Case Study : Selection of the ideal consolidant for treatment of a 19th century reverse glass print by W.B. Walker

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ABSTRACT

This paper presents a brief history of reverse glass prints, the intriguing production methods traditionally used in their manufacture and the conservation issues they consequently present. The paper will outline the condition, materials analysis and proposed treatment of a case study 19th century reverse glass print by the printer W. B. Walker and the particular consolidant requirements of delaminated mediums on plate glass. Following a brief review of four suitable consolidants that fufill these requirements, the article will provide an overview of testing carried out to determine the most suitable consolidant for use on the case study and conclude with a discussion of the findings and results.

Keywords

Reverse glass print, Aquazol, consolidation, delamination, glass refractive index, W. B. Walker

THE REVERSE-GLASS PRINT

Reverse-Glass Prints (or glass prints, mezzotints under glass) are distinct from glass paintings, or transparencies, as they do not involve painting onto the actual glass, but onto the reverse of a print adhered to the glass, (Tremain 1994 p143). They are thought to have originated as a novel evolution to add colour to the mezzotint, and the earliest productions of reverse glass prints began very shortly after the invention and popularisation of the mezzotint in the middle of the 17th century, (Stanley 2002 p49 / Tremain p143). Reverse-glass prints, similar to some forms of glass paintings, were usually framed in order to resemble an oil painting (Stanley p52), and the earlier productions, particularly in the late 17th and early 18th century, were often high quality colour imitations of a famous painting of the day engraved, adhered and painted-in by a skilled mezzotint artist, (Stanley p50 /H.G Clarke 1928 p2). By the mid 18th century glass print making classes for amateurs began to be publicised in newspapers and print-sellers were advertising the sale of materials for amateurs to create glass prints of their own, (Stanley p51). Towards the end of the 18th century and in the early 19th century print sellers were themselves acquiring mezzotints on paper from artists specifically to produce reverse-glass prints with themes popular to the general public, (Tremain p145 / Stanley p51). These were generally of a simpler and lower standard than those seen originally, (H.G. Clarke p1).

PRODUCTION AND MANUFACTURING

Reverse-glass prints are novel examples of an obsolete technology constructed using distinct production methods particular to the materials available at a specific era of time. The ingenius method used to transfer a printed image onto a sheet of glass to allow colour to be applied to the verso is a process of many parts. Firstly the monochrome printed image on paper is fully wetted out, sometimes for up to two days, (Smith, 1705 p84), before being placed between two sheets of paper to remove excess water. The sheet of glass is carefully and evenly coated with a warm turpentine oil or varnish, and the damp paper print is carefully laid recto (print side) down and gently pressed and rubbed from one side to the other to ensure all air is expelled. The recto of the print is now evenly adhered to the glass and allowed to dry. When fully secure, the verso (reverse) of the paper is gently rubbed and rolled with the fingers, peeling away the majority of the fibres and leaving only the extremely thin and transparent recto layer with the inked print. The verso is then varnished with a natural resin varnish such as mastic '4 or 5 times, or so often till you may see clearly thro' it', (Clarke 1928). Mastic, a natural triterpenoid resin, has a long history of use in picture varnishes, (Rivers & Umney 2003 p594) due to its ability to brilliantly saturate painted colours, and was particularly suited for use in reverse glass prints for this reason as it enhanced the painterly qualities of the print. Once dried, the print could be coloured on the reverse with oil or watercolour paints, (Tremain p146, Stanley p51, Clarke p2), after which it would be framed, often in lavish carved or gilded wood to further enhance the resemblance to an oil painting, (Stanley p51).

A review of published records detailing the methods of production of reverse glass prints from c.1687 – c.1860 was carried out by both Tremain and Stanley individually and a summary of their findings can be seen in Table 1.

Summary of reverse glass print production methods commonly used c.1690 - c.1860

1	The print is wetted out
2	The print is placed between two sheets of paper.
3	The glass is coated with heated Strasburg or Venice turpentine or a varnish
4	The print is removed from the interleaving paper, is laid face down onto the glass, and is allowed to dry.
5	Most of the paper is removed from the verso of the print by rolling with the fingers; a thin layer of paper and the inked image is all that remains.
6	The print is allowed to dry
7	The print is varnished with a mastic varnish.
8	The print, now transferred onto glass, is painted on the verso with oil or
9	The print is framed, sometimes with paper packing between the print and wooden backboard.

Table 1 - Summary of reverse glass print production methods as compiled by Tremain 1994 and Stanley 2002.

CONSERVATION ISSUES

The most common forms of damage that occur to reverse-glass prints are directly related to the materials from which it is produced. The fracturing of the glass layer is probably the most drastic disfigurement that can occur. The photochemical and thermal oxidisation and aging of the resinous varnish layer can cause yellowing, hazing and increased brittleness, which can visually disrupt or obscure parts of the image, but also cause delamination of the print/paint layer from the glass, (Todd 2015 / Rivers & Umney p347/ Deitemann et al. 2008 p31). Delamination can result in the formation of air pockets between the glass and the print surface, further obscuring the image, or more drastically if segments detach, can result in disintegration and loss of the print/paint layer, (Stanley p54/ Todd).

CASE STUDY

‘The Infant St John’ is a reverse glass print produced by W.B. Walker, a British publisher and printer prolific in his production of popular prints from 1801-1821, (The British Museum 2019), as evidenced by an inscription at the bottom of the print, see fig.1.

It is part of private collection and was originally mistaken for a transparency; painted scenes on glass, textile or paper that were back-lit to create an illuminated effect, (Plunkett, 2013, p44). It was removed from its frame before coming into its current owner’s possession, leaving only the glass plate with the adhered print/paint layer. Either before or after being removed from the frame it was impacted in the top left hand corner as evidenced by the radial and concentric fracture pattern of the glass expanding out from that area, (Horvát, E. Á., 2012 p926), resulting in its fragmentation into at least twenty four shards of differing sizes. There is an area of loss from the top left hand corner, leaving a total of twenty three shards intact.

MATERIAL ANALYSIS

The glass plate has very slight distinctive arced distortions, a green tint when viewed on its edge, as well as a small elongated air bubble suggesting that it is crown glass, which was often used for reverse glass prints and glass paintings in the 18th and 19th century due to its finer and more transparent quality, (Stanley p51).

A small detached fragment of the print/paint layer was embedded in resin and examined cross-sectionally under magnification, (x50 – x100) in reflected and long wave ultraviolet light, see fig 2. This revealed the presence of a thick even varnish layer in which the paper fibre is embedded and a thin distinct film of paint on top in which specks of pigment are visible. The fluorescence of the varnish layer suggests either a mastic, dammar or gum arabic varnish, (Simpson Grant 2000 p2 / Markevicius 2003 p62 / Measday 2017). Solvency tests determined the varnish layer was not soluble in either hot or cold water, excluding gum Arabic as a likely material. Further solvency tests of the paint and varnish revealed solubility in alcohol and ketones, (acetone, ethanol, and IDA), with a noticeable change in sheen to the paint layer after contact with white spirit. Xylene and toluene alongside distilled

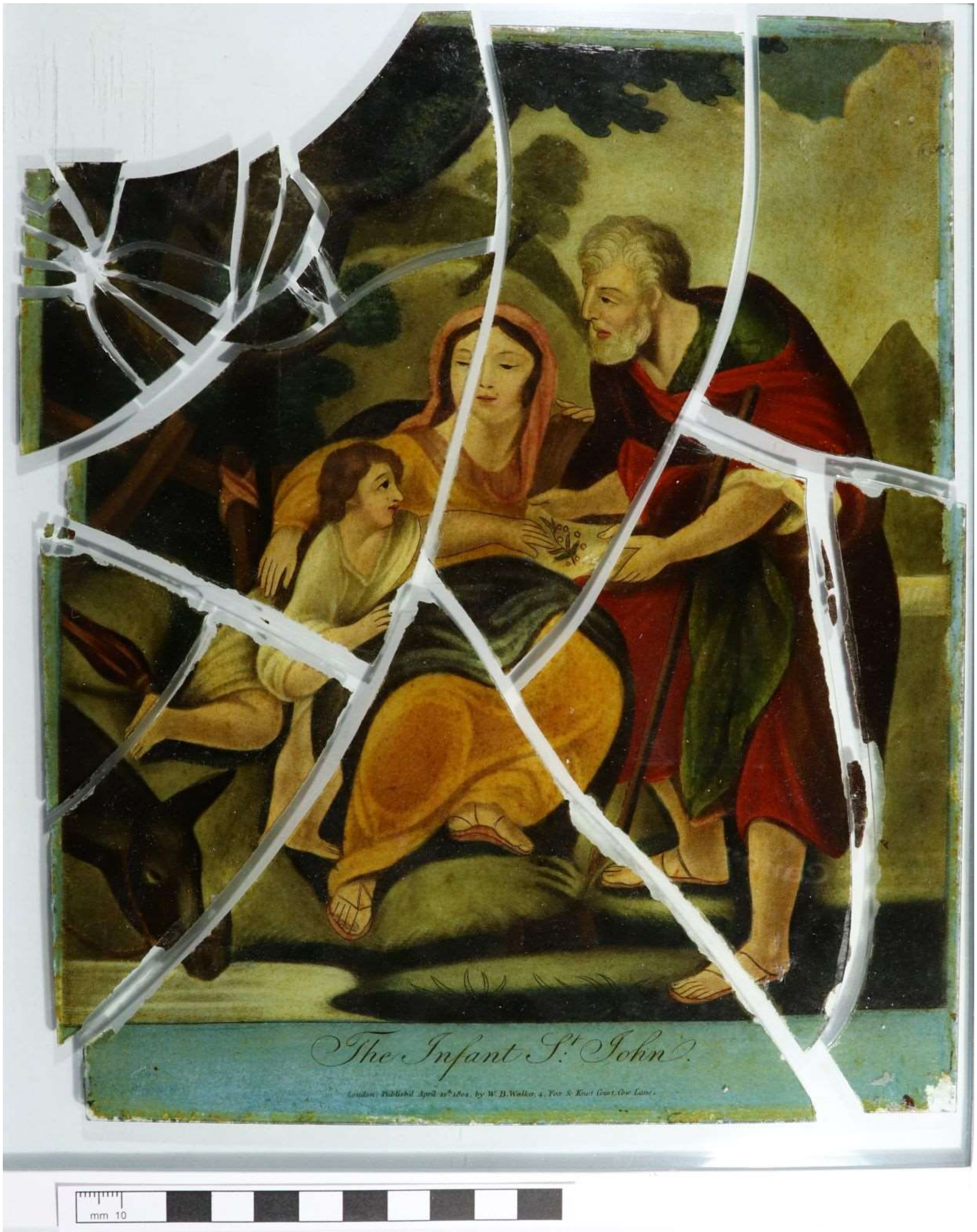

Fig.1 - *The Infant St John*, W.B. Walker, Reverse-glass print (recto), 1804, 252 x 191mm
Photo : Róisín Beirne, reproduced with photographers permission

water, (DW) were the only solvents which did not elicit a change to either the paint or varnish.

X-ray fluorescence analysis using a Bruker S1 Titan™ handheld analyser of some paint pigments determined the presence of a copper arsenic green indicating a date of between c.1775 to late 19th century, (Baty, 2017). It also showed the presence of a mercury red; Cinnabar or Vermillion, an iron Prussian blue, as well as lead white, (CAMEO Materials Database 2020 / Measday, 2017).

Fig.2 – *The Infant St John*, W.B. Walker. Cross-section of print/paint layer under long wave UV and reflected light (x100). Photo : Paul Croft, reproduced with photographers permission.

CONDITION

The reverse glass print was in a very fragile and unstable condition when first presented for conservation. As noted, the glass plate was fractured into twenty three pieces, large and small. There is a large area of glass and print loss in the top left hand corner and two small splinters of loss in different areas of the main body.

The adhesion of the print/paint layer to the glass is, for the most part, quite good with only minor areas of delamination adjacent to the fracture lines. It is, however, extremely brittle and prone to crack and detach where it is exposed as noted by numerous detached fragments and some areas of loss, (see fig. 3). In some cases a portion of the varnish and paper fibres still remain attached to the glass while the rest of the varnish and the paint layer has been lost, suggesting that the delamination was the result of mechanical cleavage arising from the glass fracture or abrasion rather than natural deterioration of the varnish. The detached fragments themselves have in some cases further fractured into numerous smaller pieces.

The vibrancy of the reverse glass print colours are still apparent despite some yellowing and spotting of the varnish layer, and when compared to other examples of deteriorated reverse glass prints it is visually in very good condition, (Todd 2015, Stanley p52).

The glass surface was coated in a hazy tacky residue, while the paint surface showed an accumulated layer of dust, particulates and a startling amount of crushed insect remains, at least one of which appears to date to the original production of the print as it was coated in paint and adjacent to an insect sized area of paint loss.

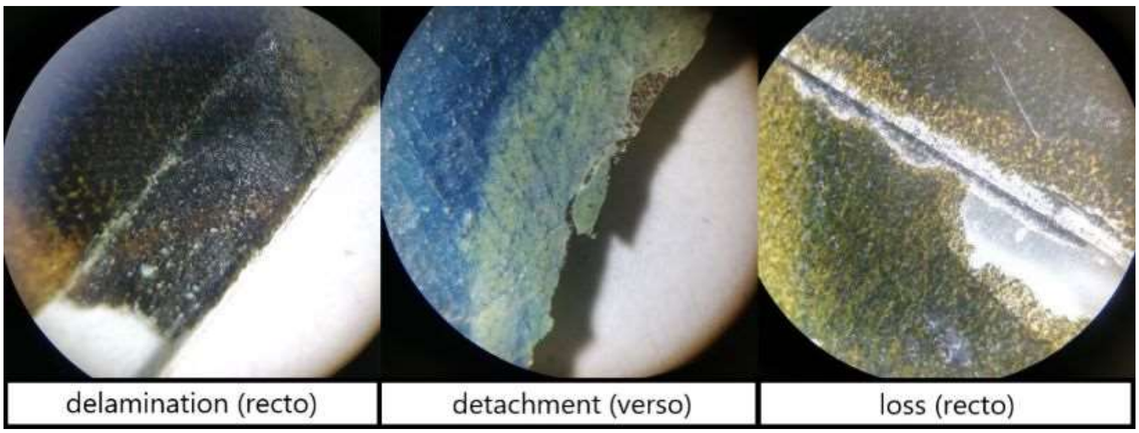

Fig. 3 – *The Infant St John*, W.B. Walker, detail of areas of delamination, fracture, detachment and loss of print/paint layer (x40). Photo : Róisín Beirne, reproduced with photographers permission.

TREATMENT PLAN

The owners' original intention was to conserve and repair the fractured print for re-display as a transparency; against a backing light, but this was re-evaluated following an understanding of the reverse glass prints production. The intention is now display as it would have been originally; in a picture frame to be viewed in reflected light.

A medium intervention treatment was decided upon in order to repair and retouch the reverse glass print to a level which would enhance its visual appearance for display while preserving the original material. The glass and verso paint surface are to be dry and wet cleaned to remove many years of accretions. Delaminated and detached areas of print/paint layer are to be re-adhered in a manner that would improve the visual appearance of the reverse glass print but also preserve the original material. The glass fragments are then to be re-adhered, areas of print and glass loss to be filled and retouched to conservation standards to create a visually cohesive image, before mounting securely in a frame to give support as well as physical and environmental protection for display outside of a museum environment.

CONSOLIDANT REQUIREMENTS

Beyond the initial cleaning, the conservation treatments for this reverse glass print present particular challenges similar to those encountered in conservation of glass paintings, photographic glass plate negatives and other mediums adhered to plate glass. The selection of a consolidant to stabilise and re-adhere a medium to a glass surface requires consideration of numerous interwoven factors.

The ideal consolidant for this purpose should firstly have a good history of use in conservation. It should have low viscosity in order to flow well into the areas of delamination and provide good saturation of colour, and it should have good adhesion to securely adhere the medium to the glass surface at low viscosity. It should have good optical qualities and remain visually unobtrusive so as not to cause aesthetic discrepancies between treated areas and original areas of colour when viewed through the glass. Similarly it should also have good aging properties so as not yellow over time. While the resin varnish of a reverse glass print for example will continue to yellow as it ages, the ideal consolidant should remain transparent. The consolidant needs to be dispersed and reversible in a solvent which will not interfere with the material of the medium. For this particular reverse glass print a consolidant that is dispersible in either water, xylene or toluene and also reversible using one of the same is required. It should also have a good versatility to allow ease of application for both areas of delamination and re-adhesion of detached fragments.

CHOICE OF CONSOLIDANTS

A number of consolidants were considered which could fufill these requirements and four were selected to test their suitability for consolidation of this particular reverse glass print.

Paraloid® B72

Paraloid® B72, (ethyl methacrylate/ methyl acrylate copolymer) is one of the most stable resins available to conservators. It is transparent, reversible, has good adhesion and has been proven to have good aging qualities, (Romano 2019). It is soluble in xylene and has a low refractive index that makes it ideal for use with glass, 1.479-1.489 (CAMEO Materials Database 2019 / Kurkjian & Prindle 1998 p799), though it is not usually recommended for use with transparent glass due to the fine air bubbles that can become trapped in it from solvent loss and are highly visible in refracted light, (Koob p48 / p67). It was however successfully used for reverse glass print consolidation by Tremain in 1988 at 8% in xylene and is used often in paint consolidation on different substrates at a similar percentage, (White 2013 p15). It does have a high viscosity which can hinder its ability to flow, (Romano), and in a test of its suitability as a consolidant for a reverse glass painting by Jessica David in 2009, it was noted to produce a ‘milky appearance as if it were not in full contact with the support [glass]’, (2009 p226 / Millard et al. 2012 p166).

Lascaux® Medium for Consolidation 4176

Lascaux® Medium for Consolidation 4176, (an aqueous dispersion of an acrylic copolymer based on acrylic ester, styrol, and methacrylic ester) is a highly stable acrylic resin which is known for its low viscosity and good penetration power. It has good adhesion at a low concentration, as well as a good flexibility which makes it a valuable consolidant for paint on dimensionally shifting materials such as wood or canvas but which has little consequence when used on a substrate such as glass. It is dispersible in water, dries to a clear transparent film, and is reversible in many solvents including xylene and toluene. It is a relatively new conservation material, but is generally considered to have good durability and aging properties based on artificial aging, though a recent study in 2018 has claimed that it does yellow as it ages as well as increase in acidity, (Romano 2019/ Millard et al. 2012 p166 / Lardet 2013 p3).

Isinglass

Isinglass, also known as Sturgeon glue is a proteinaceous, water soluble adhesive containing collagen, keratin or elastin, derived from the swim bladder of various different species of fish. It is superior among animal glues for good adhesion, a lower gelation temperature, low viscosity and good penetration, (Petukhova & Bonadies 1993 p23/ Schellmann 2007 p60). It has a good history of use as a consolidant in painting conservation in Russia and has been used in conservation outside of Russia in more recent years. It is soluble in water and generally remains reversible after aging though it has proved to be insoluble in some documented instances as a result of different preparation procedures, (Schellmann p63). It dries as a clear colourless film with a low refractive index of 1.516 – 1.534, (CAMEO Materials Database 2020) and is known to have very good aging properties, (El-Feky & Abd Elhady 2009 p250). Its greatest drawback is its sensitivity to biological attack, and changes to relative humidity (RH). It also has a complicated preparation procedure and a tendency to shrink as it dries, (Romano 2020 / Arslanoglu 2003 p12). For consolidation of a paint layer a 5% w/v solution is recommended, dry weight to distilled water, (El-Feky & Abd Elhady p246/ / Petukhova & Bonadies p24).

Aquazol®

Aquazol® (poly(2-ethyl-2-oxazoline)) is a tertiary amide polymer resin soluble in water and a large variety of other solvents. It is available in three different molecular weights, of which the higher is known to wet better than the lower, (Arslanoglu p2003 p16). It has a low viscosity, very good adhesive properties at low concentrations, and has shown good UV and thermal aging properties in artificial aging tests, (Wolbers et al. 1994 p523). It has a good history of use as a versatile consolidant for paint on various surfaces, but is particularly valued for its use with mediums on glass as it has a refractive index very close to that of crown and other soda-lime-silica glass, 1.519 – 1.521, (Arslanglu p12 / Kurkjian & Prindle 1998 p799 / Augustyn, A. 2019). Aquazol® 500 was used successfully in consolidation of a reverse glass painting by Damian Lizun in 2010 at a 10% solution in distilled water, (2010 p33), and at an unknown concentration for the successful consolidation of gelatin glass plate negatives by Romel Namde in 2015, (2015 p257). As with Isinglass its greatest drawback is its sensitivity to relative humidity, (Ebert, B., Singer, B. & Grimaldi, N. 2011 p72 / Arslanoglu p13 / Wolbers et al. p525).

TESTING

Initial testing to determine suitable adhesive concentration, viscosity, and application technique was carried out using dried slips of a mastic resin based oil paint, (Maimeri® Restauro) on a sheet of soda-lime-silica glass. While the paint samples do not provide an exact match for the print/paint layer it was felt that the material properties such as weight, texture and permeability would provide a suitable surrogate for carrying out initial tests in order to narrow the selection of consolidants.

Test 1

Initial concentrations of consolidants were selected for trialling based on reported successes in treatments of reverse glass prints or paintings as detailed in Table 1. Different concentrations of Aquazol® 500 were trialled from 5 – 20% at 5% increments to determine the ideal viscosity vs adhesion of the consolidant as its viscosity is known to directly relate to its concentration, (Arslanoglu p12).

Consolidant concentrations	Sources		
Aquazol® 500 at 2.5 - 20%	Lizun, D. (2010) p33	Ebert, B., Singer, B. & Grimaldi, N. (2011) p68	Namde, R. (2015) p257
Lascaux® 4176 at 15% in DW	Lardet, G. (2014) p4	Bernucci, A & Allington-Jones, L. (2017) p36	
Lascaux® 4176 at 100%	White, A. (2013) p15	Tobit Curteis Associates & Sally Woodcock (2008)	Marriot, S. (2010) p34
Isinglass at 5% in DW	Millard et al. (2012) p166	El – Feky, O. M. & Abd Elhady, A. A. (2009) p246	White, A. (2013) p15
Paraloid® B72 at 8% in xylene	Tremain, D. (1994) p148	David, J. (2009) p225	White, A. (2013) p15

Table 2 - Trial consolidant concentrations and their reference sources

Different forms of application were also trialled to determine which method provided the best adhesion among all consolidants and most improved penetration in areas where capillary action would be relied on to ensure full saturation. There initially was some concern that solvent loss and therefore setting time might be hindered by the impermeable nature of the glass, therefore waiting until the adhesive on the paint sample reached a tacky state before adhering to the glass surface was also trialled.

A. Consolidant applied to paint sample with fine tipped brush, allow to become tacky before adhering to glass surface. Light even pressure maintained for a short period. Concern about slow solvent evaporation against glass.

B. Consolidant applied to paint sample with fine tipped brush and adhered immediately to glass surface. Light even pressure maintained for a short period.

C. Paint sample placed onto glass surface and distilled water applied to edges using pipette until glass surface beneath sample fully wetted. Consolidant is dotted along the paint sample edges and relies on capillary action to draw it under the paint sample.

D. Paint sample placed onto glass surface. Consolidant is dotted along the edges with fine tipped brush and relies on capillary action to draw it in under the paint sample.

Table 3 - Trialled consolidant application methods

Following initial testing it was noted that application of distilled water did not noticeably aid capillary action. However, though all samples remain adhered to the glass, consistent contact between the paint sample and the glass was reduced, presumably as the water diluted the concentration of consolidant and so the adhesive power. There were significantly more small air bubbles or minute delaminated areas between the paint and glass surface on these samples compared with those applied without distilled water. Brushing and waiting until the consolidant became tacky produced similarly poor results as the viscosity of the consolidant was increased with the evaporation of solvents, which reduced its ability to flow and so reduced its area of adhesion.

The best results were achieved by applying a generous application of consolidant to the paint surface by fine tipped brush and immediately adhering to the glass surface, with light pressure maintained for a short period. Application by capillary action produced good results when a generous amount of consolidant was allowed to flow under the surface.

No distinctly superior consolidant was apparent following initial testing, therefore Paraloid® B72 in xylene was excluded as an option for further tests as there were less toxic options available that performed just as well. The 5% concentration of Aquazol® 500 and the 15% solution of Lascaux® 4176 were excluded also as they

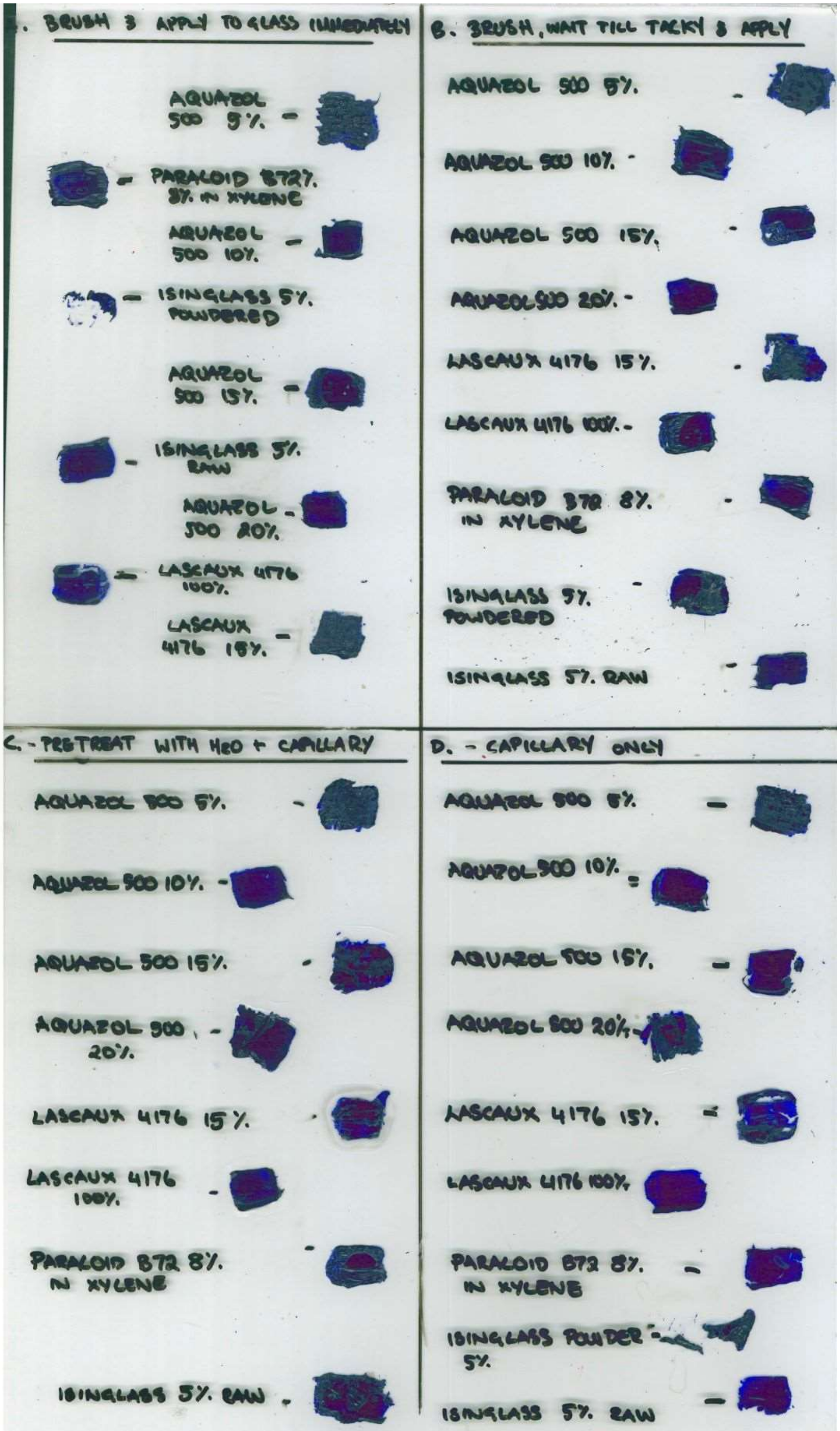

Fig.4 - *Consolidant testing no.1.* Photo : Róisín Beirne, reproduced with photographers permission

did not appear to have sufficient adhesion to maintain consistent contact between the paint and the glass in most of the applications. The 100% solution of Lascaux® 4176 and the next highest concentration of Aquazol®, 10%, performed well and were chosen as suitable concentrations to continue testing along with the isinglass.

Test 2

In the second round of testing, as suitable application methods had been determined, the consolidant was applied only by a fine tipped brush and adhered immediately to the glass surface. As the texture of the print/paint layer of the reverse glass print is varied on different fragments and areas, four paint samples of different textures, rough and smooth, were used with each consolidant to determine if consistent results would be observed. The Lascaux® and Aquazol® solutions appeared to display greater viscosity and consistent adhesion, outperforming the isinglass, which could potentially be due to inexpert preparation of the animal glue.

Test 3

All three consolidants were tested for their optical qualities by applying a thin film of each solution directly onto a clean glass surface, as well as applying under a glass coverslip and allowing to dry. The Aquazol® solution displayed the best optical qualities appearing nearly invisible against the glass, with Isinglass performing well also. The Lascaux® also displayed very good optical qualities but when compared against the Aquazol® it appeared to have a faintly yellow tint. The Aquazol® and Isinglass solutions both yielded very smooth surfaces with little distortions due to their low viscosity, while the Lascaux® could not be easily smoothed.

Test 4

A few microscopic samples, (<2mm^2) of the original print/paint layer whose original location on the print could not be determined were selected for testing the compatibility of the consolidants with the material of the print/paint layer. As the samples were so small a minute dot of each consolidant was applied to a test glass surface and the print/paint sample was applied recto side down and held in position under light pressure using a micro-spatula for a short period. When observed under microscopy the Aquazol® solution performed the best by far. It had the most uniform saturation, no doubt due to a combination of its low refractive index and its low viscosity, (Rivers and Umney p587). The isinglass and Lascaux® solution samples both retained minute air bubbles between the recto surface and the glass, which made the textured surface of the varnish layer more visible and detracted from the saturation of the colours and print, see Fig.2.

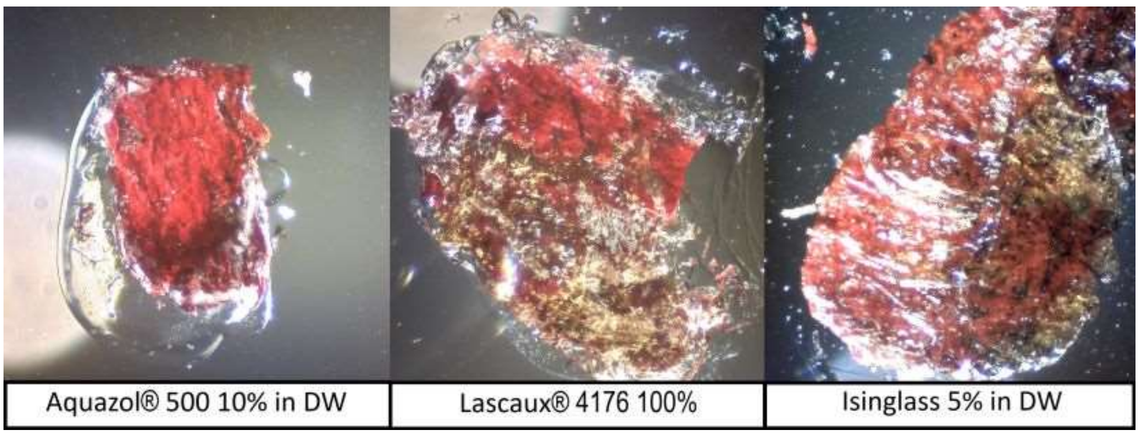

Fig. 5 - *The Infant St John,* W.B. Walker. Original sample consolidant testing (x120). Photo: Róisín Beirne, reproduced with photographers permission.

Test 5

As the Aquazol® solution appeared to be the best consolidant in terms of adhesion, viscosity, and optical qualities but is known to be sensitive to lower levels of RH, it was decided to test its adhesive abilities against that of the Lascaux® solution in a humidity chamber before trialling on the reverse glass prints. A glass plate with a paint sample and a glass cover slip adhered using both consolidants was placed in a humidity chamber at a RH of approximately 77% for five days at a temperature of approximately 23C. After the third and fifth day the adhesion of the samples was tested by applying gentle but firm lateral pressure to each. There was no observed change in adhesion and tackiness of either consolidants.

APPLICATION

Testing of the Aquazol® solution was subsequently trialled in unobtrusive and peripheral areas of the reverse glass print to ensure the same results could be achieved on larger samples. The results were successful and selective consolidation of the areas of delamination was carried out through out.

At the time of writing reattachment of the detached fragments was yet to be completed but similarly successful results are expected.

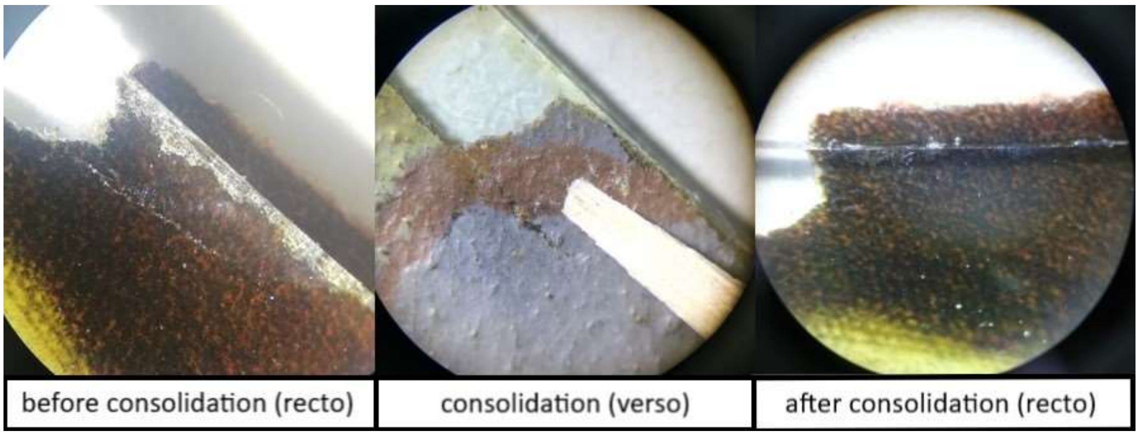

Fig. 6 – *The Infant St John*, W.B. Walker. Print/paint layer consolidation with Aquazol® 500 10% in distilled water. Photo : Róisín Beirne, reproduced with photographers permission

DISCUSSION

The low toxicity of Aquazol® and its miscibility in the limited number of solvents available for use with this reverse glass print were its initial attractions. Its workability, flow, low-viscosity and refractive index however produced excellent saturation and optical results, in some cases resulting in near invisible re-adhesion of the print/paint layer.

Rivers and Umney note that good saturation of colour when using a transparent film such as a varnish or consolidant, is dependent on a films low viscosity and ability to thoroughly wet a surface, ‘i.e to displace the air on the surface, spread out and achieve intimate molecular contact with it’, (p587). While many of the tested consolidants achieved good adhesion at low concentrations and their viscosity was low enough to draw them under the print/paint layer, their visual appearance was disrupted by their inability to 'thoroughly wet' the print/paint layer surface, resulting in small areas of opacity between the consolidant and the print/paint surface.

The almost matching refractive index of Aquazol® and crown glass further enhanced its optical qualities for this particular reverse glass print. The closer the refractive indices of the two materials, the less light is reflected at the join between them, resulting in more light being transmitted through them into the print and paint layer, allowing greater saturation of the colour, (p589).

Its reported sensitivity to relative humidity is a drawback for its use in many cases but is unlikely to be a particular issue in this instance considering that the framing of the object will provide some protection against changes in relative humidity outside of a museum environment.

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BIOGRAPHY

Róisín Beirne received a BA Hons in Fine Art Sculpture from the National College of Fine Art, Dublin in 2009. She has been a committee member of the newly formed Irish branch of the Society for Protection of Ancient Buildings since 2017 and was employed with Lambstongue Ltd a historic window company based in Dublin from 2017 – 2019. She is currently an MA student in conservation of cultural heritage at the University of Lincoln 2019/2020.

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REFERENCES

Arslanoglu, J (2004) ‘Aquazol as Used in Conservation Practice’, *WAAC Newsletter*, Volume 26 Number 1, p10-15, accessed on 23/01/2020, available at https://cool.culturalheritage.org/waac/wn/wn26/wn26-1/wn26-105.pdf

Arslanoglu, J (2003) ‘Evaluation of the Use of Aquazol as an Adhesive in Paintings Conservation’, WAAC Newsletter, Volume 25, Number 2, accessed on 27/01/2020, available at < https://cool.culturalheritage.org/waac/wn/wn25/wn25-2/wn25-205.pdf>

Augustyn, A. 2019*, Refractive Index,* ENCYCLOPÆDIA BRITANNICA.com, *accessed on 16/02/2020, available at* <https://www.britannica.com/science/refractive-index>

Baty, P. (2017) *The anatomy of colour : the story of heritage paints and pigments*, Thames & Hudson, London

Bernucci, A & Allington-Jones, L. (2017) Conservation of James Sowerby’s Fungi Models, *Journal of Natural Science Collections*, Volume 2, 35 - 40, accessed on 27/01/2020, available at <http://www.natsca.org/article/2077>

The British Museum (2019) *W B Walker (Biographical details),* Trustees of the British Museum, London, accessed 17/10/2019, available at < https://research.britishmuseum.org/research/search_the_collection_database/term_details.aspx?bioId=177221>

Clarke, H. G. (1928) *The Story of Old English Glass Pictures*, Courier Press, London

David, J. (2009) ‘Case study: the treatment of six reverse paintings on glass from William Nicholson’s Loggia with Figures and Architectural Fragment’*, Journal of the Institute of Conservation,* 32:2, p.219-232, accessed on 20/01/2020, available at <https://www.tandfonline.com/doi/full/10.1080/19455220903059917?needAccess=true>

Dietemann, P., Higgitt, C., Kalin, M. , Edelmann, M. J., Knochenmuss, R. & Zenobi, R. (2008) ‘Aging and yellowing of triterpenoid resin varnishes : Influence of aging conditions and resin composition’, *Journal of Cultural Heritage,*Vol.10, p.30 – 40, accessed on 08/04/2020, available at <http://andbeyond.ch/Dissertation/Publications/J_Cult_Herit_2009_10_30-40.pdf>

Ebert, B., Singer, B. & Grimaldi, N. (2011), ‘Aquazol as a consolidant for matte paint on Vietnamese paintings’, *Journal of the Institute of Conservation*, Vol. 35, Issue 1, accessed on 03/02/2020, available at <https://doi.org/10.1080/19455224.2012.672813>

El – Feky, O. M. & Abd Elhady, A. A. (2009) ‘Treatment and Restoration of an oil painting by sturgeon glue’, *Proceedings of the 4th International Congress on Science and Technology for the safeguard of cultural heritage in the Mediterranean Basin,* Vol 2, Session B, p246 – 264, accessed on 04/02/2020, available at <https://books.google.ie/books/about/PROCEEDINGS_4th_International_Congress_o.html?id=uuRLHs472RsC&redir_esc=y>

Horvát, E. Á., Járai-SzabóJ., Brechet, Y. & Néda Z.(2012) Spring-block approach for crack patterns in glass, Central European Journal of Physics, 10/4, p926 - 935

Koob, S. P. (2006) *Conservation and Care of Glass Objects*, Archetype Publications Ltd. London

Kurkjian, C. R & Prindle, W. R. (1998) ‘Perspectives on the History of Glass Composition’, *Journal of the American Ceramic Society*, Vol. 81, No. 4, p795 – 813, accessed on 11/11/2019, available at < https://ceramics.onlinelibrary.wiley.com/doi/epdf/10.1111/j.1151-2916.1998.tb02415.x>

Lardet, G. (2014) ‘Comparison of Plexisol® P550 and Medium of Consolidation® 4176 : Installation in the impregnation of painted supports and the consolidation of the pictorial layers', *CeROArt* [Online], EGG 4, accessed on 11/02/2020, available at http://journals.openedition.org/ceroart/3986

Lizun, D. (2010) 'The conservation of a reverse painting on glass depicting Charles Stewart Parnell', ICRI *Conference Paper : Conservation Activities in Ireland 2, at the National Library of Ireland,* p29 – 34, accessed on 20/01/2020, available at https://www.researchgate.net/publication/326250752_The_conservation_of_a_reverse_painting_on_glass_depicting_Charles_Stewart_Parnell

Maimeri (2020) Restauro and Pigments : Restauro, Maimeri.it, Italy, accessed on 29/01/2020, available at <https://www.maimeri.it/en/products/restauro-and-pigments/restauro.html>

Markevicius, T. (2003) 'DECEPTIVE FLUORESCENT VARNISHES: A COMPARATIVE STUDY OF THE UV LUMINESCENCE OF A FRESH APPLIED VARNISHES PRODUCED USING FLUORESCENT COATING MATERIALS', *Art Forgeries : Preprints*, IIC Nordic Group 16th Congress, June 2003, REYKJAVIK, ICELAND, , p58 – 64, accessed on 23/01/2020, available at https://www.researchgate.net/publication/316511739_DECEPTIVE_FLUORESCENT_VARNISHES_A_COMPARATIVE_STUDY_OF_THE_UV_LUMINESCENCE_OF_A_FRESH_APPLIED_VARNISHES_PRODUCED_USING_FLUORESCENT_COATING_MATERIALS

Marriot, S. (2010) 'Material Focus : Lascaux 4176 Material for Consolidation', *The Picture Restorer*, Autumn, p 34-35, accessed on 05/02/2020, available at <https://lascaux.ch/dbFile/2274/u-0d16/u-0d16/The_Picture_Restorer_2010.pdf>

Measday, D. (2017) *A summary of ultra-violet fluorescent materials relevant to conservation*, The Australian Institute for Conservation of Cultural Material, accessed on 20/01/2020, available at <https://aiccm.org.au/national-news/summary-ultra-violet-fluorescent-materials-relevant-conservation>

Millard , T., Le Cornu, E., Smith, R., Hasler, E., Cowdy, H., Chisholm, R. & King, E. (2012) The conservation of 830 oil paintings on paper by Marianne North, *Journal of* *the Institute of Conservation*, Vol. 34, Iss.2, p.159-172, accessed on 27/01/2020, available at <https://doi.org/10.1080/19455224.2011.608341>

Namde, R. (2015) ‘Consolidation of Four Flaking Gelatin Glass Plate Negatives from the University of Colorado’, *Topics in Photographic Preservation*, Volume 16, p257-258, accessed on 28/01/2020, available at < http://resources.culturalheritage.org/pmg-topics/wp-content/uploads/sites/9/2019/05/39-T-16-Namde_paginated.pdf>

Petukhova, T. & Bonadies, S. D. (1993) ‘Sturgeon glue for painting consolidation in Russia’, *Journal of the American Institute for Conservation*, Vol 32, No.1, Spring, p23-31, accessed on 04/02/2020, available at <https://doi.org/10.1179/019713693806066483>

Plunket, J. (2013) ‘Light work : Feminine Leisure and the Making of Transparencies’, *Crafting the Woman Professional in the Long Nineteenth Century : Artistry and Industry in Britain*, Ashgate Publishing, Surrey

Romano, C. (2019) *Paint Consolidation*, American Institute for Conservation Wiki, accessed on 06/02/2020, available at <https://www.conservation-wiki.com/wiki/Paint_Consolidation>

Schellmann, N. C. (2007) ‘Animal glues : a review of their key properties relevant to conservation’, *Studies in Conservation,* Vol.52, Sup 1, p55 -66, accessed on 04/02/2020, available at <https://doi.org/10.1179/sic.2007.52.Supplement-1.55>

Simpson Grant, M. (2000) *The Use Of Ultraviolet Induced Visible-Fluorescence In The Examination Of Museum Object : Part II : Conserve-o-gram,* No.1 /10, December, National Park Service, Washington, US, accessed on 23/01/2020, available at <https://www.nps.gov/museum/publications/conserveogram/01-10.pdf>

Smith, J. (1705) *The Art of Painting in Oyl,* 4th Edition, For A.Bettesworth, F. Clay & E. Symonds, London

Stanley, T. (2002) ‘The Glass Print’, *The Book and Paper Group : Annual 21,*p.49-55, publication of proceedings of Book and Paper Group Session, AIC 30th Annual Meeting, June 6-11, 2001, Miami, Florida.

Tobit Curteis Associates & Sally Woodcock (2008) *ST BOTOLPH’S CHURCH, CAMBRIDGE : CONSERVATION OF THE 19TH CENTURY PAINTINGS IN THE CHANCEL* ,Tobit Curteis & Sally Woodcock, Cambridge, accessed on 27/01/2020, available at <http://www.stbotolphs.net/pdf/St_Botolph_treatment_report.pdf>

Todd, D. (2015) The non-conservation of a reverse glass print : Identification, analysis and preservation, The Book and Paper Gathering.org, accessed 17/10/2019, available at < https://thebookandpapergathering.org/2015/05/06/the-non-conservation-of-a-reverse-glass-print/>

Tremain, D. (1994) ‘Reverse-Glass prints : Their history, technique and conservation’, *Conservation of historic and artistic works on paper: proceedings of a conference Symposium 88,* The Canadian Institute for Conservation, Ottawa

White, A. (2013) Condition Assessment and Treatment Recommendations for the Nave and South Aisle Ceilings, St Bridget’s Church, Brigham, Cumbria, Hirst Conservation, Lincolnshire, accessed on 27/01/2020, available at <http://www.stbridgetsbrigham.org.uk/workspace/pdfs/treatment_report_st_bridgets.pdf>

Wolbers, R., McGinn, M. & Durbeck, D. (1994) ‘Poly(2-ethyl-2-oxazoline):A New Conservation Consolidant’, *Painted Wood, History and Conservation,* postprints from symposium in Williamsburg, VA, Getty Conservation Institute, Los Angeles, pp. 514-528.

MATERIALS AND SUPPLIERS

Aquazol, Paraloid B72:
Kremer Pigmente GmbH & Co. KG
Hauptstr. 41-47
88317 Aichstetten
Germany

Isinglass (Sturgeon Glue), Lascaux 4176:
A P Fitzpatrick
142 Cambridge Heath Road
Bethnal Green
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Xylene:
Sigma-Aldrich Company Ltd
The Old Brickyard
Gillingham
Dorset SP8 4XT
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Restauro varnish colours:
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