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The Removal of Leather Dressing from Paper

ABSTRACT

This paper represents the preliminary findings of an ongoing study of techniques for the removal of leather dressing from paper. Four types of paper were selected for study, using three dressing formulae, and four aging protocols. Five immersion techniques for reduction and/or removal of leather dressing stains were compared, and their effectiveness measured using qualitative examination. The results were analyzed by type of dressing, age of stain, and kind of paper.

INTRODUCTION

Traditionally, the preservation of leather bound books included the regular application of "leather dressing," a mixture of fats, waxes, solvents, and other ingredients designed to keep the leather supple and resistant to moisture, insects, microbial attack, and environmental pollutants. This process of furbishing and conditioning the leather was typically undertaken in concert with wet or dry surface cleaning of the binding.

In recent years, however, conservators have become increasingly aware of the detrimental effects of leather dressing. While the routine dressing of leather bound books has fallen out of favor, many previously treated volumes are now suffering from waxy surface residue (bloom), formation of corrosion products around metal furniture, and perhaps most problematically, staining of the textblock. This staining occurs when the leather dressing penetrates through the leather and spine linings and is absorbed into the textblock, causing discoloration and damage to the paper. A second mechanism for transmission is via direct contact with dressed turn-ins, leading to staining of the outermost pages of the textblock. Over time, discoloration caused by oxidation of the oil impairs legibility, and gradual embrittlement of the stained paper puts the entire volume at risk.

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Stains resulting from leather dressing are comprised of a mixture of ingredients. Some of these ingredients may be soluble in water, while others may only respond to organic solvents. Still other elements, such as waxes, may be insoluble in water and unaffected by treatments commonly used to reduce oil stains. These stains may also contain components of the leather covering that have been solubilized and carried along with the dressing into the textblock.

Treatment of these complex stains poses ethical, technical, and logistical problems. Staining typically affects the entire textblock, as oily elements of the dressing are wicked along the sewing supports and into the sewing thread. Because the gutter is usually the area most heavily affected, the book must often be disbound for treatment. Immersion treatments are generally selected for efficiency, but lack the level of control offered by a localized technique. While solvents are frequently used to reduce oil stains, they have the potential to cause problems such as softening, desiccation, and bleeding in oil-based printing inks. Given these concerns, it is important to select a technique that is effective enough to justify a highly invasive treatment without causing damage to the inks.

The goal of this study is to evaluate common immersion treatments for oily stains to determine which are most effective at reducing leather dressing stains without harming printing inks.

PAPER SELECTION

Four papers from the seventeenth to twentieth centuries were chosen for testing (fig. 1). Three of the papers were taken from German printed books, selected in order to test the effect of the various treatments on printing ink. The fourth paper tested was Whatman #1 filter paper.

The outer margins of each sampled book page were trimmed off to eliminate any possible differences in the character of the paper caused by prolonged exposure to air. The first and last pages of each book were rejected for the same reason. Areas with staining, tears, previous repairs, or any other detectable deviation from the normal character of the

Paper	Origin	Description	Observations	Optical microscopy of fibers	Thickness	pH	Biuret test for protein	Iodine / potassium iodide test for starch	Aluminon test for alum	Phloroglucinol test for ligin
1	*Luther Bible*—matches collation of 1670 and 1693 editions, pp. 55/56 and 941/942	17th century handmade, laid paper from a German Bible	Rattles like gelatin sized paper, yellowish color, opaque, fluoresces yellow under UV	Looks like cotton with a few shives or woody inclusions	.11 mm	5.0	Slight positive	Negative	Slight positive	Slight positive - localized in woody inclusions
2	*Sammlung ber besten Reisebeschreibungen* (Brunn, 1786), pp. 27-98	18th century handmade, laid paper	Slightly textured, little body, many visible inclusions, fairly opaque	Looks like cotton with shives or woody inclusions and blue and red fibers	.09mm	5.3	Negative	Negative	Negative	Slight positive - localized in woody inclusions
3	*Stunden der Undacht fur Befürderung wahren Christenthums und häuslicher Gottesverehrung* (Frankfurt, 1848), pp. 27–52	19th century machine made wove paper from a German book	Smooth, thin, regular, shorter fibers, opaque	Looks like cotton	.06 mm	4.3	Negative	Positive	Positive	Slight positive - localized in woody inclusions
4	N/A	Whatman #1 filter paper, known to be cotton	Fairly soft, somewhat textured	Cotton	.16mm	4.8	Negative	Negative	Negative	Negative

Fig. 1. Sample Papers

historic paper were removed from the sample population. Each historic sample included an area without printing, to facilitate measurements of color change and translucency, and an area with printed text. Some samples of the seventeenth-century paper also had areas of woodcut printing.

DRESSINGS TESTED

Three dressings were selected for testing based on their frequent mention in literature describing the application of leather dressing, and the range of ingredients and working properties they represent. They were numbered from earliest to latest publication and distribution, and perhaps not coincidentally, from least to most viscous—later formulae typically contained a far higher proportion of wax, possibly in response to an increased awareness of the potential damage caused by excessive application of oily, readily flowing dressings.

While the formulae of leather dressings varied widely, they generally contained some combination of liquid oils, solid fats, waxes, and various additives such as soaps, metal salts, and starches (fig. 2). Although animal fats such as neat's-foot oil and lanolin were most common, fish, vegetable, and mineral oils were also used. Solvents were sometimes added to thin dressing mixtures and to enhance penetration.

Formula #1
Lanolin (anhydrous)..........................7 oz
Cedarwood Oil..................................1 oz
Beeswax...1/2 oz
Hexanes..11 oz
(Plenderleith 1946)

Formula #2
Neat's-foot Oil..................................60%
Lanolin (anhydrous)..........................40%
(Rogers and Beebe 1956)

Formula #3 [1]
30 parts Neat's-foot Oil
20 parts Anhydrous Lanolin
10 parts Carnauba Wax

The dressings were applied with a brush to one side of each paper sample, and allowed to air dry for one week on a sheet of Mylar. It is important to note that this method of application does not replicate the wicking action most commonly implicated in this type of staining. Nevertheless, brush application was selected because it ensured that all components of each formula (including those that do not

Lubricants	Polishes/surface sealants	Solvents	Other Additives
Lanolin	Beeswax	Hexanes	Cedar oil
Mutton fat	Carnauba wax	Turpentine	Glycerin
Tallow	Paraffin	Trichloroethane	Castile soap
Butter	Japan wax	Diethyl ether	Salt
Egg yolk	Acrylic wax	Alcohol	Borax
Oil of egg	Microcrystaline wax	Milk	Imidazole
Neat's foot oil	Acrylic resins	Water	Sodium stearate
Sperm oil	Egg white		Lye
Cod oil	Blood albumen		Potassium lactate
Castor oil	Starch		Saddle soap
Linseed oil	Rosin		Shoe polish
Coconut oil	White glue		
Olive oil			
Mineral oil			
Vaseline			

Fig. 2. Some ingredients mentioned in recipes for leather dressings

flow readily at room temperature) were applied to each sample. One group of samples was left undressed as a control.

AGING PROTOCOL

The samples were broken into four groups for aging.

- *Unaged:* The unaged samples were treated after air-drying for 3 weeks.
- *Oven-aged:* The oven-aged samples were aged at 75°C and 65% RH for two weeks before treatment.
- *Naturally light-aged:* The naturally light-aged samples were hung in a south-facing window in the Thaw Conservation Center.
- *Naturally dark-aged:* The naturally dark-aged samples were placed on a sheet of Mylar and stored in a drawer in the Thaw Conservation Center.

Only the unaged and oven-aged samples were treated for this paper. Aging continues for the naturally aged samples.

TREATMENT PROTOCOL

In order to more closely simulate the conditions of treating an entire stained textblock, only immersion techniques were evaluated. The treatments were selected based on approaches used by book and paper conservators who had treated leather dressing stains. Three solvent-based treatments and two aqueous techniques were selected for testing. One group of samples was left untreated as a control.

Hexanes (15 minutes)

Hexanes were selected for their low polarity, and because they are a component of Formula #1 leather dressing. Each sample was washed in a single fifteen-minute bath, blotted lightly, and allowed to air dry on blotter.

Isopropanol (15 minutes)

Alcohols are among the solvents most frequently used by paper conservators. Isopropanol was selected over ethanol because it is available at a very high purity for substantially lower cost than absolute ethanol. Each sample was washed in a single fifteen-minute bath, blotted lightly, and allowed to air dry on blotter.

Acetone (15 minutes)

Acetone is a moderately polar solvent frequently used in laboratory settings as a degreaser. Each sample was washed in a single, fifteen-minute bath, blotted lightly, and allowed to air dry on blotter.

Lipase bath (300 units of activity/mL, 30°C for a total of 1 hour, plus 30-minute rinse)

Lipase is a water-soluble enzyme that catalyzes hydrolysis of water-insoluble lipids, breaking triglycerides into fatty acids and glycerol (Blüher et al 1997). The solution was buffered to a pH of approximately 7.5 using Trizma® Pre-set

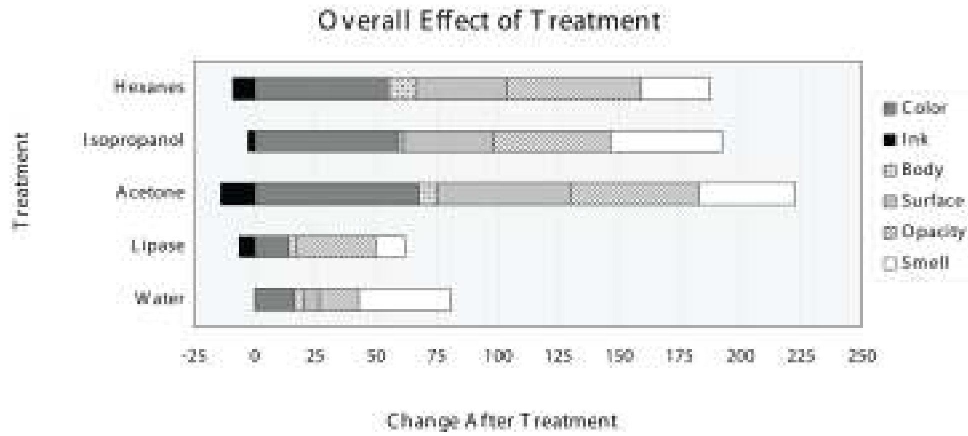

Fig. 3. The cumulative change in score on six different parameters of all treated samples. Each parameter was qualitatively evaluated before and after treatment, and a numerical score was assigned. The change in these scores after treatment is shown here. A positive score represents an improvement. A negative score represents undesirable change or damage to the paper or ink. All treatments except a water bath caused some change or damage to inks

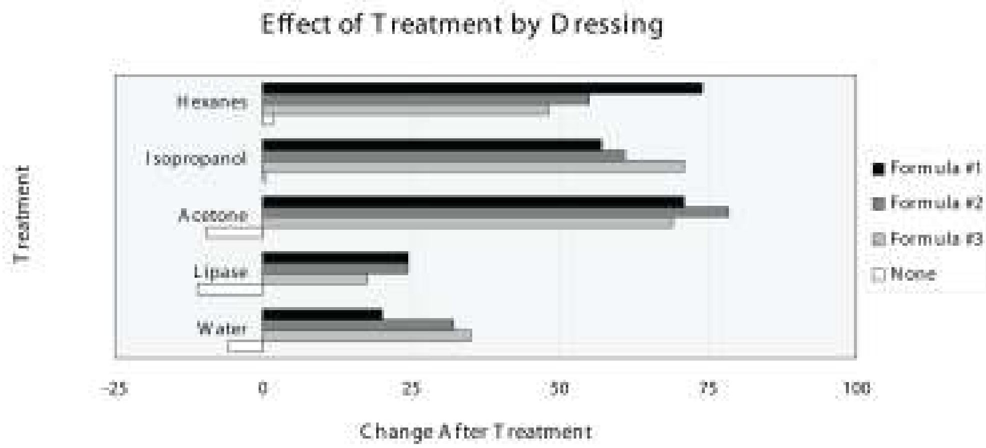

Fig. 4. The effectiveness of each treatment, broken down by type of leather dressing. A negative score represents undesirable change or damage to the paper or ink. The hexanes bath was notably more effective in treating samples dressed with Formula #1, which contains hexanes as a solvent. This increased effectiveness was most pronounced in the unaged samples

Crystals[2]. Each sample was washed in two successive thirty-minute baths, followed by a thirty-minute rinse. After treatment, the samples were blotted lightly and allowed to air dry on blotter.

Water (30°C for a total of 1 hour, in 3 baths)

A water bath was selected to compare the effectiveness of a lipase bath with that of warm water. The pH of each bath was adjusted to approximately 8 using calcium carbonate. The samples were washed in three successive baths. After treatment, the samples were blotted lightly and allowed to air dry on blotter.

ASSESSMENT

Each sample was evaluated before and after treatment, and assigned a score[3] for each of six parameters: color, strength of ink, body, surface feel, opacity, and smell. The change in score after treatment was calculated for each sample. A positive number indicated an improvement, and a negative number indicated an undesirable change or damage. In the case of the control samples that were not stained with leather dressing, any detectible change to the paper or ink resulting from treatment (such as softening, loss of sizing, or color change) was considered undesirable.

RESULTS

The data were analyzed to determine which treatments were most effective at reducing the undesirable characteristics of leather dressing stains. The findings were broken down by several variables to identify secondary trends, such as a treatment being particularly effective on one type of paper or dressing. The findings are summarized in figures 3–6.

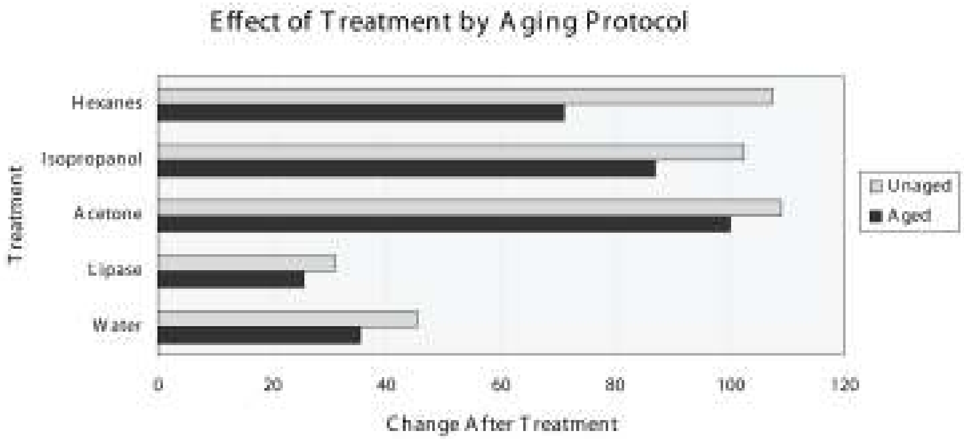

Fig. 5. The effectiveness of each treatment, broken down by whether or not the sample was aged. The unaged samples showed more improvement with all treatment protocols. The more polar solvents were most effective in treating the aged samples, where cross-linking was likely to have occurred

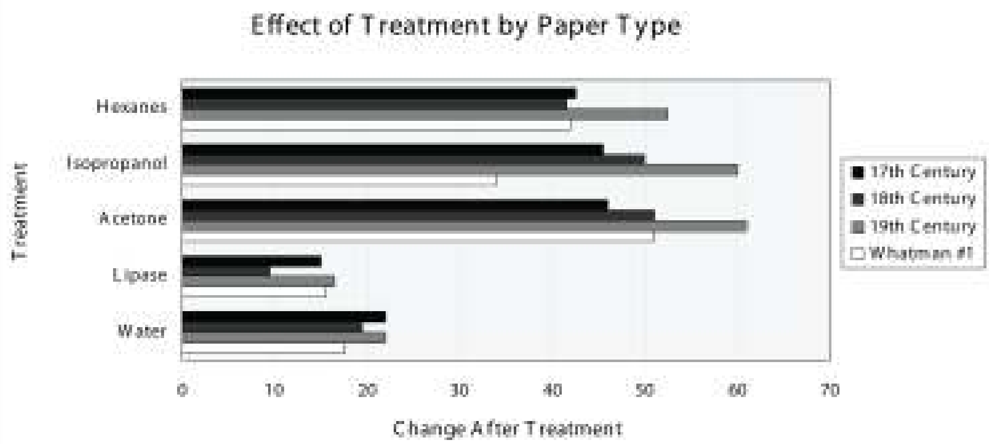

Fig. 6. The effectiveness of each treatment, broken down by the type of paper. The nineteenth-century paper showed the most improvement with all treatments, possibly because its smoothly sized surface made it less absorbent

Overall, acetone was found to be the most effective at reducing the discoloration and oily surface feel of the stained samples (fig. 3). Unfortunately, acetone was also most likely to damage the printing inks, including softening of the ink leading to offset, haloing, and the formation of a white bloom on the surface of the ink. This haze was most noticeable in the samples dressed with Formula #3, which contained the highest proportion of wax. Treatment may have resulted in selective removal of the oily components of the dressing, leaving the wax behind as a white film.

Isopropanol and hexanes were both moderately effective at reducing staining, with less risk of damage to the printing ink and paper. Hexanes were particularly effective at removing Formula #1, which contains hexanes. Isopropanol worked well overall, and was the least likely of all the treatments other than water to damage the printing inks.

The aqueous treatments were significantly less effective, particularly at improving the color, opacity, and surface feel of the samples. Aqueous samples were most likely to dramatically change the character of the paper, probably due to the removal of sizing in the bath. Warm water was effective at reducing the smell of the dressed samples, and was the only treatment that caused no damage to the printing ink. Lipase was slightly more effective than water at improving opacity, but was least effective at reducing discoloration, smell, and oily surface feel. The samples treated with lipase tended to have a yellow cast and a blotchy appearance after treatment.

Variables such as the dressing type (fig. 4), age of stain (fig. 5), and type of paper (fig. 6) were all shown to have some effect on the outcome of treatment. A different treatment was most effective on each leather dressing formula, but acetone and isopropanol were reasonably effective at reducing all three. Knowing the type of dressing used might give the conservator a slight advantage in selecting a treatment protocol, but the same advantage could be gained through spot testing.

No one dressing was markedly harder or easier to remove, although the waxy component of Formula #3 did not seem to be removed by any treatment. All treatments were more effective on unaged samples, but the difference was most pronounced in the hexanes bath. The cross linking that occurs with aging may have made the oils less soluble in non-polar solvents.

While different types of paper showed trends in terms of the overall effectiveness of treatment, a given treatment was not notably more effective on a specific type of paper within the sample set. The nineteenth-century paper showed the most improvement with all treatments, possibly because it was less absorbent than the other papers tested. Conversely, the highly absorbent Whatman filter paper generally showed the least improvement. The ink on the nineteenth-century paper was the most vulnerable to damage.

CONCLUSIONS AND RECOMMENDATIONS

None of the treatments completely removed the stains; however solvent treatments generally produced good results. Thorough testing of the ink and paper is necessary to determine the most appropriate balance of stain reduction and protection of the original character of the object. Spot testing for the formation of waxy bloom should also be carried out before immersion. In general, isopropanol provided the best compromise between effective treatment and minimal damage.

It is important to note that solvent baths, while efficient and effective, require large volumes of solvent. Access to a fume hood or alternate source of ventilation is essential, as is personal protective gear. Because of the cost and environmental impact of organic solvents, care should be taken to minimize the amount of solvent wasted.

While lipase was not found to be effective in this study, it is possible that longer immersion, higher concentration, or other refinements in technique could increase its effectiveness. Poulticing with lipase in an agarose gel has been shown to be effective in reducing oil stains in works of art on paper (Stockman n.d.).

Successive solvent baths, or solvent baths followed by aqueous treatment were not tested as part of this study but could potentially provide greater improvement.

While this study investigated a range of dressing formulae, paper and ink compositions, and treatment approaches, every object and every treatment is different. Treatments that were not found to be effective may prove ideal for certain applications, and treatments that were relatively safe for the papers and inks used in this study may cause damage to other artifacts. In some cases, forgoing treatment may be the best option.

FUTURE WORK

The next phase of this investigation will examine the effectiveness of each treatment on naturally aged samples. The questions of which components of leather dressing are wicked into the paper, and whether they carry any components of the leather itself along with them, will also be explored.

ACKNOWLEDGEMENTS

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NOTES

1. Clarkson, Christopher. Conservator of Library & Archive Materials. Personal correspondence. 22 February 2009.
2. Sigma-Aldrich # T8068. The exact pH of the buffer is dependent upon the temperature of the solution. The pH ranges from 7.7 at a temperature of 25°C to 7.4 at 37°C. Testing of the treatment solution with pH strips showed the pH to be approximately 7.5 at 30°C.
3. Each qualitative parameter was scored based on a pre-determined scale. Color and surface feel were evaluated using thirteen-point scales based on the paper samples in *The Print Council of America's Paper Sample Book* (Lunning and Perkinson 1996). The scales ranged from "very bright white" to "brown" (4) for color, and "very smooth" to "rough" (2) for surface feel. Because many samples had substantial leather dressing residue on their surfaces, the surface feel scale was extended to include scores for slight, moderate, or extreme oiliness, waxiness, and/or stickiness. Ink quality was rated on a six-point scale from "very strong" to "very weak." Embrittlement, smell, and opacity were rated based on six-point scales ranging from "supple" to "very brittle," "no odor" to "very strong odor," and "opaque" to "very translucent," respectively.

The scores shown in the charts reflect the change after treatment. For example, if a sample was "brown" (4) before treatment and "brown" (1) after treatment, the score would be 3. A positive score reflects an improvement, whereas a negative score reflects damage or undesirable change.

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