

Historic Adhesive Reconstruction: A 19th-Century Sturgeon Bladder 'Cement' Recipe Comparison

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INTRODUCTION

During the Masters in Conservation and Restoration module in Art Technological Source Research at the University of Amsterdam, research was undertaken to interpret and compare two similar sturgeon bladder-based historical 'cement' recipes specifically recommended for mending ceramics and glass by planning and executing

reconstructions. The historical sources used were written for different audiences, and while both recipes name primarily the same ingredients and have a similarly descriptive text (although recipe two is more elaborate), the quantities and preparation processes differed.

RECIPES AND SOURCES

Recipe one

A Manual of Mending and Repairing (1896)

'A very strong cement is made as follows: —Take one ounce of finely powdered mastic dissolved in six of spirits of wine and two ounces of shredded sturgeon's bladder dissolved in two ounces common spirits; add one half ounce of gum-ammoniac as it hardens; warm it when it is to be used. This is as strong a cement as can be made.' (Leland 1896, 24)

Recipe two

The Servants' Guide and Family Manual (1831)

'To an ounce of mastic, add as much spirits of wine, as will dissolve it. Soak an ounce of isinglass in water until quite soft, then dissolve it in pure rum or brandy, until it forms a strong glue, to which add a quarter of an ounce of gum ammoniac, well rubbed and mixed. Put the mixtures together in an earthen vessel over a gentle heat; when well united, the mixture may be put in a phial, and kept well stopped. When wanted for use, the bottle must be set in warm water.' (The Servants' Guide and Family Manual 1831, 191)

Recipe one is featured in *A Manual of Mending and Repairing with Diagrams* written in 1896 by Charles Godfrey Leland (1824-1903), a humorist, poet, and journalist ('Charles Godfrey Leland' 2018). The book is comprised of advice and recipes on the repair of various household items such as ceramics, glass, clothes, and pictures. In the introduction he stresses that the subject is relevant to every household (Leland 1896, vii) and that due to the very practical explanations of general principles and application, everyone could successfully conduct repairs (Leland 1896, viii).

Recipe two is from *The Servants' Guide and Family Manual: with new and improved receipts. Arranged and adapted to the duties of all classes of servants* published by John Limbird (1796-1868) in 1831. The book is a guide for staff in an early nineteenth-century household and has everything a servant might have needed to know, including appendices of aids for addition, weights, finances, and quantity translations (though this not applicable to the recipe in question). The chapter on a butler's duties has a few paragraphs on mending 'china, glass etc.' and as this is the only time adhesives are mentioned, it appears he was to fix breakages. (*The Servants' Guide and Family Manual 1831*, 191) These recipes were written by several, unnamed authors from various sources (*The Servants' Guide and Family Manual 1831*, vi).

The existence of many similar nineteenth-century recipes indicates their common use at the time, suggesting a reasonably accurate reconstruction can be created from both recipes, dependent on a correct interpretation of the ingredients and application methods. It was expected that the *Manual of Mending*, with two whole chapters dedicated to 'Mending broken china, porcelain, crockery, majolica, terra-cotta, brick and tile work' and glass would be more reliable than the *Servants' Guide*, which only had a few 'cement' recipes for mending 'china, glass etc.'

METHODOLOGY

Table 1 contains a list of ingredients and a discussion on the historical accuracy and potential interpretation or availability issues. The recipes were tested on both a non-porous glass and porous pottery object to assess the effectiveness of the cements on different substrates, as indicated in both sources. The adhesives were prepared in a

bain-marie and the temperature monitored with a cooking thermometer. The practicability and effectiveness of the recipes were assessed during and after application. The strength of the cement was assessed by normal handling. Alterations were made to the recipes regarding protein, procedure, and alcohol content to assess which element of a recipe needed correction (Tables 2 and 3), and both recipes were repeated four times with variations in ingredients and/or process.

RESULTS AND DISCUSSION

While all reconstructions of recipe two resulted in functional adhesives, contrary to expectations, only one test of recipe one was successful (Table 2, M4). Difficulties in dissolving the components were encountered, particularly in the preparation of recipe one, therefore solubility of different components was compared. While mastic should be soluble in ethanol ('Mastic Resin' 2018), this was not observed during this experiment. The 'mastic' obtained from a Dutch supplier for the testing was labelled as 'Arabische gom' and therefore thought to be Arabic gum (another word for mastic) derived from the *Pistacia Lentiscus* tree, not to be confused with gum Arabic which is derived from the Acacia tree ('Gum Arabic' 2018). The words mastic and gum Arabic are sometimes used interchangeably ('Mastic. Plant Resin' 2018), despite their different composition and solubility. The retailer's website translates 'Arabische gom' as gum arabic, a substance that is insoluble in ethanol and soluble in water ('Gum Arabic' 2018) and may therefore not have been the material referred to by Leland. Mastic on the other hand is soluble in ethanol and insoluble in water ('Mastic Resin'), which would be more logical in these recipes. It may be beneficial to repeat the experiment with actual mastic and compare the results with the attempts of this experiment.

In general, in the nineteenth century, editing was done by scholars, and given the extent of reprints of both sources, both may be expected to be reliable. Based on the results of this experiment, the guide written by and for people managing a household was easier to follow than the *Manual of Mending* that claimed to be more reliable due to its scientific approach. This is not to say that the latter provides incorrect information but merely stresses the implications for repeatability due to a lack of instructions and the different knowledge

INGREDIENT (Source/Brand)	TERMS USED RECIPE 1	TERMS USED RECIPE 2	NOTES/ ALTERATIONS
Sturgeon bladder (<i>Deffner & Johann</i>)	Sturgeon bladder	Isinglass	The definition of sturgeon bladder used did not suggest any pre-treatment other than cutting and soaking: 'With this the bladders of several kinds of fish are classed. Cut in small pieces and dissolved in spirits (...)' (Leland 1896, 5).
Rabbit skin (<i>Kremer Pigmente</i>)	N/A	N/A	A variation of the recipe was prepared replacing the sturgeon bladder with another protein, rabbit skin, due to its similar properties but greater ease of preparation compared to sturgeon bladder (Schramm and Hering 2000, 113-115 and 118-120; Petukhova and Bonadies 1993, 23-31).
Ethanol (<i>Sigma Aldrich</i>)	Spirits of wine	Spirits of wine	Ethanol was used as spirits of wine (see 'Spirit of wine' 2018) which is referenced in multiple adhesive recipes (Cannon 2012, 44). A dictionary of scientific terms from the nineteenth century confirms this definition 'Alcohol, (the finely divided substance) = <i>spirit of wine</i> = C_2H_6O = Hydrated ethyl = (...) a colourless in-flammable liquid, volatile and stimulating, much used as a solvent, and forming the base of all fermented liquors.' (Rossiter 1879, 11)
Rum (<i>Stroh, Austria</i>)	Common spirits	Pure rum or brandy	Rum with common alcohol contents of 38% and 80% were compared. Common spirits were often referred to as strong spirits. A 19 th -century English dictionary defines it as follows: ' <i>spirit</i> , (...) a liquid, as brandy, whisky or rum, obtained by distilling a fermented vegetable extract; (...)' (Stormonth 1874, 603). As the <i>Servants' Guide</i> receipt specifically referred to brandy or rum, one of these was chosen for both recipes for better comparison. Due to conflicting sources regarding alcohol content of brandy at the end of the nineteenth century, rum was used. During the nineteenth century, rum generally contained a minimum of 43–49 percent of alcohol by volume ('Rum' 2018). This is confirmed by another source that classifies alcoholic beverages into four categories: spirits, beer, wine and cider and then goes on to give a list of approximate percentages among which whiskey, brandy, and rum are classified in the same group with about 52% (Dutton 1898, 110). Therefore, rum with 40% and 80% <i>Stroh Rum</i> (the highest available) were purchased for this reconstruction. <i>Stroh Rum</i> does have a very dark brown colour, particularly the 80% version and contains colourants (<i>Handbuch Alkohol - Österreich</i> 2018) that may not have been used in the nineteenth century and may influence the colour or other properties of the adhesive produced.
Gum ammoniac (<i>L. Cornelissen & Son</i>)	Gum ammoniac	Gum ammoniac	Gum ammoniac is a gum/oil/resin mixture obtained from the stems of a plant from the carrot family <i>Dorema ammoniacum</i> , native to Iran and India. Commonly mixed with mastic and isinglass, it is used for gilding, setting gemstones, and fixing broken porcelain ('Ammoniac Gum' 2018).
Mastic (<i>Labshop.nl</i>)	Mastic (Arabic gum)	Mastic	Powdered mastic, a pale, yellow natural resin produced by the evergreen mastic shrub, <i>Pistacia lentiscus</i> , which occurs in southern Europe and northern Africa ('Mastic Resin' 2018).
Water (<i>Tap water, Amsterdam Netherlands</i>)	Water	Water	

Table 1. List of ingredients, discussion of interpretation and historical accuracy




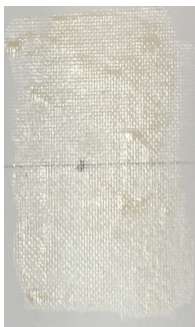
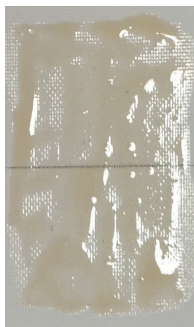
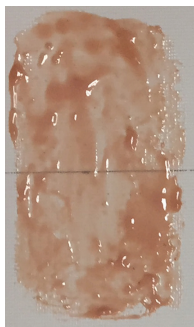

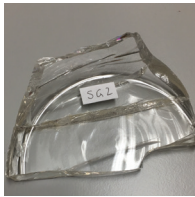



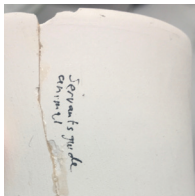
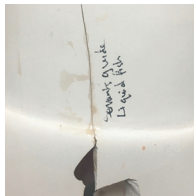

SAMPLE #	TEST 1 (M1)	TEST 2 (M2)	TEST 3 (M3)	TEST 4 (M4)
Cements applied to: canvas (hardboard)				
Cements applied to: non-porous substrate (glass)	<i>No adhesion</i> <i>Not spreadable</i>	<i>No adhesion</i> <i>Not spreadable</i>		
Cements applied to: porous substrate (ceramic)	<i>No adhesion</i> <i>Not spreadable</i>	<i>No adhesion</i> <i>Not spreadable</i>		
Recipe Notes	Original recipe <i>(original ingredients and process)</i>	Altered recipe <i>(different protein but original process)</i>	Altered recipe <i>(original protein, but different process)</i>	Altered recipe <i>(original protein, higher alcohol %, different process)</i>
Alterations, protein, alcohol percentage etc.	Fish glue 38% rum	Animal glue 38% rum	Fish glue 38% rum Sturgeon bladder was soaked in water (1:10) for 24 hours and heated until thickened	Fish glue 80% rum Sturgeon bladder was soaked in water (1:10) for 24 hours and heated until thickened
Application and adhesion	<ul style="list-style-type: none"> • No adhesion • Too viscous to spread evenly • Greasy 	<ul style="list-style-type: none"> • No adhesion • Too viscous to spread evenly • Greasy 	<ul style="list-style-type: none"> • Adhesion • Too viscous to spread evenly • Ceramic came apart during handling • Greasy • Staining ceramic 	<ul style="list-style-type: none"> • Adhesion • Too viscous to spread evenly • Greasy • Staining ceramic

Table 2. Results for Recipe 1 – A Manual of Mending and Repairing

SAMPLE #	TEST 1 (SG1)	TEST 2 (SG2)	TEST 3 (SG3)	TEST 4 (SG4)
Cements applied to: canvas (hardboard)				
Cements applied to: non-porous substrate (glass)				
Cements applied to: porous substrate (ceramic)				
Recipe Notes	Original recipe <i>(original ingredients and process)</i>	Altered recipe <i>(different protein but original process)</i>	Altered recipe <i>(original protein, different process)</i>	Altered recipe <i>(original protein, higher alcohol %, different process)</i>
Alterations, protein, alcohol percentage etc.	Fish glue 38% rum	Animal glue 38% rum	Fish glue 38% rum Sturgeon bladder was soaked in water (1:10) for 24 hours and heated until thickened*	Fish glue 80% rum Sturgeon bladder was soaked in water (1:10) for 24 hours and heated until thickened
Application and adhesion	<ul style="list-style-type: none"> • Adhesion • Liquid consistency • Less glossy • No staining 	<ul style="list-style-type: none"> • Adhesion • Liquid consistency • Less glossy • No staining 	<ul style="list-style-type: none"> • Adhesion • Liquid but more viscous than SG1 and SG2 • Dried more slowly • No staining 	<ul style="list-style-type: none"> • Adhesion • Liquid but more viscous than SG1, SG2, SG3 • Dried faster • No staining

*(Petukhova and Bonadies 1993, 23-31; Schramm and Hering 2000, 113-120; Alba 2015)

Table 3. Results for Recipe 2 – The Servants’ Guide and Family Manual

of the readers at the time. With an increase in factory-produced goods, it was less common to rely on the place of purchase for repairs (Thornton 1998, 6-7; Leland 1896, xxi), so the general public in the nineteenth century was more likely to be accustomed to working with these ingredients.

CONCLUSION

Despite the discrepancy in results between the two recipes, research into sources contemporary to the manual and guide suggested that further experiments might confirm whether the *Manual of Mending* was a less reliable source. By considering chemical aspects such as solubility, as well as observations made during the reconstruction, possibilities for further research were addressed that might determine whether the sequence of processing or the quantities of ingredients might result in success or failure.

Overall, it was concluded that many factors influence the outcome of a reconstruction. Correct interpretation of the terms used, and preliminary knowledge of the ingredients' chemical properties is essential for an effective execution as well as preparation regarding the process. Discrepancies in both present day and past definitions may also cause errors. To overcome the differences in experience and knowledge, an awareness of definitions or technical terms and how they may have changed over time may alleviate what appears now to be a lack of instruction in the recipe. From a conservator's point of view this reconstruction is particularly valuable as this type of recipe may have been commonly used on artefacts that are now treated.

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