason for that might be the fact that its use was too obvious and too well established.

Gardthausen cites some old texts he found and interprets them in such a way that the knife had various functions: to erase mistakes while writing, to sharpen the writing tool and to shape the papyrus: „Ferner fehlt unter den aufgezählten Schreibgeräten niemals das Federmesser σμίλη δονάχων ακροβελων γλυφίς oder χάλυψ σκληρος καλαμηφάγος oder wie es in einem anderen Epigramme heißt: καί γλυφάνου καλάμου πλατέος γλωχινα σιδήρου. In dem Glossar des Philoxenus wird σμίλα erklärt scalprum sicila sculpium, σμίλα χαρτοτόμος, sicila σμιλίον scalpellum. Es diente also sowohl zum Schneiden des Schreibrohrs und zum Beschneiden des Papyrus.“ (Gardthausen 1911:190)[5]

Table 1
The knife and its application and traces left

Means and methods of deleting	Material of deletable/ deleted text	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Knife	All inks on papyrus, parchment and paper	always	Bible, depictions, Gardthausen 1911:190	Thinner and rougher areas	Lighter area: transmitted light, darker area: raking light. Locally, smeared inks. Ink written over the area in most cases blurring. This may also be the case with other dry deleting methods, however if full pages are cleaned they are often re-polished after this, which is actually not the case when knife was used.	Comparing with surrounding area	Areas which are thinner due to preparation of the parchment, in such cases no locally rougher area, no smearing of ink and no relation to the text

4 Jeremias 36,23
5 Gardthausen, V. “Das Buchwesen im Altertum und im byzantinischen Mittelalter“ 2. Aufl. Leipzig (1911):190 (translation by the author and Dr. B. Gallistl Hildesheim: Furthermore never is missing amongst the maned writers´ tools the knife, the knife with the sharp point, which cuts the reed or as it is expressed in a different epigram: the iron point of the flat knife for the reed. In the glossary of Philoxenus the knife is explained as chisel of Sicilian carving, papercutting knife. Thus it served for cutting the reed and the paper.)
6 The survey was made with the unaided senses as well as with a microscope 20x and a hand held UV lamp 380-315 nm. The sort of microscope actually does not play a role in detecting the findings.

3.1.2 Dry Cleaning Methods for entire pages

Pumice, sepiolite, sandstone, "bread" and eraser powder

Pumice, sepiolite, sandstone, "bread" and eraser powder are all deleting materials.
Their common feature is that they allow cleaning text from entire pages of parchment, which is not achievable with a knife.
To distinguish which of the 5 methods were applied we may use several indicators:

- the probability that the respective material was available,
- the traces it leaves, which are detectable with the naked eye in transmitted or raking light at an angle and with magnification,
- one further way of distinguishing between them is the analysis of trace elements presumably left by the particular material.

Pumice is volcanic rockglass in which the incapsulated gas was released immediately, which accounts for its porous structure; the pours may be of different sizes (Here, and for the following material, we should provide links to Materials section of SKOS).

Sepiolite (**Os sepium**) is the inner skeleton of a sepia fish (sepia officinalis), a light white porous piece consisting mainly of aragonite (calcium carbonate).
As this bone has a distinct structure it sometimes is possible to see the traces of this structure on a palimpsest showing parallel lines of scratches.

"Bread" (**Schleifbrot**) is a mixture of flour, chalk, egg white and glass (sometimes yeast was added too and the substance was baked (personal communication, D. Oltrogge). This chalky "bread" was used in geographic areas far from sea coasts, where pumice and sepiolite were not readily available.

Sandstone is a natural fine-structured stone which was also readily available in areas far from sea coasts. It was made into sticks and used for deletion of text.

Eraser powder is a comparatively late recipe for deleting texts; the powder made of dried powdered hare skin was used in combination with pumice as a tool for rubbing the powder into the letter required to be deleted – the leather fibres penetrated both the pumice and the surface of the writing material.

3.1.2.1 Pumice

Theophrastus mentions pumice in his tractatus about stones: „Γίνεται γαρ τις και τοιαυτη κίσσηρις και βάρος έχει και πυκνότητα και έν τη χρησει πολυτιμοτέρα της ετερας. Τμητικη δε και η εκ του ρυακος μαλλον της κούφης και λευκης, τμητικωτάη δ΄ (η) έκ της θαλάσσης αύτης. και περι μεν της κισσηριδος έπι τοσουτον είρησθω." (Theophrastus 1956:22[7])

Mappae Clavicula[8]: "pumice is made everywhere"

7 Caley, E. R. "Theophrastus on Stones" Introduction, Greek text, English Translation and Commentary Earle R. Caley, The Ohio State University Columbus, Ohio, The Ohio State University, (1956) translation: „for a pumice of this kind, having both weight and density, is also produced, and this is more valuable than the other in its practical use. The one that comes from the lava stream can cut better than the white kind, which is light in weight, but the kind that comes from the sea itself cuts best of all. So much for pumice." THEOPHRASTUS ON STONES, INTRODUCTION, GREEK TEXT, ENGLISH TRANSLATION, AND COMMENTARY EARLE R. CALEY THE OHIO STATE UNIVERSITY JOHN F. C. RICHARDS COLUMBIA UNIVERSITY COLUMBUS, OHIO THE OHIO STATE UNIVERSITY 1956. P. 49 file:///home/bernhard/Downloads/THEOPHRASTUS_CALEY.pdf (31st Aug. 2021)
8 Smith, C. S.; J. G. Hawthorne "Mappae Clavicula: A little key to the world of Medieval Techniques" Transactions of the American Philosophical Society (n.s.) 64(4) (1974) and Petzold, A. "De coloribus et mixtionibus: The Earliest Manuscripts of a Romanesque Illuminator´s

Albertus Magnus in his systematic of stones: ”sicut pumex, et lapis quem evomunt thermae vel ignis Vulcani…“ (Albertus Magnus after Ed. 1890:3) [9]

More specific evidence about deleting text with pumice: Catull: „…puto esse ego illi milia aut decem aut plura perscripta, nec sic, ut fit, in palimpseston relata: cartae regiae, novi libri, novi umbilici, nova rubra membranae, derecta plumbo et pumice omnia aequata. Haec cum legas tu…“ (Catull C. 22.5)[10]

Ovid (trist. 1,1.11)[11] and Horace (Horace ep. 1,20, 1-2)[12] mention pumice in their introductions: „Vortumnum Ianumque, liber, spectare videris, scilicet ut prostes Sosiorum pumice mundus“. [13]

Horace Epistulae. liber 1, epistula 20, Zeile1-2 „Nec fragili geminae poliantur pumice frontes”[14]

Pumice is also mentioned by antique authors as tool to smoothen edges of writing material – most probably papyrus (Ovid, Tristia, liber primus, Kapitel 1, line 11 (trist. 1,1.11)) Horace (Horace epistulae. liber 1, epistula 20, lines 1-2 Quintus Horatius Flaccus) „Vortumnum Ianumque, liber, spectare videris, scilicet ut prostes Sosiorum pumice mundus”.

„Secretum Philosophorum“ copies from „Mappae Clavicula“ an instruction on the way of cleaning parchment which was already used. (Fanger 1998:78)[15]

3.1.2.2 Bread

Liber illuministarum – same recipe in London, Brit. Libr., ms. Sloane 362, fol. 82r, (see Helen Saxl 1954:58-590)[16] : „Cretam sic facies Recipe ij partes testas ouorum bene tritas et tertiam partem crete trite in clara insimul et siccetur quod et aliqui pro vernisio sumunt“ (Bartl, Krekel, Lautenschlager, Oltrogge 2005:110)[17] „Die kreide mache so: nimm zwei Teile gut geriebene Eierschalen und einen dritten teil

Handbook” in: Making the Medieval Book: Techniques of Production, Hsg. Brownrigg, L. , Los Altos Hills, London (1995):59-6

9 Alberti Magni, B. Ratisbonensis Episcopi, ordinis Praedicarorum opera omnia, Ex editione Lugdinensi Religiose Casticata, et pro auctoritatibus ad fidem vulgatae versionis accuratiorumque Patrologiae Textuum Revocata, Auctaque B. Alberti vita ac Bibliographia operum A. PP. Quetif et Echard, Exaratis, Etiam Revisa et Lacupletata cura ac labore Augusti Borgnet, Sacerdotis diaecesis Remensis Ammente Faventeque Pont. May. Leone XIII Volumen Quintum Parisiis Apud Ludovicum Vivès, Bibliopolam Editorem 13, Via Vulgo DICTA Delambre, 13 MDCCCXC (1890):1-57 Libellus de alchimia Ascribed to Albertus Magnus Translated from the Borgnet Latin edition, University of California Press Berkley and Los Angeles (1958) translation by the author: as pumice, a stone which is thrown out by warmth of fire of a volcano

10 Helm, R. “Catull Gedichte“ carmen 22 Zeile 5 Lateinisch und deutsch von Helm, R. Akademie Verlag, Berlin (1963):38-3 translation: I think that either 10000 or more verses/Have been written by the man, as is common in palimpsest/Having been noted there are: royal papers (extensive papyri), new books,/New knobs, red straps, scroll covers,/All things having been ruled with lead and smoothed by pumice./When you read this…(rudy.negenborn.net/Catullus/text2/e22.html)

11 Ovid Tristia, liber primus, cater 1, line 11

12 Kytzler, B. Quintus Horatius Flaccus epistulae . liber 1, epistula 20, Zeile1-2 Epistulae, Briefe, lateinisch-deutsch Übersetzt und herausgegeben von Bernhard Kytzler, Philipp Reclam jun. Stuttgart, 1986, Seite 78-79 Horatius (Sat.2,7,98)

13 It seems, my dear book, you look towards Janus and Vertumnus, most probably to present yourself for selling, made nicely smoot by pumice of the Soci.

14 The two front pages (of the book/scroll) should not be smoothened with the fine pumice.

15 Fanger, C. “Conjuring Spirits: Text and Traditions of Medieval Ritual Magic” Hsg. Fanger, C. Stroud: Sutton Publishing, (1998):76-86

16 Saxl, H. An investigation of qualities. The Methods of Manufacture and the Preservation of Historic Parchment and Vellum with a View to Identifying the Animal Species Used, Masterarbeti, University of Leeds, Dep. Of Leather Industries, (1954):24-27

17 Bartl, A. et al. ”Der liber illuministarum aus Kloster Tegernsee” Franz Steiner Verl. Stuttgart (2005) translation by the author: The chalk make this way: take two parts of well ground egg shells and a third part chalk, mix them together with egg white and dry this. This some also use as a varnish.

Kreide, die zusammen in Eikläre verrieben und trocknen gelassen werden; dies nehmen manche auch für einen Firnis“. (Bartl, Krekel, Lautenschlager, Oltrogge 2005:111)

3.1.2.3 Sandstone

„…es scheint, dass auch kleine Stäbchen aus Sandstein verwendet wurden, um die Zeichen auszureiben.[18] “ (Lucas 1989:365)
Such a sandstone wrapped in linen cloth was found in a sarcophagus of the 12th Dynasty. Two similar sticks are kept in Ashmolean Museum, Oxford. (Lucas 1989:365)[19]

3.1.2.4 Eraser Powder

„Ad delendum litteras de carta absque lesione carte. – Accipe cossam leporis, et decoria ipsam, et postea in salla, et desicca ad fumum ignis, et pulveriza, et posito de ipso pulvere super litteris quas raddere vis, trahe desuper pumicem, et radetur absque lesione carte.“ (Experimenta de coloribus by Jehan le Begue in: Merrifield, M.P. Mrs. 1849:47)[20]

3.1.2.5 Feathers

In contrast to all above mentioned methods, which scratch off the ink and the upper layer of the surface, there is another tool for charcoal available, which is feathers. They dust off the coal without harming the parchment surface.

Cenini: „Togli prima il carbone, sottile e temperato com`è una penna o lo stile; e, la prima misura che pigli a disegnare, piglia l`una delle tre che ha il viso, che ne ha in tutto tre, cioè la testa, il viso, e `l mento colla bocca. E, pigliando una di queste tre guida di tutta la figura, de` casamenti dall` una figura all` altra è perfetta tua guida, aoperando il tuo intelletto di sapere e guidare le predette misure. E questo si fa perchè la storia, o figura, sarà alta, che con mano non potrai aggiungere per misuralla. Conviene che con intelletto ti guidi: e troverai la verità guidandoti per questo modo. E se di primo tratto non ti viene bene in misura la tua storia o figura,abbi una penna, e co` peli della detta penna, di gallina o di oca che sia, frega e spazza, sopra quello che hai disegnato, il carbone. Anderà via quel disegno. E ricomincialo da capo tanto e quanto tu vedi, che con misura si concordi la tua figura coll` esempio; e poi, quando ti avvedi che stia appresso di bene, togli lo stile di argento, e va ricercando su per li contorni e stremità de´ tuo´ disegni, e su per le pieghe maestre. Quando hai fatto cosi, togli da capo la penna pelosa, e spazza bene il detto carbone, e rimarrà il tuo disegno fermato collo stile.“ (Cennini cap. 30)[21]

18 It seems that also small sticks of sandstone were used to delete the signs.
19 Lucas, A. „Ancient Egyptian Materials and industries“ London (1989):361-366.
20 Merrifield, M. P. Original treatises, dating from the 12th to 18th centuries on the arts of painting in oil, miniature, mosaic and on glass; of gilding, dyeing, and the preparation of colours and artificial gems : preceeded by a general introduction with translations, prefaces, and notes / ... 2 vols. London: John Murray (1849) Dover ed reprinted in 1999 in 1 Vol as Medieval and Renaissance Treatises on the Arts of Painting /Orig. Text with Engl. Translations translation: Delete letters from the carrier without damaging it – take a hair skin and prepare it, and salt it and dry it over the smoke of the fire and make it into a powder and put some of the powder onto the letters, which you wish to delete, move pumice over it and it will delete without damaging the carrier.
21 Tambroni, G. “Di Cennino Cennini, Trattato della pittura” Hsg. Tambroni, G. (1821) Ilg, A. “Cennino Cennini das Buch von der Kunst“ Quellenschriften für Kunstgeschichte und Kunsttechnik des Mittelalters und der Renaissance, übers. Albert Ilg Neudruck der Ausg. 1871, Otto Zeller Verl. Osnabrück (1970) translation: take first a well sharpened coal, prepared as the feather or the stylus, however if your sketch did not work out at first try, take the feather of a hen, goose or whatever and brush off the coal with the feather, the sketch will disappear. Re-start to draw until you see that your drawing meets with the shape of the model and as soon as you see that it comes close use a silver point and re-work

The fact that coal and other pigments without binding media are easily deletable is indirectly confirmed by Horace when he writes: „Proelia rubrica picta aut carbone“ (Sat.2, 7, 98)[22] and carm. 1, 36: "Cressa ne careat pulcra dies nota"[23].

the outer lines of your drawing …after this take again the feathers and clean off the coal and the drawing will be fixed by the silver point.

22 Kytzler, B. Quintus Horatius Flaccus epistulae . liber 1, epistula 20, Zeile1-2 Epistulae, Briefe, lateinisch-deutsch Übersetzt und herausgegeben von Bernhard Kytzler, Philipp Reclam jun. Stuttgart, 1986, Seite 78-79 Horatius (Sat.2,7,98) translation: (Gladiator) fights with red chalk or char coal.
23 Such a nice day must be marked with white chalk.

Table 2
Dry deletion material and methods for wider areas their application and traces left

Means and methods of deleting	Material of deletable/ deleted text	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Pumice	All inks on papyrus and parchment Secretzum talks about palimpsesting	Classical antiquity	Theophrast, Mappae Clavicular, Albertus Magnus, Catull, Ovid, Horace, Secretum Philosophorum	Parallel scratches visible under magnification and in raking light as darker area	Transmitted light: lighter area, raking light: darker/rougher area	Naked eye, detection of trace elements of the pumice?	Areas which are thinner due to preparation of the parchment, in such cases no locally rougher area, no smearing of ink and no relation to the text
Sepiolite	All inks on papyrus and parchment	Classical antiquity			Parallel scratches	Elements of the sepiolite	Very similar appearance to sandstone and pumice erasings
Bread	All inks on papyrus and parchment		Liber illuministarum – same recipe in London, Brit. Libr., ms. Sloane 362, fol. 82r		Transmitted light: lighter area, raking light: darker/rougher area	Elements of the bread	Very similar appearance to bread and pumice erasings
Sandstone	All inks on papyrus and parchment		Evidence of erasers in 12th Dynasty Egypt		Transmitted light: lighter area, raking light: darker/rougher area	sand	
Eraser powder	?	From c. 1500 on – only 2 recipes before 1500	Jehan le Begue in: Merrifield, M.P. Mrs. 1849		Hare skin and pumice should leave collagen material of hare	Elements of the hare/ DNA?	
Feathers	All non inks such as charcoal on any surface		Cennini		It is relatively difficult to trace this method on smooth surface of parchment and paper, no traces may be left, for the rough parchment it leaves a wider dissemination of writing substance on the page, which could be staming also from other smearing deleting methods. To our knowledge the feathers themselves do not leave and particular traces.		

3.2 Liquid

Liquids work in three ways: they either wash off the inks or modify them in such a way that inks become invisible/less visible (for example by pH changes). A third possible way of using liquid deletion agents is to swell the surface of the parchment and then scratch it off.

It can be presumed that liquids were used to delete the entire text and not as a way to delete local letters or words.

The following chapters describe liquids used over time in chronological order. The level of the headline indicates that they are of the same order in SKOS.

3.2.1 Water

Water was an obvious medium to use for washing off text. ἐξαλείφειν = oint off i.e. wet washing off. “Aiacem suum in spongiam incubuisse”[24] (Suetonius Tranquillus 1997:282)[25] Sponges were found along the coasts of the Mediterranean Sea. (Weeber 2001:217) [26]

The use of saliva is documented at Caligula (Suetonius Cal.20) (Weeber 2001:308): „Edidit et peregre spectacula, in Sicilia Syracusis asticos ludos et in Gallia Luguduni miscellos; sed hic certamen quoque Graecae Latinaeque facundiae, quo certamine ferunt victoribus praemia victos contulisse, eorundem et laudes componere coactos; eos autem, qui maxime displicuissent, scripta sua lingua velut spongia delere iussos, nisi ferulis obiurgari aut fiumine proximo mergi maluissent.“ [27]

This is only mentioned as an example confirming the use of “water” in the wider sense, but saliva is not included in the list of deleting methods in its own right, as we can take for granted that it was not used for deleting text by those who prepared writing material as a part of their professional task.

However, the procedure whereby a poet deleted their own poems in case they failed to please the audience with their own tongue was a widespread habit in classical antiquity. (Martinet 1997:470-473)

Theophilus suggests using water in the process of miniature painting as a creative activity: „De veneda in oculis ponenda Deinde commisce nigrum cum modico albo, qui color vocatur veneda, et inde imple pupillas occulorum. Adde ei etiam de albo amplius, et imple oculos ex utraque parte, et album simplex linies inter pupillam et ipsum colorem, et cum aqua lavabis.”[28] (Theophilus Presbyter after Brepohl, E. 1999:55)[29] This is not a deleting action in the narrow sense of the word, either, but since it is closely related to manuscript making, it should be mentioned here.

3.2.2 Wine

Medieval wine had an acidic pH-Value of about 2-3. (see Bartl et al. 2005)

So-called Schwabenspiegel (1274/75,

24 Ajax plunged into the sponge
25 Martinet, H. „Die Kaiserviten“ De Vita Caesarum lateinisch-deutsch herausgegeben und übersetzt Hans Martinet Artemis u. Winkler Verl. Düsseldorf, Zürich 1997:282 (Augustus Absatz 85, 2. Teil) and 470- 473 (Caligula Absatz 20)
26 Weeber, K.-W. “Alltag im Alten Rom“ Patmos Verl., Düsseldorf (2001)
27 He also made contests outside Rome, for example in Syracuse in Sicily, in honour of Bacchus and in Lugudunum in Gallia, which consisted of various sorts; here he also made contest of Greek and Latin eloquence, in which they say that the victorious conquerors conferred rewards on the conquerors, and that they were obliged to compose praises for the winners; they whos poems were considered the worse were ordered to destroy thir own poems with their own tongue, like a sponge, unless they had preferred to be rebuked with rods, or to be sunk nearby into a river.
28 Add more white and fill both eyes. And with more white draw a line between pupil and the same colour and wash it out with water.
29 Brepohl, E. “Theophylus Presbyter und das Mittelalterliche Kunsthandwerk“ 2 Vols, Köln, Weimar, Wien, Böhlau Verl. (1999)

Augsburg)[30] „das man ettwenne machet von weine vnd von wasser das dew schrift gar ab geet, vnd gibt es einen büchueller der es mit seiner kunst gar ab tüt, vnd scribet dann wider daran nach seinem willen vnd nach seinem nutze."

In this text we also find a hint at how to identify the deleted area: „gen der sunnen haben, so mag man es wol erkennen, so sicht man der alten schrifft immer etwe uil in dem pirmit in der newen."

In the Nürnberger Kunstbuch the use of wine for removing stains from clothes is mentioned explicitly. (after Ploss 1962:108)[31] Alternatively „Resche Laugen"[32] were applied.

More information on removal of stains from cloth can be found in the Berlebureger Malerbuch. (Tenner 1978:203-210)[33]

3.2.3 Milk

Milk contains fats and is able to address fatty substances in writing liquids better than water. The use of milk for deleting texts is mentioned in a number of sources; even though in most sources it is later published secondary literature, we would like to mention it here:

„Im Abendland war im Mittelalter eine Mischung von Milch, Käse und ungebrannten Kalk als Tilgungsmittel bekannt" (Mazal 1999:94)[34]

In "Lexikon des Mittelalters" (Lexikon des Mittelalters 1993[35]:1641 „Abwaschen der Ruß- oder Pflanzentinte mit Milchlauge o.ä". is mentioned.

In the „Lexikon der Buchkunst und Bibliophilie" milk is also mentioned among deleting agents, however, in contrast to the above mentioned lexicon, it is mentioned in connection with deleting metal inks. (Lexikon der Buchkunst und Bibliophilie 1988:281)[36]

Some recipes combine milk with lime, which results in a strongly alkaline mixture. The milk may curdle, which might be the reason why sometimes "Käse" (cheese, however this "cheese" was most probably fresh cheese) is used in these texts.

Tegernsee Manuscript c. 1500 Bayrische Staatsbibliothek, München, SB Clm 18628, fol. 105v: (M) „Quicunque in semel scripto pergameno necessitate cogenteiterato scribere uelit, accipiat lac, inponatque pergamenum per unius noctis spacium. Quod postquam inde sustulerit, farre asspersum, ne ubi sicari incipit in rugas contrahatur, sub pressura castiget quoad exsiccaetur. Quod ubi fecerit, pumice cretaque expolitum priorem albedinis sue nitorem recipiet." (Tegernseeer Handschrift 11. Jh. Cod. Lat. 18628)[37]

This recipe actually consists of two elements, the first being the loosening of the

30 Schwabenspiegels (1274/75, Augsburg), To make text disappear with wine and water, give it to a "buechueller", who applies his art and you may write on it again, as you please.
31 Ploss, E. "Ein Buch von alten Farben" Impuls Verl. Heinz Moos, Heidelberg, Berlin (1962)
32 Strong leach
33 Tenner, Ch. "Vleck ûz dem gewant ze bringen" ein bairisch-ostfränkisches Fleckenreinigungs-Büchlein aus dem 15. Jahrhundert in: Pharmazie und Geschichte Festschrift für Kallinich, G. Donau Verl. Sraubing, München (1978):203-210
34 Mazal, O. "Geschichte der Buchkunst I" Akademische Druck- und Verlagsanstalt, Graz (1999):94 translation by the author: In the middle ages a mixture of milk, chese and unslaked lime was known as deleting agent.
35 „Lexikon des Mittelalters" VI, Artemis u. Winkler Verlag, München, Zürich (1993):1641 washing off soot or plant-inks with milkleach or similar.
36 Lexikon der Buchkunst und Bibliophilie Herausg. K. K. Walther, Saur Verl. München, New York, London, Paris (1988):281
37 Tegernseeer Handschrift 11. Jh. Cod. Lat. 18628 translation by the author: Who wants to write, if needed, onto a parchment, which had been used before, should take the parchment and immerse it into milk over night. After he has taken it out of the milk, he should put flour onto it, to prevent wrinkling when it starts drying and he must press it under a press until it is dry. After he has done this and after he has polished it with pumice and chalk, the parchment will have its white gloss again.

parchment structure, the second, the mechanical scratching of the text off the surface. A third additional element may be the use of a white pigment to cover the remaining ink.

3.2.4 Mixtures

All recipes for mixtures of substances to result in a liquid or, in most cases a pasty mass for deleting text originate from the 15th century or later. They rely on physico-chemical degradation of the ink, washing off, swelling of parchment and, in some cases, additional scratching off the surface.

The composition of these recipes and the instructions for their application are complex and it can be taken for granted that the problem at issue is the removal of texts written in iron gall ink, since washing off soot ink in this way would mean inordinately great effort. Furthermore, in most cases these instructions inform the reader about the support they may be used for: parchment is mentioned five times and paper three times (see also Bartl, Krekel, Lautenschlager, Oltrogge 2005:653). However, the words were not used in very strict sense at that time, so we may read "paper" but the author may actually mean parchment. Therefore, we must estimate ourselves how the actual words must be interpreted. Finally, there are often no clear instructions how much of which substance must be used, so it was the conservators´ experience with material that allowed for finding the right amounts when the recipes were performed by the author to obtain the traces left by the various material and methods.

It should be emphasized that the results of the deleting action on parchment is highly dependent on the roughness of the parchment. While on smooth parchment deletions are often complete, the same method might leave considerable stains on rough parchment.

The recipes are given below in chronological order. Valuable information on their applicability and possible identification is summarized in the tables 3 and 4.

Altmünster manuscript (around 1418): „Jtem sj volueris delere in pirgameno scripturam, fac tibilixiuium cum calce viua, jn wlgari ongelesten kalch. Pone hoc lixiuium in reseruaculum mundum vel vitrum. Impone simul ad mensuram jntegram vitriolum romanum semalbum bene sublimatum, id est weysser vitriol wol gelewttert, ½ lotonem, aluminis quintionem, similiter bene in lapide porhiry aut in mortario bene contritum. Sicque puluerem paratum mitte vna cum reliquo apud jgnem lentem modicum bulire, non fortiter, ne spiritus fortes extingwantur. Quasi tepidum fac. Demumque para tibi pannum de lana alba factum, intingwe (in) materiam bulitam hanc, et effunde super pirgamenum. Frica juxta posse tuum. Non fortj laborj delebitur ad placitum. Postmodum mitte in vmbra tergere, et prepara cum vernisio, ut cathetralium modis. Est melius pristine forma scribendo florisando aut quouis modo priori." (Handschrift aus Altmünster, Cod. lat. 2942, Staatsbibliothek München, Spalte 1, Seite 1 viertletztes Blatt nach dem Jahr 1418) (see also Bartl, Krekel, Lautenschlager, Oltrogge 2005:731-732)[38]

38 (Handschrift aus Altmünster, Cod. lat. 2942, Staatsbibliothek München, Spalte 1, Seite 1 viertletztes Blatt nach dem Jahr 1418) (see also Bartl, Krekel, Lautenschlager, Oltrogge 2005:731-732) and Bartl, Krekel, Ch.; Lautenschlager, Oltrogge, D. "Der liber illuministarum aus Kloster Tegernsee" Franz Steiner Verl., Stuttgart (2005) translation: If you want to delete the text from a parchment take unslaked lime, which is called „ongelesten kalch" colloquially, put this mix into a clean pot or into a glass, add tot he full measure Roman vitiol, half white and well sublimated, which is so called "weysser vitriol wol gelewttert" half a lot, a quantum (i.e.1/5 lot) alum, the same measure well ground in a mortar. The powder prepared in this manner, together

Another recipe is provided for deleting black letters on paper “Ad delendum litteras nigras de carta. – Fac aquam de (Id est infrascriptum et scribitur ut supra causa brevitatis – Randbemerkung des Autors) infrascriptis rebus. Accipe salniterum, et vitriolum Romanum. De quolibet libram unam, et distilla per alembicum, et erit clara aqua, et cum ipsa aqua balnea spongiam modicum, et de ipsa frica litteras.” (Experimenta de coloribus, Jehan le Begue in: Merrifield 1849:47)[39]

Another recipe: “Ricepte d´affare pui colori”: “Tolle sal nitro e vetriuolo romano, di ciascuno una libra, e sia chiaro. Poi tolle una spogna, e bagnala di questa acqua, e mectela in sulla carta, e levaranne le lectare.” (Ricepte d´affare pui colori of Ambrogio di Ser Pietro-da Siena after Thompson, D. V. Jr. 1933:346) [40] As this recipe does not include any liquid, it can be assumed that water is expected to be added, and this was so self-evident for the scribe who wrote it down that he did not mention it.

From the 15th century onwards, alum mixtures are en vogue.

“Experimenta de coloribus” by Jehan le Begue: „Si vis elevare litteras de carta. – Accipe aluminis roche, et tere et impasta cum succo pomi aranzii, et pone ad auram, et dimitte siccari; postea frica super litteras, et levabit eas a carta.“ (Jehan le Begue quoted after Marrifield 1849:63)[41]

„Ad delendum litteras de carta. - Accipe succum pomi ranzii, et in ipso balnea bombacem vel spongiam, et frica leviter super litteras, et optime dellet, et quia carta libri balneatur, et efficitur mollis, remediari debet isto modo, ut sit sicca et alba. Accipe florem calcis, distemperate cum aqua clara, postea cola cum pecia lini alba, et de aqua alba que exibit balnea bombacem, quam ducas super cartam ubi mollis erat, et fiet alba et solida. Credo quod melius esset intingere bombacem in calce sicca et non madida.” (Jehan le Begue nach:Merrifield, 849 59)[42]

In the Berliner mansucript Ms. Germ. Qu. 417 we find four recipes for deleting text:

First recipe: “Wiltu ein schrifft auff Pergamen auß leschen Nym Colofonia, das

with the other must be put on a mild fire and let it cook carefully, not strongly, so that the strong spirits do not disappear. Make it nearly lukewarm. Finally take a cloth of white wool, dip it into this heated mixture and spred it over the parchment. Rub it according to your feeling with gentle preasure, this way the deletion is made according to your wish. Then put it into the shade, dry it, and prepare it with varnish in the way the Dominicans do. This is better for a pattern or any other way. (meaning you may write onto the parchment whatever you wish to)”

39 Merrifield, M. P. ”Original Treatises, dating from the XIIth to XVIIIth centuries on the Art of Painting” John Murray, London (1849) translation: to delete black latters from paper: take nitrate and Roman vitiriol, a pound each, and distill it, and you will get a water. With this water make a sponge slightly wet and rub over the letter

40 Thompson D. J. Jr.; G. H. Hamilton ”Ananonymus fourteenth century treatise De Arte illuminandi, The Technique of Manuscript Illumination” NewHaven: Yale University Press (1933) translation: take nitrate and Roman vitriol, a pound each and it must be clear. Then bath a sponge in this water and put it onto the paper and lift the letters.

41 Merrifield, M. P. ”Original Treatises, dating from the XIIth to XVIIIth centuries on the Art of Painting” John Murray, London (1849) translation: if you wish to lift letters from the paper, take alumstone, grind it and make it into a paste with the juice of an orange, put it into the wind and let it dry; then rub it over the letter and it will lift it from the paper.

42 Merrifield, M. P. ”Original Treatises, dating from the XIIth to XVIIIth centuries on the Art of Painting” John Murray, London (1849) translation: to delete letters from parchment (it can be assumed, that parchment is meant here) – the the juice of an orange and dip into it cotton or a sponge and rub gently over the letters and it will delete perfectly. However as the parchment will have been made wet, it must be made dry and white in the following way: take white lime as a powder, mix it with pure water and squese it through a white linen cloth, dip cotton into the thus produced liquid and tap it onto the parchment in the areas where it is soft and it will become white and hard. I believe it would be better to dip the cotton into dry lime and not to make it wet.

ist krichisch hartz, zerstoß klain vnnd strew es auff die schrifft, netze dann ein tuch vnnd legs darauff, darnach auff das tuch frischen pferdskat, vnnd zu aller oberst leg ein schlechten ziegel vnnd laß es Im winter ein nacht steen vnnd Im somer von morgen an bis es 9 schlecht." (Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap. 202, f 67, Datenbank Oltrogge)[43]

Another recipe: "Ain annders. Nym salarmoniac, Alomin plomosum, disteliers durch ein allempic, mit disem wasser bestreich die schrifft, so geet sie aus." (Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap.203, f 67)[44]

Another recipe: "Schrifft außzuleschen Nym hasenflaisch vnnd machs zu puluer, darnach nem gelesten kalck mischs zusamen vnnd legs auff die schrifft so vergeet sie." (Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8 Folio / Seite F. 67 Kap.204)[45]

Another recipe: "Wiltu ein schrifft auff dem Pirgamenn abthun Nym weissen alaun vnnd vngegossen waidaschen yedes gleich, temperirs mit eim weissen eins aies laß es trucken werden, vnnd nem dann ein nassen schwammen, bestreich die schrifft wol damit vnnd nem dann die temperierung, bestreich auch damit die schrifft, so sichst du die schrifft nimer Wiltu es dann wider machen, so nim lauter Prunnenwasser, vnnd geus auff das, so wurt es gantz weiß." (Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8, f. 67v, Kap. 205)[46]

"Ad delendum litteram sine rasura contere carnem leporis bene assatam et bene salsam in puluerem et dictum puluerem cum calido vino misce et demum pone super litteram de nocte uel de die et remouebuntur litteram omnino sine rasura." (München, Bayerische Staatsbibliothek, Cgm. 824, Ms. 60, f. 72v, Kap 99)[47]

In „Ambrogio Ricepte d´Affare piu Colori" (Thompson:1933): „Tolle gemma di corna, di corna di becco o di castrone o vero di bu´, cioe ei mirollo spognoso che sta dentro al corno, e fanne polvare. Vuolsi scaldare la decta polvare in sur una teglia. E poi mectela in sull´olio, e vuolsi sopressare e lassare stare cosi un di; e poi pienamente necta, e se non fusse ito via, rifa´da capo. Anco polvare d´osso di vitello che sia arso e spolvaricato: mectelo in sull´olio e scaldalo un poco, e quando ellosso e nero e´ tu lo rinnuova; e tanto fa´cosi, chell´olio se ne vada." (Thompson 1933:346)[48]

43 Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap. 202, f 67, Datenbank Oltrogge translation: If you wish to delete a text on parchment take rosin, this is a moving rasin, grind it well and disseminate it onto the text. Then make a cloth wet and display it onto the rosin. Then put fresh hourse dung onto it and onto this put a bad old brik and leave it there over night in winter and in the summer from morning until you hear the clock strike 9.

44 Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap.203, f 67 translation: Another: Take ammonia and Halotrichit , distill it and with this water cover the text, it will disappear.

45 Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8 Folio / Seite F. 67 Kap.204 translation: To delete text take the flesh of a hare and grind it to powder then take slaked lime mix it together, put it onto the text and it will disappear.

46 Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8, f. 67v, Kap. 205 translation: If you wish to delete a text from parchment, take white alum and willow ash at same measure, mix it with egg white and let it dry. Then take a wet sponge and touch the text well with it and then take the mixture and smear it onto the text and you will not see the text any more. In case you wish to restore the text, take fresh water from the dwell and poor it over then it (the text) will become white.

47 München, Bayerische Staatsbibliothek, Cgm. 824, Ms. 60, f. 72v, Kap 99 translation: As to delete text without erasing it, grind the well fried and salted flesh of a hare into powder and mix this powder with warm wine. Then apply it during the day or the night onto the letter and the text will disappear completely without erasing.

48 Thompson D. J. Jr.; G. H. Hamilton "Ananonymus fourteenth century treatise De Arte illuminandi, The Technique of Manuscript Illumination" NewHaven: Yale

In the manuscript München, Bayerische Staatsbibliothek, Clm. 20174, Ms. 52, f.254r, Kap 225: "Item ad delendas litteras de carta ut non appareant tunc recipe pomorum siluestrium succum ex ipsis pomis et superaspergas carthis et dimitte stare per aliquam horam. Deinde recipe pannum asperum et frica super cartham et littere omnino delebuntur."[49]

In "Liber illuministarum" „ad delendum scripturam": „Recipe weinhepfen, vnd thue sy in ainen sack als ain laugsack. Also lass den wein daruon trieffen, das die hepffen dick vnd starck werd. Die mach zu pallen, vnd legs an lufft, das sy wol trucken werden, vnd nit an die sunnen noch in kain hayssen stuben, wann sy verlüren ire peste krafft. Darnach prenn die pallen so sy trucken wol sein worden also: mach aus den pallen ainen ofen, vnd mitten darein ein gluet, so werden die pallen auf ij oder drey stund prinnen, vnd lass selber derleschen. Darnach thue die gluet seyberlich heraus so die hepfen noch prinnen, damit das kain asch von der gluet nit köm vndter die rechten materi. Darnach thue die materi in ainen mörser, vnd dar zu ainen achten tayl von waidaschen, das ist zu j pfd. prentter hepfen 4 lot waidaschen. Darnach nim vj masz lautters wassers: das geusz vber den obgeschriben aschen sechs- oder vij mal. Vnd die selbig laug behalt in ainem glas." (Bartl et. al 2005: 383)) ("Liber illuministarum", Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 229´)[50]

Tilgung der Schrift auf Pergament: „Ad deletionem scripture in pergameno: Recipe pergamenum scriptum, et intinge in ain pais, quam sic facias. Recipe j partem calcis, ij partes farine. Et addatur aqua. Postea addantur ij partes ayrschalen gestossen. Et permittatur iacere 6 diebus. Postea tendatur in ain ram, et radatur cum rasorio bono. Postea supersparge cretam bene tritam. Et tunc siccetur. Postea deponatur." ("Liber illuministarum", Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 36´) about "supersparge cretam": Recipe ij partes testas ouorum bene tritas, et 3am partem crete trite in clara oui insimul, et siccetur. Quod et aliqui pro vernisio sumunt."[51] 3.3 Overpainting, pasting over and oversewing

University Press (1933) translation: Take the marrow of the horn of a male goat or ram or from the cattle, this means the spongy marrow which is inside the horn and grind it to powder. The resulting powder must be warmed up in a pan and then oil is added, press it down and let it rest for one day, then clean it, and if it does not disappear repeat it. Also powder of cattle bones, which is fried and made into powder. Put it into oil and and warm it a bit and when it is oily and black, make it again and make is so much so that the oil goes away.

49 München, Bayerische Staatsbibliothek, Clm. 20174, Ms. 52, f.254r, Kap 225 translation: How to delete the letters from parchment, so that they are invisible. For this take the juice of the wild apple and sprinkle with it the parchment and let it rest for about one hour. Then take a rough cloth and rub over the parchment and the letters are deleted completely.

50 (Bartl et. al 2005: 383)) ("Liber illuministarum", Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 229´) translation: take wine yeast and put it into a sack the sort of leach sack and let the wine drip out, so that the yeast becomes thick and strong. Make balls of it and deposit them in the fresh air to dry them well, but not into the sun and also not into a hot room, because from this they would lose their strength. The dried balls then burn in the following manner: put on onto the other as in an oven and put glowing coals into their centre, this way the balls themselves will glow well for 2 or 3 hours. Let them become cold by themselves. Then take out the coals from the centre carefully out while the balls are still glowing, as to not have ash in the actual substance. Then put the substance together with an eighth of willow ash into a mortar, so that for each pound burt yeast you have 4 lot of willow ash, according to that add 6 liter of clear water 6 or 7 times over the earlier described ash. The resulting leach keep in a glass.

51 Liber illuministarum", Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 36´ translation: take used parchment and immerse it into a mordant, which you prepare this way: take one part of line, 2 parts of flour, and water. Add 2 parts ground egg shells and let it rest for 6 days. Strech the parchment in a frame and scrape with the good knife. Then well ground chalk is applied, then dry and put aside.

Table 3

Water, milk and other liquids to delete text, their application, and traces left

Means and methods of deleting	Material of deletable/ deleted text	Carrier	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Water	Soot inks on papyrus and parchment, however, this method is not easy to apply on parchment. Iron gall ink on papyrus was well deletable	Soot inks on papyrus and parchment, however, this method is not easy to apply on parchment. Iron gall ink on papyrus was well deletable	Classical antiquity	Suetonius Tranquillus, (Theophilus Presbyter nach Brepohl, E. 1999)	Depending on the amount of water used and the way of application we find roughened areas.	Light lines of iron gall ink both on rough and smooth parchment and also on papyrus lighter than before. On rough parchment not so well working, as the parchment becomes a bit translucent from rubbing. Soot ink washed off on smooth surface, however, it is trapped in the corners of the papyrus structure and also in the rough parchment	Microscope	
Wine	All inks	Parchment,	1274	Schwabenspiegel (1274/75, Augsburg), Nürnberger Kunstbuch				
Milk	All inks	Parchment,	11th cent.	Tegernsee Manuscript c. 1500 Bayrische Staatsbibliothek, München, SB Clm 18628, fol. 105v: (M)	Soot ink completely deleted on smooth and rough parchment Iron gall ink on smooth parchment completely deleted, on rough parchment a light grayish line is still visible, flour must be scratched off		Grayish line flour in the structure In case flour was involved: soot ink virtually invisible, the parchment smells more after milk and less goat Iron gall ink: On smooth side virtually not detectable, on rough side detectable under the microscope; in transmitted light traces detectable. Smells of milk	

Table 4

Mixtures of substances their application and traces left

Means and methods of deleting action	Material of deletable/ deleted text	Carrier	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Mixture: lime, vitriol, alum; Cloth must be immersed into the mix and spread over the parchment and later rubbed, varnish is a final step pH of the mix is 13	Most probably meant to delete iron gall inks	Parchment, entire page	1418	Altmünster, Cod. lat. 2942, Staatsbibliothek München, Spalte 1, Seite 1 viertletztes Blatt nach dem Jahr 1418	CaO, ZnSO4·7H2O, FeSO4·7H2O) (KAl (SO4)2·12 H2O), as the vitriol is not specified: FeSO4 · 7H2O or CuSO4 · 5 H2O) or ZnSO4 · 7H2O Also alum is not defined: KAl (SO4)2 · 12 H2O or Al2 (SO4)3 · 18 H2O.	The loss of dark colour might have been achieved by destroying this complex by the extremely alkaline conditions	Analytical: identification of area with various sorts of vitriol other than from the ink; also alum might be detectable	Light lines: light brown after water, grayish after milk
Mixture of vitriol and potassium or sodium nitrate, application with a sponge gently rubbing	Black letters (soot ink is black, but black might also mean brown)	Paper (this might not mean that it was not used on parchment) Entire page,	15th cent.	Ricepte d´affare pui colori of Ambrogio di Ser Pietroda Siena after Thompson, D. V. Jr. 1933:346)		Nitration, yellow stain on paper (method was not tested on parchment)		
Mixture: potassium or sodium nitrate and iron sulfate and water, sponge soaked in the mixture and put on the letter The mixture is bright yellow and has a pH of 2 – strong smell of iron	Most probably for iron gall ink	Paper (this might not mean that it was not used on parchment) Entire page	15th cent.	Ricepte d´affare pui colori of Ambrogio di Ser Pietroda Siena after Thompson, D. V. Jr. 1933:346)		Nitration, yellow stain on paper (method was not tested on parchment)		
Alum,orange juice, rub over letters, pH value around 2, depending on the sort of orange	Most probably iron gall ink	paper	15th cent. onwards	"Experimenta de coloribus" by Jehan le Begue		Iron gall ink becomes much lighter on paper, other writing material, such as stylus, abrasives and soot ink can be deleted completely. Surface texture of paper or parchment stays unchanged. The fresher the inks are the easier they can be deleted using this recipe.		

Means and methods of deleting action	Material of deletable/ deleted text	Carrier	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Orange juice and sponge, rubbing over the letters, then chalk with water applied in the relevant area or as a powder	Most probably iron gall ink	Carta – parchment? Entire page	15th cent. onwards	Jehan le Begue nach:Merrifield, 849 59)	Chalk, locally different then in unchanged areas.	We must see the impact of the orange juice on a parchment Chalk applied locally Actually the wet application of lime should bring the pH back to 13 and make the ink visible again, therefore it is better to apply the chalk as a powder	Ink is light brown after application of orange juice	
Rosin as powder, most probably as sort of sucking sand, a cloth to cover the text, horse dung on top and a weight	Most probably iron gall ink	Parchment Entire sheet		Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap. 202, f 67, Datenbank Oltrogge)			Horse DNA?	
A sort of alum – unspecified and salmiak	Not specified	Not specified, but acid would help delete iron gall ink		Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Kap.203, f 67)	Oltrogge suggests that hydrochloric acid is created as working agent (3153 Data base Oltrogge)			
Powdered hare meat and lime, mixed and applied onto the text	High pH – iron gall inks?	Entire page?		Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8 Folio / Seite F. 67 Kap.204	The mixture should have a high pH value.			
Mixture: alum, ash, egg shells, application with sponge	Most probably iron gall inks	Parchment, full page		Berlin, Staatsbibliothek Preuß. Kulturbesitz, Ms. germ. qu. 417 Ms. 8, f. 67v, Kap. 205		Egg shells might be an abrasive agent.	Egg shells	
Hare flesh fried and salted, wine (wine had a low pH in the Middle ages)	Most probably iron gall inks	Most probably entire page		München, Bayerische Staatsbibliothek, Cgm. 824, Ms. 60, f. 72v, Kap 99)		The recipe stresses that no additional abrasing is neded to delete the text, It might be that fried hare meat meant active coal	Salt (NaCl)	

Means and methods of deleting action	Material of deletable/ deleted text	Carrier	Time	Source	Traces left by the method	Detectable by[6]	Method of detection	Pitfalls
Mixture: bone marrow, oil,	?	?		„Ambrogio Ricepte d´Affare piu Colori“ (Thompson:1933)		Active coal? On smooth parchment soot ink was completely deleted, iron gall ink was significantly lighter, on rough parchment and paper a smearing and oil stain was left		
Malus sylvestris (low pH) juice, and a rough cloth	Most probably iron gall ink	Parchment most probably entire page		München, Bayerische Staatsbibliothek, Clm. 20174, Ms. 52, f.254r, Kap 225				
Wine yeast (saccharomyces cerevisiae), ashes, water – a lye is the result pH was 11	Most probably iron gall ink	Most probably entire page		(“Liber illuministarum”, Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 229´)	A lye from K2CO3, possibly with parts of KOH – dissolving the iron ink complex	On the smooth parchment both soot ink and iron gall ink could be deleted, iron gall ink left a light tine, on rough parchment the treatment resulted in stains.		
Lime, flour, water, egg shells, swelling stretching and shaving then application of chalk. The pH of this mixture went up to 14.		Parchment. Krekel believes that this is a recipe for deleting an entire page of text.[52]	Around 1500	Tegernsee um 1500, Staatsbibliothek München, Cod. germ. 821,fol. 36´		The parchment is immersed into the mixture for 6 days, then stretched and shaved – virtually all previous findings should be eliminated.		

52 „Hier wird das Pergament in eine Beize aus Kalklauge (Calciumhydroxid, Ca (OH)2), Eiserschalenkreide (Calciumcarbonat, CaCO3) und Mehl gegeben. Die Kreide ergibt dabei wenig Sinn, da sie kaum wasserlöslich ist. Vermutlich ist an gebrannte Eierschalen, also Calciumoxid (CaO) gedacht, das mit Wasser abermals Kalklauge ergibt. In dieser Beize quellen, wie bei der Kalkäscherung die Hautfasern, wobei das Mehl vermutlich nur eine untergeordnete Rolle spielt, da sich in der stark alkalischen Kalilauge kaum Enzyme bilden können. Das gebeizte Pergament lässt sich dann wie eine frische Haut im Spannrahmen bearbeiten. Dabei wird eine dünne Pergamentschicht zusammen mit der ersten Beschriftung abgeschabt; Anschließend wird die Oberfläche mit einer „künstlichen Kreide“ fein aufgerauht und egalisiert.“ (Bartl 2005:653, 654)

3.3 Overpainting, pasting over and oversewing

After scratching off the text and washing it off in wider sense, the third main category of methods to make a text invisible is to cover it up. The author could not find any written instructions for overpainting, pasting over or oversewing, however, ample evidence of this practice is found in manuscripts.

3.3.1 Overpainting

Fol. 100 r Sakramentars Bernwards, Hildesheim, 1014, Domschatz Nr. 19

Guntbald Evangeliar, Hildesheim, 1011, im Hildesheimer Domschatz, Domschatz Nr. 33 fol. 10.

3.3.2 Pasting over

Ratmann Sakramentar fol. 75r.

Missale/Graduale Domschatz Hs 681 13th/ 14th Cent.

3.3.3 Oversewing

Missale/Graduale Domschatz Hs 681 13th/ 14th cent. Only parchment can be sewn.

3.4 Cutting out

Even though cutting out parts of a page is not a proper method for covering text, we should mention it in this context. The only thing both methods have in common is that, although evidence of their use is ample in manuscripts, they are not mentioned as instructions in scribes' manuals.

Cut out areas are well visible on any material. Yet, not every cut out area is an indication of the intent to delete text. Sometimes it seems that material (parchment) was needed and pages without text seemed a good source for such material.

3.5 Lifting off

Lifting off is a deleting technique relevant for charcoal. Cennini recommends fresh bread for this purpose. We might assume that this was a widely used method. However, in manuscripts charcoal was actually only used for first sketches for illuminations.

„Nella carta bambagina puoi disegnare col predetto piombo, senza osso, ed eziandio con osso. E se alcuna volta ti avvenisse trascorso, che volessi tor via alcuno segno` fatto per lo ditto plombino, togli una poca di midolla di pane, e freganela su per la carta, e torrai via quello che vorrai. E similmente su per la detta carta puoi ombrare d`inchiostro, di colori, e di pezzuole con la predetta tempera." (Cennini Kap 12)[53]

4. Identification of deleted area and deleting method

The identification of the shape and dimensions of the deleted area - these may be faint ink lines under the recent text, scratched off areas, stains, etc. - may indicate a deleting method used, while the identification of the deleting method may indicate

- The proper/inappropriate choice of deleting material for a given text and its material (sort of ink)
- The usual/unusual choice of deleting material/method for its purpose (availability of deleting material and time to spare to finalize the deletion in case of a palimpsest)

53 Translation: on wooly paper you can use the lead-point with or without primer made of bones. And in case a mistake happens, and you wish to delete a sign, which was made with the lead point, so take a bit of bread, move it on the sheet and take away what you with to take away.

We see that we have actually a time line here. And we started from the reason why a deletion was made; however, SKOS also allows us asking another question: what alteration do we face in a particular manuscript or even: on what finding can a conservator´s decision be based?

4.1. Visible observation with the conservator´s eye and "background assumptions and theory

4.1.1 visible light reflected randomly from the page surface

4.1.2 visible light used at a raking angle

4.1.3 visible light transmitted

4.1.4 visible light under magnification

4.1.5 instrumental analysis

here we need a link to the relevant analytical methods

5. Conservation of deletions

Finally, the step-by-step conservator´s approach shall be described, focusing on deletions.

In the course of the conservator´s description of the item at hand they will see traces of deletions, if any. In any case there are two main questions a conservator will ask immediately:

- Is this a deletion – intentional change of material – or a damage – an unintentional change of the material?
- Does the situation endanger the further life of the cultural heritage item at hand?

Depending on the answers we have several general options

- Deletion and no risk to the item – leave it as it is
- Deletion and some risk to the item – find a method to preserve as much information about the deletion as possible and then – if needed – even alter the area
- No deletion and no risk – possibly improve the appearance
- No deletion and some risk for the item– restore.

In general, it can be presumed that dry deleting methods do not mean any real risk for the manuscript; it is more likely for parchment or ink to have been affected by mixtures, due to their stronger impact.

We should also underline that parchment, which is in most cases the text carrier, is quite a strong material and we more often come across ugly stains, which of course may mean a complete damage of the parchment, but the parchment still serves as a text carrier, even when brown or transparent.

The conservator should know of these deletion methods and materials in order to be able to act as a sort of translator telling other researchers, such as historians and philologists: here is a deletion, here is the way it was made, this manner of deletion is appropriate or inappropriate, as the case may be, here are the reasons why – offering a well-grounded interpretation of the finding in an interdisciplinary context.

Conclusion and next steps (Introduction and Conclusion are not numbered, as this would disturb the visibility of the SKOS layers)

The work presented will be put online in an open access manner in the framework of DITAH project and is based on the dissertation work of the author.

The paper´s hypothesis was that better understanding of damage of material of manuscripts done in the course of a deletion procedure can carry information on the history of the particular manuscript. Therefore, areas of deletions must be detected, interpreted and preserved. This paper is dedicated to the tools and methods available for achieving that.

The deleting methods described come from European sources in the time between the classical antiquity and 1500 AD. After 1500 AD, the deleting methods become very diverse and their study is still a work in progress.

This approach also sheds some light on the changing philosophy of conservation. While at the early stages of the discipline cleaning was one of its essential elements, today we may even consider stains (for example, those left by deleting substances or even dust) a valuable source of information and the discussion around whether we should take them out and thereby eliminate evidence of time and place that they may provide is still ongoing, putting conservators before difficult decisions and choices.

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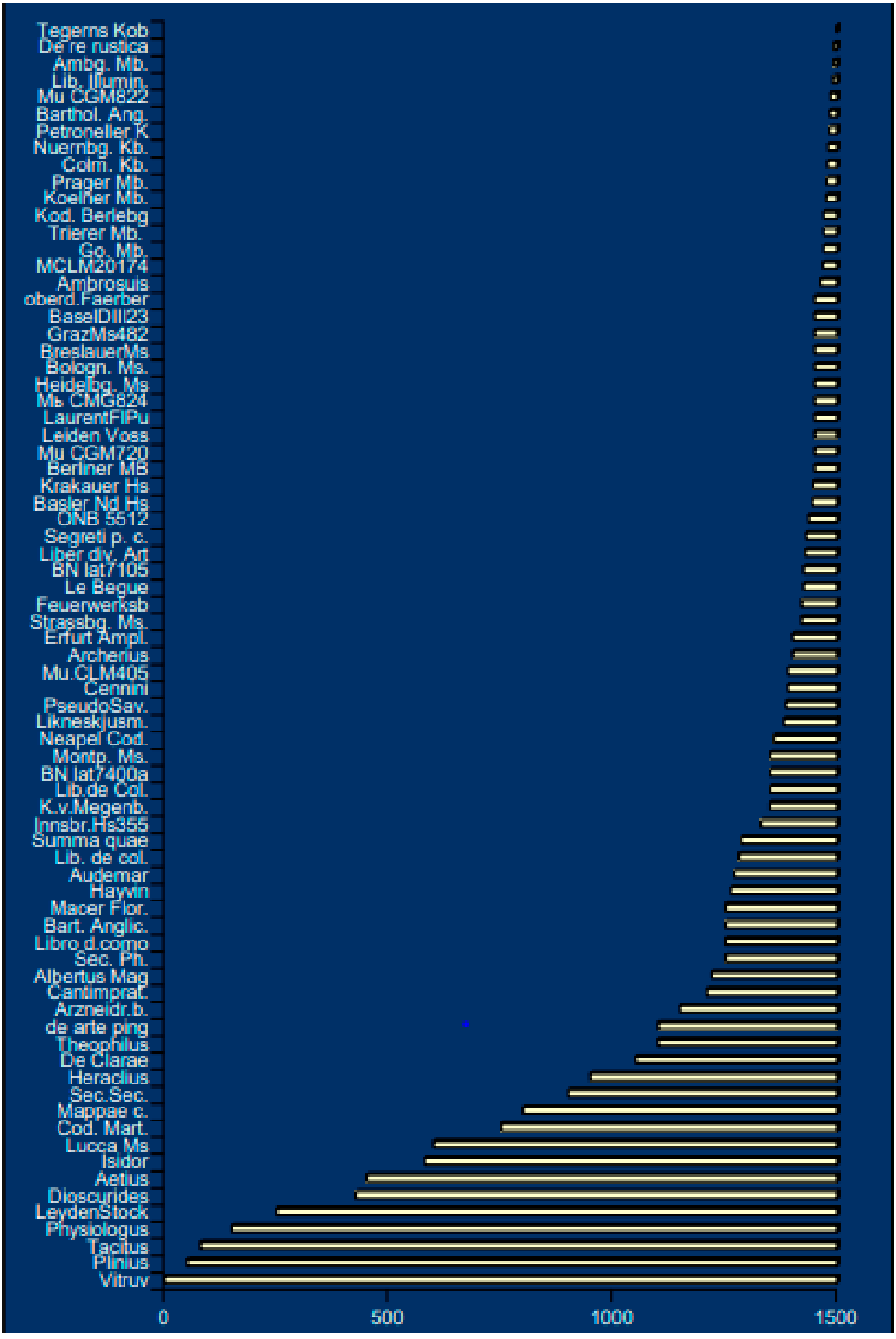

Figure 1: *sources listed according to time*

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