Beatriz Maria Barata Rodrigues
Licenciada em Conservação-Restauro

From Production to Preservation: Hand-Painted Magic Lantern Slides from the National Museum of Natural History and Science

Dissertação para obtenção do Grau de Mestre em
Conservação e Restauro, especialização em Conservação e Restauro

Orientador: Professora Doutora Márcia Gomes Vilarigues
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FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

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Abstract

The present work arises as part of the first systematic investigation on hand-painted magic lantern glass slides resorting to multi-analytical techniques combined with critical analysis of historical written sources on the painting materials and techniques used to produce them. The magic lantern was an optical instrument, used to project images from the seventeenth to the twentieth centuries, that attained great success with high impact on entertainment, science, religion and advertisement.

In the framework of this work, five hand-painted magic lantern glass slides from the National Museum of Natural History and Science (University of Lisbon) were studied. The glass support, the colourants and organic media were characterised.

The glass was analysed by Micro-Energy Dispersive X-Ray Fluorescence, and the oxide quantification unveiled that the glass belongs to the soda-lime silicate type and was possibly produced between 1870 and 1930 in England. Additionally, considering the standardized size of the slides and the similarity of the subjects represented with other English slides from the nineteenth century, it was possible to narrow the production period of this collection between 1870 and 1900.

Ultraviolet-Visible, Micro-Raman and Micro-Fourier Transform Infrared spectroscopies allowed the characterisation of the colourants. The colour palette is composed of Prussian blue, an anthraquinone red lake pigment of animal origin (such as cochineal carmine), an organic yellow whose identification was not yet possible and a carbon-based black pigment. The remaining colours – green, purple and brown – were achieved by mixing the pure pigments. Through infrared analysis, a terpenoid resin such as shellac was identified. The detection of metal carboxylates was essential to assess the state of conservation of the paints.

The identification of the main risks that might endanger the collection in study was made, as well as a risk assessment scale. Preventive conservation guidelines were proposed taking into consideration the literature on the preservation of the different materials that compose the magic lantern slides, as well as the results of surveys submitted to national and international museums that hold similar collections.

Keywords: Magic lantern glass slides; Prussian blue; Cochineal lake; Carbon-based black; Shellac resin; 19th century

Resumo

O presente trabalho surge inserido na primeira investigação sistemática de diapositivos de lanterna mágica pintados à mão, recorrendo a uma metodologia multi-analítica combinada com a análise crítica de fontes históricas escritas acerca dos materiais e técnicas de pintura utilizados para a produção destes diapositivos. A lanterna mágica era um instrumento ótico destinado à projeção de imagens, usado desde o século XVII ao século XX. Este aparelho ótico atingiu um grande impacto em áreas como o entretenimento, a ciência, a educação, a religião e a publicidade.

No contexto deste trabalho, cinco diapositivos de lanterna mágica pintados à mão, pertencentes ao Museu Nacional de História Natural e da Ciência (Universidade de Lisboa) foram estudados. O suporte de vidro e os materiais de pintura foram caracterizados.

O vidro foi caracterizado através de Micro-Espectrometria de Fluorescência de Raio-X Dispersiva de Energia e a quantificação dos seus óxidos constituintes revelou que se trata de um vidro silicatado sodo-cálcico, possivelmente produzido entre 1870 e 1930, em Inglaterra. Adicionalmente, considerando o tamanho estandardizado dos diapositivos e a sua semelhança com outros diapositivos ingleses do século XIX, foi possível restringir o período de produção da coleção entre 1870 e 1900.

A espectroscopia de Ultravioleta-Visível, Micro-Espectroscopia de Raman e de Infravermelho com Transformada de Fourier permitiram a caracterização dos colorantes. A paleta cromática é composta por azul da Prússia, uma laca vermelha de origem animal (possivelmente cochinilha), um corante amarelo orgânico cuja identificação ainda não foi possível e um pigmento preto à base de carbono. As restantes cores – verde, roxo e castanho – foram obtidas através de misturas dos pigmentos puros. A análise por espectroscopia de infravermelho permitiu identificar uma resina terpenoide, possivelmente goma-laca, bem como carboxilatos, fundamentais para a avaliação do estado de conservação das tintas.

Foi realizada a identificação dos principais riscos que poderão pôr em causa a coleção de diapositivos em estudo, assim como uma escala de identificação de riscos. Foram propostas diretrizes de conservação preventiva, considerando a literatura sobre os diferentes materiais que constituem estes diapositivos de lanterna mágica, bem como os resultados dos inquéritos submetidos a museus nacionais e internacionais detentores de coleções semelhantes.

Palavras-chave: Diapositivos de vidro de lanterna mágica; Azul da Prússia; Laca de Cochinilha; Negro à base de carbono; Resina de goma laca; Século XIX

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1. Introduction

1.1. The Magic Lantern: its origin and evolution through time

The invention of the magic lantern took place in the second half of the seventeenth century. From that moment until the last quarter of the nineteenth century, it proved to be an optical instrument able to provide knowledge on different topics as well as to provide shows that entertained a collective audience by joining the projection of images with the recitation of texts and the interpretation of melodies. This offered entertainment, mystery and adventure [1,2].

The magic lantern can actually be considered a simple device, similar to a box with an artificial light source, containing a concave mirror and a system of lens that enabled the projection of magnified images over a white surface, achieved through glasses painted with transparent colours [2].

Even though there is no date or author credited to the exact invention of the magic lantern, literature points out three crucial personalities to the description, study and development of the apparatus: it is known that it was first completely described in 1646 by Athanasius Kircher, a German Jesuit priest, in *Ars Magna Lucis et Umbrae*. An illustrated second edition was published in 1671 [2]. In 1659 Christian Huygens, a Dutch mathematician and astronomer developed a manuscript where it is referred a preparatory study for what seems to have been the first animated glass slide for magic lantern; despite this, Huygens only took into consideration the magic lantern in 1692, when it was already quite popular and studied, having drawn a scheme of it two years later [2,3]. The third remarkable name in the history of the origin of the magic lantern is of the Danish mathematician Thomas Walgenstein that presented it as an instrument of entertainment through all Europe since 1664 [2,3].

In 1721 William Jacob Storm Van's Gravesande produced an improved diagram of the magic lantern with the most complete description on the technical level, only surpassed 100 years later by Phillip Carpenter, one of the most important individuals regarding the history of the magic lantern in the nineteenth century [3,4].

In a short period of time, the magic lantern established itself as an instrument worthy of attention and study, theorized, illustrated and tested by various scientists, serving multiple and versatile functions [3].

The illumination of the first magic lanterns did not allow for big public projections at the time, but this did not preclude for it from becoming a form of public entertainment. Through Europe, travelling lanternists brought the magic lantern into homes and public squares. By the end of the eighteenth century Etienne Gaspard Robertson, a Belgian showman, promoted the popularisation of the magic lantern through the Phantasmagoria shows. These performances consolidated the magic lantern as a form of entertainment, using the movement – mechanical or manual – of the lantern, making the figures seem bigger or smaller by moving the lantern closer or further away from the screen, also combining special conceived sound effects [2,4].

Precisely with the name *Phantasmagoria Lantern*, the English optician Philip Carpenter launched in 1821 the first important model of the magic lantern in the nineteenth century. Carpenter was also the inventor of the copper-plate sliders, slides produced by a printing process that allowed large scale production. These two inventions contributed considerably to the transformation of the magic lantern

into an educational and recreational device, disseminated in unprecedented proportions and made economically accessible [3].

During the nineteenth century, the magic lantern was improved: the lighting was reinforced, allowing for exhibitions for a wider audience and people could now watch the shows indoors and in great halls. The performances themselves also changed, changing the subjects projected and introducing dissolving views, in which a scene could change from day to night or from one season to another. To achieve this, a biunial or triple lantern was required, enabling a scene to gradually fade away while another one was gradually introduced at the same time [2,5].

In the 1890s the first films were introduced, and they were an immediate success. For a while, the magic lantern was used at the same time: until the 1930's magic lantern slides were used as fillers between film reels, but cinema marked the obsolescence and decline of the magic lantern [2,3].
As the importance of the magic lantern as a leisure instrument declined in the last five years of the nineteenth century – mainly due to the introduction of the cinematograph – education was still one of the few fields where the magic lantern was kept in use, serving as a visual aid for classes [1].

1.2. Glass slides for projection with magic lantern

With the projection of images and the synchronized use of sounds, the magic lantern became an audio-visual form with glass as the fundamental support to record the images. The glass can be considered as the support of the image represented, which is then projected by the magic lantern; it is called a glass slide for magic lantern.

The first known draw of a glass slide for the magic lantern is from Christian Huygens and depicts a skeleton that removes and places back his head, anticipating the search for dynamic images for the luminous projections. Starting from the subject of the death and the idea of movement, Huygens set the stage for the representation of fantastical figures, demons, skeletons and ghosts, entering in the representation of themes related to the supernatural and macabre [3].

Magic lantern slides were applied in various contexts and its use has evolved through the centuries. In the eighteenth century, scenes like fables, children's stories, mythological, allegorical and comical themes were represented in the slides [6]. During the nineteenth century, there was an increase in the subjects represented, that included sequences of popular fiction, topographical themes, historical episodes, news, educational and pedagogical subjects, as well as ludic scenes, generally combined with movement mechanisms [3,7].

1.2.1. *The search for movement in the slides*

Following the path of animation, other lantern rotating slides or slipping glass slides started to be produced, corresponding to the animated component of the subject. Thus, it is clear the desire and necessity to create dynamic effects in the projected images; the iconographies represented became richer and wider and it became a priority to show the projected images on the screen in action [3].

Various scholars developed different mechanisms for the movement of the glass slides, while they also evolved in terms of the subjects depicted [3].

By the eighteenth and nineteenth centuries, the illusion of movement was achieved through different types of slides, with distinct movement mechanisms. These are fully described by Crompton et al. [8] but the more relevant ones are described below.

In the *lever/rocking slide*, the illusion of movement is given by the superimposing of an image of one of the glasses over the other, with one mounted glass and the other glass being movable [7]. The *slipping slide* consists of one of the glasses mounted into the wood frame with another glass on top with the aim of being moved horizontally/laterally in a manual way (slipping glass); the mounted glass representing the static part of the painting and on the slipping glass is painted the part of the subject intended to 'move'. There's still the subcategory of double slipping slide where neither of the glasses is considered stationary and both confer movement to the image [7,8]. The *rackwork slide* owns its movement to the action of a rack and pinion, activated by moving a crank. There are two glasses, one that spins in front of the other and they are fixed to the wood frame, normally secured with a brass ring [7,8]. The *pulley slide* operates with two glasses, one revolving in front of the other through a thread connected to the pulley, activated by moving a crank [8].

Additionally, please note that the slides mentioned can be subcategorized in "single" and "double", with one or two glasses with movement, respectively [8].

1.2.2. *The production technique*

Three different techniques were used to manufacture the images on the glass slides for projection by magic lanterns. The first slides produced were hand-painted (discussed below) and this technique gave way to printing techniques in the first half of the nineteenth century, and in the second half, to photographic techniques, although the last two (outside the scope of this work) often included hand-colouring [6].

1.2.3. *Flat glass for magic lantern slides*

Flat glass was made from silica (glassformer) which melts at a very high temperature, making it necessary to add alkali oxides like potassium oxide or sodium oxide (fluxes) to lower the melting temperature. However, the chemical durability of the glass is affected by the addition of these oxides which justifies the introduction of calcium oxide or magnesium oxide (property modifiers) [9,10].

The appearance of flat glass – the type of glass used in a magic lantern slide – depends on its colour, opacity/transparency, presence of bubbles or other defects, thickness and surface finish. Other aspects of the glass result mainly from the processes used to melt the raw materials and then form the glass into thin sheets [10]. It is rare for historical flat glass to be completely colourless since sand with traces of iron was used, which gave a green or blue-green tint to the glass; a variety of materials were applied to reduce this colouring effect of the iron, namely manganese that 'decolourizes' the green of the iron [10]. When the glass begins to melt in the furnace it tends to contain bubbles of gas. During the refining stage, the glass is heated until it becomes fluid enough to allow these bubbles to rise to the surface, but the visual examination of most historical flat glass shows that it was practically impossible to remove the bubbles. If the melting process was flawed it could make the glass chemically inhomogeneous which visually translates into a wavy pattern due to variations in the refractive index,

even if the glass itself is perfectly flat. Any bubbles in plate glass tend to be circular but they will be elongated in most blown or drawn glass [10].

Before the twentieth century, most of the window glass was produced using the cylinder technique or the crown technique. In either case, molten glass was collected from the furnace on the end of a hollow iron tube and the glassworker blew down the tube to produce a bubble of glass. Cylinder glass was made by elongating this bubble that was then cut open and flattened on a smooth surface. Although this technique improved with time, the resulting glass would normally have a slight roughness to one or both surfaces. Crown glass was made by opening the bloated bubble and spinning it until it formed a disk. Subsequently, crown glass had a 'fire-polished' surface, more often appreciated than cylinder glass. Both these techniques produced glass with slight variations in thickness, which influenced the distortion of the image transmitted. When present in large sheets, crown glass can usually be recognized by the concentric variations in thickness [10,11].

Modern flat glasses are produced with high-purity materials in carefully defined limits, but in the past, they were made with several raw materials of variable purity. Through the centuries there was a change in the chemical composition of English flat glass that seemed to have occurred abruptly since once a new technology or raw material was available, it became widely implemented by the glass industry [10]. From the end of the seventeenth century to the early nineteenth century, most window glass is of the mixed alkali type. Dungworth (2012) states this glass was made using seaweed ashes (kelp), which has a lower content of iron than HLLA (high-lime low-alkali) glass.

The most important change occurring in the glass industry during the nineteenth century was the substitution of plant ashes for synthetic soda; by 1820s the Leblanc soda technique was imported namely into England and by the late 1830s Leblanc soda displaced plant-based alkalis. This process consisted of converting common salt (NaCl) into sodium carbonate (Na_2CO_3). From now on, almost all window glass was of the soda-lime-silica type but it is noteworthy to mention the synthetic soda glasses can be divided into two groups: the early group (pre-1930) with high calcium and almost no magnesium, and the latter group (post-1930) with some magnesium and lower calcium content [10]. The twentieth century was marked by the search of improved mechanized production of flat glass and it was achieved in the late 1950s when Pilkington developed the float technique [10].

1.3. Magic lantern slides painting: what do the historical written sources tell us?

In order to understand the materials used and the painting techniques of the hand-painted magic lantern slides, nineteenth-century historical sources were consulted. These written sources comprise manuals with practical instructions or edited books on the magic lantern and optical projection instruments. Table 1 summarizes the historical written sources consulted.

Most of these manuals, with practical instructions or books edited about the magic lantern and optical projection apparatus, arise as publications from artists' colourmen business, such as Winsor & Newton, Brodie & Middleton and M. J. Whipple & Co.

Table 1. Historical written sources from the 19th century, referring to author, date, title and corresponding reference.

Author	Date	Title	Reference
E. Groom	1855	*The Art of Transparent Painting on Glass*	[12]
Unknown	1856	*Directions for the Graduation and Mixture of Colours, to which are added Directions for Transparent Painting on Glass*	[13]
A. N. Rintoul	1867	*Transparent Painting on Glass for the Magic Lantern in Water, Oil & Varnish Colours*	[17]
C. Middleton	1876	*Magic Lantern Dissolving View Painting*	[15]
W. J. Chadwick	1886	*The Magic Lantern Manual*	[18]
T. C. Hepworth	1888	*The Book of the Lantern being a Practical Guide to the working of the Optical (or Magic) Lantern*	[14]
W.C. Hughes	1893	*The Art of Projection and Complete Magic Lantern Manual*	[16]

1.3.1. Painting technique

Most of the historical sources consulted [12-18] indicate the colours were usually applied from tubes, which could be watercolours or oil colours, following a successive and predefined set of laborious stages that could take several days until the final painting was finished.

As mentioned by the authors, the process began with the selection of the finest thin glass plate that should have been well cleaned, and the smoother side of the glass was chosen to paint on [12,13]. The next step was the drawing of the outline[1] in the glass, that should stay undisturbed through the subsequent painting [12]. Some authors advised to primarily cover the glass with a thin layer of varnish, diluted gelatine or a solution of sugar dissolved in water to increase the adhesion of the outline to the glass support. Others recommended using varnish to cover the painted outline to protect it [14,15]. The painting process would start by placing the glass in a retouching desk and using painting procedures and materials similar to the ones used in traditional easel painting; they began by painting the most distant subjects, followed by the foreground, and then finishing the painting [12,15]. After the necessary touch-ups, it was recommended to protect the painting by covering it with a varnish ("[…]. The varnish may be employed at the various stages, and at the finish of the work, to fix the colours.") [10] or by placing a similar glass plate on top of the painted one [16].

The major artistic challenge of painting on magic lantern glass slides might be the great mastery necessary for the execution of the drawing and the painting since once the image is projected the most minimal details and imperfections are amplified. The other challenge arises from the transparency of the colours. The thickness of the paint layer and the amount of pigment used had a strong influence on the final result [6], and if the paint was not transparent enough it would not be possible to project the image. To achieve this transparency, the colours used to paint the magic lantern slides were necessarily less varied than the ones for traditional painting, and the authors of the written sources of the nineteenth century were aware of that [12,17,18]. Painting on magic lantern glass slides required the mastery of miniature painting on a glass substrate, and therefore, hand-painted glass slides are considered to be miniature masterpieces of cold paint on glass in their own right [6].

[1] Middleton (1876) referred the use of Indian ink for the outline to which could be added a few drops of gum water to promote the adhesion to the glass. Hepworth (1888) advised to use black pigment for the outline and Groom (1855) indicated that the outline should be drawn with the colours that would be used to paint the distance, middle distance and foreground.

1.3.2. Colourants mentioned in the historical written sources

Twenty-six colourants were mentioned in the nineteenth-century written sources consulted. Table 2 presents the mentioned colourants, predominately organic. Yellow colours display more variety of colourants with seven pigments, followed by brown and orange hues (six colourants). Red and black come next, with five colourants mentioned each. Two different blue colours are mentioned and just a purple colourant is mentioned. In most cases, the purple colour is described as a mixture of red and blue, but Rintoul (1888) mentions Purple Lake [14]. The green colour is not mentioned in any written source which seems to show it was obtained by mixing yellow and blue [12,13,17]. Another colour that is not mentioned by any of the authors is the white; in fact, Groom (1855) states that the white hue is represented by the absence of paint, which means white is achieved by letting the light pass through completely.

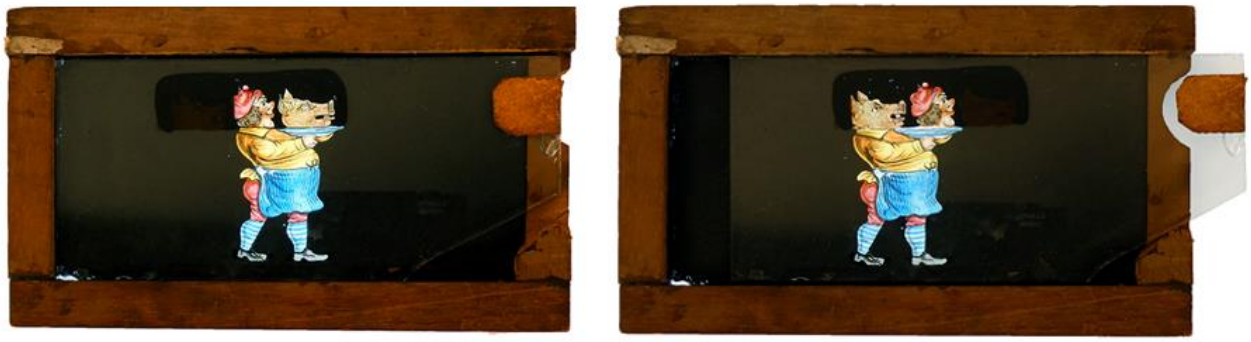
Table 2. Colourants mentioned in each 19th century written source consulted.

Colourant	Groom (1855)	Unknown (1856)	Rintoul (1867)	Middleton (1876)	Chadwick (1886)	Hepworth (1888)	Hughes (1893)
Asphalt		✓					
Blue black		✓					
Ivory black			✓			✓	✓
Lamp black	✓		✓				
Neutral Tint						✓	
Indigo	✓		✓			✓	
Prussian blue	✓	✓	✓		✓	✓	✓
Brown pink						✓	
Gallstone	✓						
Gamboge	✓		✓				
Indian yellow	✓		✓				
Italian pink	✓					✓	✓
Raw Sienna				✓		✓	
Yellow lake		✓				✓	
Brown madder	✓	✓				✓	
Burnt Sienna	✓	✓	✓	✓	✓	✓	✓
Burnt Umber		✓					✓
Chinese orange						✓	
Raw Umber			✓				
Vandyke Brown	✓		✓				✓
Carmine			✓				
Crimson lake	✓				✓	✓	✓
Madder lake	✓	✓					
Rose madder						✓	
Venetian red			✓				
Purple madder						✓	

1.4. Case-study: MUHNAC-ULisboa's hand-painted slides collection

This work focuses on five hand-painted slides from the MUHNAC-ULisboa that were temporally loaned to the Department of Conservation and Restoration from FCT NOVA and Research Unit Vicarte in order to be studied. The slides were acquired in 1986 and were kept at MUHNAC's storage. Figure

1 illustrates one of the five magic lantern slides currently in study. The five slides are displayed in Appendix I.



A) B)

Figure 1. Hand-painted glass slide with inventory number MUL/MUHNAC UL000068 from MUHNAC-ULisboa. **A)** stationary image; **B)** movable image resulting from the operation of the slipping glass.

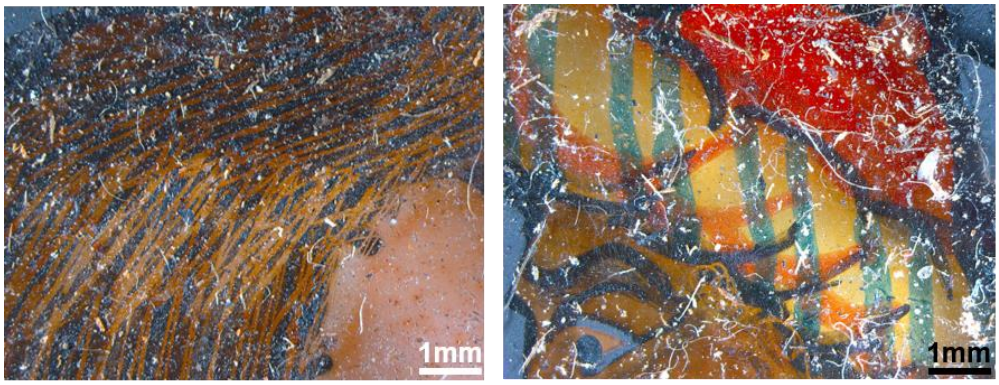
The slides are denominated single slipping slides [8] since one of the glasses is stationary (mounted glass), mounted in the wood frame, and the other glass is movable to an extent (slipping glass), secured to the wood frame with metal nails. The movement of the slipping glass allows for the idea of animation intended with this type of slide.

The mounted glass has an opaque black background, and it contains most of the drawing, namely the subjects that remain still. The slipping glass on top, which appears slightly separated from the other glass by a paper tape painted in black is the one to be pulled horizontally in and out to achieve the movement action. This glass is painted with the part of the drawing that it is intended to "move" when handled; the orange tape serves the purpose of easily pulling the glass.

Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours and an opaque black background surrounds the subjects. This could imply the presence of a varnish or a resin-like material. It is quite interesting to notice that the white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area (Figure 2B), adding detail. The intensity of the brushstroke is also varied according to the desired effect of lighter or darker details. Equally interesting is another technique observed that is similar to stained glass, namely in grisaille, which is the technique of “opening lights” in which the black background seems to be scraped off, allowing the passage of light in specific areas (Figure 2A). This demonstrates that several creative techniques and materials were employed to achieve different effects, such as the apparent application of the outline simultaneously with the black background, as well as the juxtaposition of colours to create more intricate patterns (Figure 2B).

Regarding the provenance of these objects, it is plausible to suggest they could have been produced in the nineteenth century in England, especially considering the 'standardized size' of the slides, the similarity of the subject represented [8] and the ‘wide production’ of similar depictions, with slight colour and stylistic differences that can be found in several collections attributed to this period and place of production. This suggestion is in agreement with the information present in MUHNAC's

inventory that points the nineteenth century as the date range for the execution of these magic lantern slides.



A) B)

Figure 2. Detail (stereomicroscope photography) of **A)** the black background scraped off, to allow the passage of light in the areas where the brown colour was afterwards applied giving a more realistic effect to the hair (slide MUL/MUHNAC UL000065) and **B)** the juxtaposition of blue, red and yellow colours, creating more intricate patterns (slide MUL/MUHNAC UL000067). Note that the white particulate observed at the surface corresponds to the dirt seen under the light.

To the extent of the author's knowledge, there are only two studies concerning the characterisation of magic lantern slides materials [10,11]. One of them studied the presence of gum Arabic, oil, natural resins, and animal glue in different slides by means of attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) and pyrolysis-gas chromatography-mass spectrometry (Py-GC/MS) [19]. The second paper identified oil mixed with watercolour binding and resinous materials using mid-infrared fibre-optic reflectance spectroscopy [20].

The present work, an in-depth analysis of the historical glass and paints used to produce nineteenth-century hand-painted glass slides, combined with a critical analysis of the historical written sources allows, for the first time, to extend the understanding of the artistic context in which historical hand-painted magic lantern glass slides were produced.

2. Experimental part

2.1. Conservation assessment methodology

As soon as the slides were transferred to FCT NOVA/ Vicarte facilities, photo documentation and conservation state assessment via macroscopic observation were first done, considering the different materials composing a magic lantern slide. The condition reports are displayed in Appendix II. After taking note of all the main properties of the slides, observation and photography resorting to stereomicroscope were the next step. It was possible to observe the detail of the application of the pictorial layer as well as the damages present which are better seen with ampliation. The photos taken allow for the documentation of the state of the slides before any kind of intervention or analyses.

2.2. Material characterisation methodology

One of the main goals of this work was the development of a multi-analytical experimental methodology for the material characterisation of the hand-painted glass slides, namely for the identification of the glass support, the colourants, and the organic media, using analytical techniques complementary to each other. The glass was characterised using Micro-Energy Dispersive X-Ray Fluorescence Spectrometry (μ-EDXRF) and the identification of the painting materials was performed by UV-Vis absorption spectroscopy, Micro-Raman spectroscopy (μ-Raman), Fourier Transform Infrared spectroscopy (μ-FTIR), combined with the μ-EDXRF analysis. Whenever possible, in situ analysis were given priority and micro-sampling was only employed for μ-FTIR analyses. Figures VI.1-VI.6 in Appendix VI display the micro-sampled and in-situ areas analysed.

All equipment used and data acquisition conditions are displayed in Appendix III.

2.3. Cleaning test methodology

A preliminary cleaning test was performed in a small area of the slide MUL/MUHNAC UL000069 resorting to an air blower. A CL-DF1 JJC® Professional Dust-free Air Blower was used to achieve the purpose of removing some of the potential damaging substantial dirt at the surface of the glass support. Photographic documentation via stereomicroscope was carried out before and after performing the air blowing test and is presented in section 3.5.

3. Results and Discussion

3.1. Conservation assessment

Besides MUHNAC's collection, Portuguese Cinematheque – Cinema Museum and National Archive of the Image in Movement magic lantern slides collection was visited. These visits allowed to expand the knowledge on different magic lantern slides, to observe the different typologies of slides and to assess the main conservation issues that affect this type of collections. Generally speaking, the major pathologies observed were breakage and/ or loss of the glass support, corrosion of the metallic parts, wearing and/or tearing of the tape (typically present in slipping slides), which could have been caused most likely due to the handling of this element, loss and/or tearing of the framing tape (typically in single slides with no wood frame), general dirt at the surface of the slide, dirt and/or stains in the wood frame and apparent presence of insects (visible through round holes in the wood frame). In what concerns the painted subjects, the main issues observed were the presence of abrasion in preferential direction (horizontal), which was most probably due to the movement of the slide during the projection, a generalized crackled pattern over the painted representation, that could possibly be attributed to the failure of the binder when exposed to aggressive projection conditions, detachment of the black opaque background paint, detachment of a specific colour – that seems to be an inherent damage to that paint formulation used – and generalized vanishing and detachment of the pictorial layer. The collection of the five slides in study, and in contradiction to the identification of degradation products via infrared analysis, is at a relatively good state of conservation, mainly displaying:

- Corrosion of the metallic nails;
- Wearing and tearing of the tape;
- Substantial surface dirt;
- Small-scale stains and scratches on the wood frame;
- Detachment of the black opaque background paint;
- Minimal detachment in the pictorial layer.

3.2. Characterisation and oxide quantification of the glass support

The elemental composition of the glasses was obtained through EDXRF analysis and three measurements were performed on each side of each of the glasses of the slide.

The spectra obtained for the analysed glasses (see the representative spectrum in Figure 49 of Appendix V) are very similar and consistent, with the same elements identified in each analysis. Therefore, it is possible to state that the five slides are composed of the same type of glass. Besides, since the elements identified in each side of the glass are in the same proportions it can also be concluded that there is no inorganic coating in any side of the glass, such as tin, which results from the float glass production method [21]. It was also possible to verify that no relevant alkali leaching, associated with the corrosion process of the glass, has occurred.

Regarding the quantitative analysis, the analysed samples belong to the soda-lime silicate glass type, containing SiO_2 from 73 wt% to 75 wt%, K_2O circa 0.2 wt%, Na_2O + MgO from 6.5 to 9.5 wt%, and CaO from 13 to 15.5 wt%. The concentration of Al_2O_3 lays between 2.6 wt% and 1.3 wt%, Fe_2O_3 varies between 0.15-0.3 wt%, and MnO content is inferior to 0.07 wt%. Other relevant oxides are

As_2O_5 (~0.05 wt%), SrO (0.02 wt%), SnO2 (0.04-0.07 wt%, ZnO (< 0.09 wt%), and TiO2 (~0.04 wt%). The complete table with the results of the quantification of all glasses in weight percentage and parts per million of oxides can be consulted in Appendix III.

Given the possible date and place of production of the five slides – England, nineteenth century – and following the investigation of one of the main researchers in English flat glass, David Dungworth, in this period three types of glass compositions will be considered for the purpose of this study.

The first type dated between c. 1700-1835 is the mixed alkali glass, known as kelp glass since it was produced using ashes of seaweed which are detectable through the high amount of strontium [11]. The average content of strontium to consider kelp ash was used is approximately 0,45±0,1% [10] which is not verified at all in the composition of the lantern glasses analysed. Phosphorus is also an important indicator since it reveals if the glass was produced using plant ashes (for phosphorus oxide percentage of c. 1,1±0,2% [10]) or if synthetic soda was used instead. Since no phosphorus was detected it is possible to suggest we are upon a glass executed with synthetic soda. In fact, Dungworth (2011) refers that since c. 1835 glasses contain little or no phosphorus in their composition, which can indicate the glass support of the magic lantern slides would have been produced afterwards that date. The glass that corresponds to the second type of composition, between c. 1835-1870, contains fewer impurities comparing to the glass made with plant ashes and doesn't have a significant colour, possibly due to the use of purer silica sources [11]. This period, more specifically since the end of the 1830s, is marked by the production of synthetic soda (Leblanc soda) that substituted the alkalis of plants. It is important to mention that the glasses made in the first decades after the implementation of the Leblanc soda had significant arsenic concentration as this element was used as a refining agent to remove bubbles in the glass [10,11].

As of this period, almost all window glass was of the soda-lime silicate type even though it usually contained more sodium and iron than modern flat glass. In the nineteenth century, iron gave off a slightly blue-green tint to the glass, which was 'neutralized' with manganese and arsenic [10]. Since 1870 arsenic tends to decrease or disappear (comparatively to the last glass type, with 0,22±0,16% of As_2O_3); there is, however, an increase in potassium. Given the fact that the percentage of arsenic oxide in the glasses analysed is inferior to 0,2% [10] (with average values between 0,006-0,01%), it can be suggested these were produced after 1870.

The type of glass that corresponds to the third period within the date range referred, between c. 1870-1930, is very similar to what was last described. Generally, these glasses are characterised by the oxide percentage of Al_2O_3, SiO_2, SO_3, K_2O, CaO, MnO, Fe_2O_3, As_2O_5 and SrO and, by comparing the content of these oxides of the literature described from 1870-1930 [10] and the results obtained for the magic lantern glasses analysed, the similarities in the composition of the glass support of the magic lantern slides studied and English flat glass from this period are clear, which allows suggesting this period as the production dating for the glass. As mentioned, the glass used for the production of the slides is of the soda-lime silicate type, produced with synthetic soda and results suggest that it is dated between 1870 and 1930, due to the low arsenic oxide content (<0.2 wt%) and potassium oxide content of circa 0.2 wt%. Further analysis to establish the precise MgO content is needed to confirm this dating. Although the production date range of the glass substrate extends into the twentieth century, it is

possible to narrow the production range of this collection between 1870 and 1900 considering the 'standardised size' of the slides and the similarity of the subject represented with other magic lantern slides entirely produced in England [8].

3.3. Characterisation of the colourants

Figure 3 summarises the colour palette found in the five magic lantern slides under study. The identification of each colour is discussed below, divided by colour and supported by the corresponding spectra. Figures V1-V3 in Appendix V display the areas of micro-sampling and in-situ analyses presented in this work.

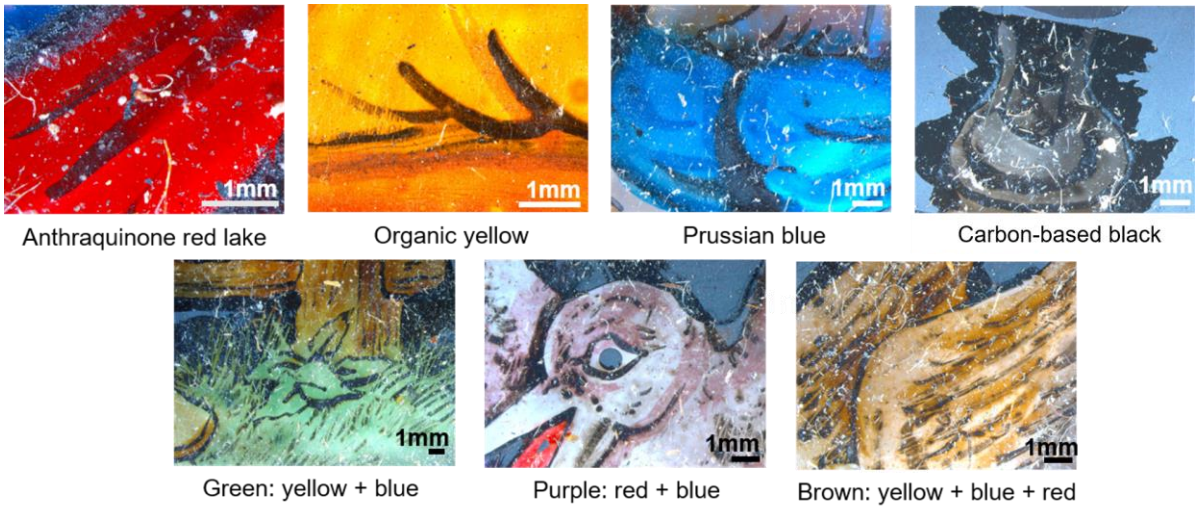


Figure 3. Details of the colours found in the hand-painted magic lantern slides studied (stereomicroscope photography). The identification of the colourants is fully discussed below, supported by the corresponding spectra. Starting from the top to the bottom, from left to right, the photos correspond to the slides MUL/MUHNAC UL000067, MUL/MUHNAC UL000068, MUL/MUHNAC UL000066, MUL/MUHNAC UL000066, MUL/MUHNAC UL000066, MUL/MUHNAC UL000066, and MUL/MUHNAC UL000069. Note that the white particulate observed at the surface corresponds to dirt seen under the light.

3.3.1. Blue colour

The UV-Vis absorption spectrum of the blue colour (Figure 4A) shows an absorption band characteristic of the charge transfer transition between the Fe^{2+} and Fe^{3+} ions between 600-1000 nm [22,23].

The µ-Raman spectrum allowed the clear identification of the Prussian blue pigment (Figure 4B), displaying the characteristic stretching vibrations of the triple CN bond at 2070-2200 cm^{-1} [24], which are visible in the spectrum at 2152 and 2090 cm^{-1}. Bands located in the spectral window between 450-620 cm^{-1} are characteristic of all Fe-C stretching vibrations [23] and manifest in the spectrum at 523 cm^{-1}. The lower spectral region (190-340 cm^{-1}) with bands at 277 and 328 cm^{-1} concern the Fe-CN-Fe bond deformation vibrations [23,24].

The µ-FTIR spectrum of the blue colour is presented in Figure 9A further below.

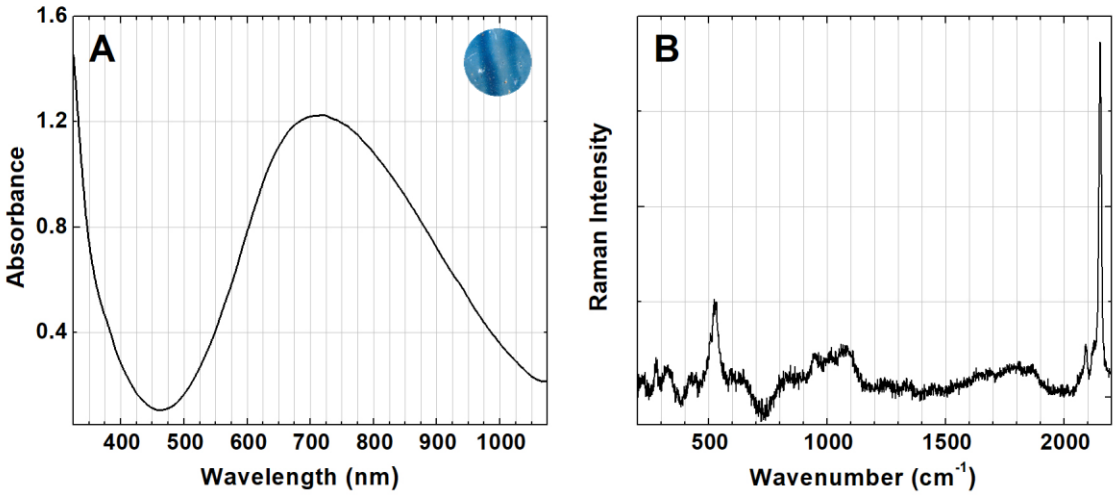


Figure 4. A) UV-Vis and **B)** Raman spectra of the blue colour, identified as Prussian blue.

Prussian blue is a ferric ferrocyanide ($Fe_4[Fe(CN)_6]_3$) or a closely similar compound, which was one of the earliest synthetic inorganic pigments to be produced, in Berlin, 1704. It is produced by the action of an oxidising agent such as potassium bichromate and sulfuric acid on a mixture of ferrous sulphate, sodium ferrocyanide and ammonium sulphate. A deep blue pigment is precipitated from dilute solutions of those salts and it is finely divided after it is washed, filtered and washed. By controlling the precipitation and oxidation conditions as well as the addition of extenders, it is possible to obtain various hues and properties of blue [25]. Prussian blue has an extremely high tinting strength and is very transparent, ideal for glazing [26]. The origin of the colour of this pigment is an electronic transition from a low-spin Fe^{2+} in a carbon coordination centre to a high-spin Fe^{3+} in a nitrogen coordination centre that occurs when visible light is absorbed at 680 nm. This absorption – the intervalence transfer band – is responsible for the intense colour of Prussian blue [27].

3.3.2. Red colour

The UV-Vis spectra representative of the red colour in all glass slides is presented in Figure 5A. It shows an absorption band structured into two characteristic bands at 522 nm and 562 nm, indicating the presence of an anthraquinone red chromophore of animal origin (such as kermes, lac and cochineal). These bands are related to the conjugated double bonds of the anthraquinone molecule, assigned to n→π* transitions of the carbonyl groups [28,29].

Figure 5B shows the infrared spectrum of the red colour where it is possible to identify gypsum ($CaSO_4.2H_2O$) through its characteristic bands at 3405 cm^{-1} (OH stretching), 1621 cm^{-1} (H_2O bending), 1125 cm^{-1} (SO_4^{2-} asymmetric stretching) and 669 cm^{-1} (SO_4^{2-} asymmetric bending) [30]. Its presence is in agreement with the EDXRF analyses, which always detected a higher quantity of calcium, together with sulphur, in the red areas of the glass slides. The presence of a terpenoid resin such as shellac was also identified, and it is further discussed in subsection 3.3. More importantly, the infrared spectrum is very similar to a historical W&N Crimson Lake oil paint tube, which has been characterised as a cochineal red lake paint where gypsum was added during pigment manufacture [31]. Investigation into the Winsor & Newton nineteenth-century manufacturing processes for cochineal lake pigments [31,32]

has enabled the identification of the main infrared bands attributed to the W&N Crimson lake pigment, in the form of a complex of carminic acid with aluminium and calcium, namely at 1569, 1465, 1411, 1309, 1288 and 1250 cm^{-1} [32], which are also observed in Figure 5B.

As previously noted, the use of Crimson Lake for painting on glass was advised by four out of the seven nineteenth-century sources authors. The complementary results obtained strongly suggest that the red colour is given by a cochineal red lake pigment, however, to confirm the presence of the carminic acid further analyses by Surface Enhanced Raman Spectroscopy (SERS) or High-Performance Liquid Chromatography – Diode Array Detector (HPLC-DAD) will be necessary.

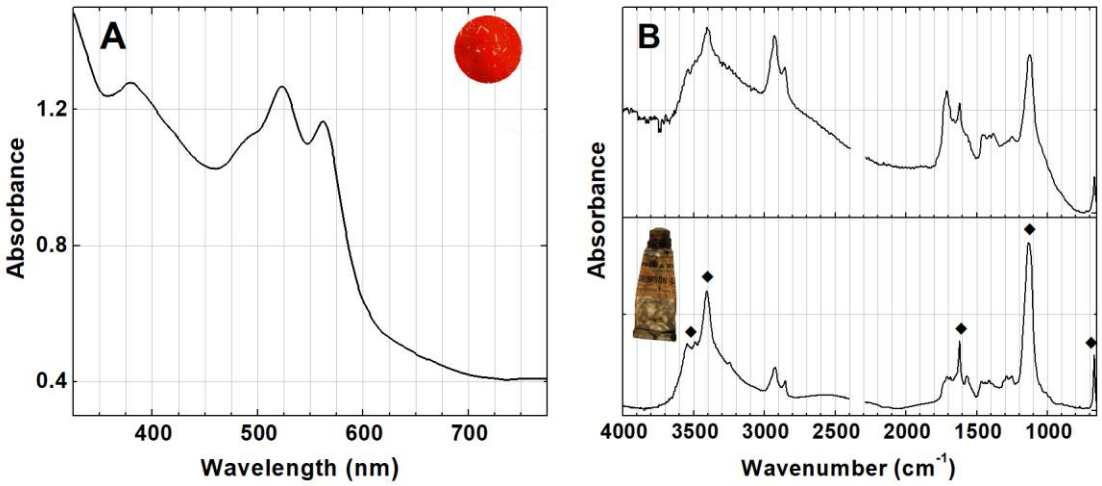


Figure 5. A) UV-Vis of the red colour and **B)** Infrared spectra of the red colour (top) and a 19th century W&N Crimson oil paint (bottom). These spectra strongly suggest that the colourant present is a cochineal red lake pigment; (◆) gypsum ($CaSO_4.2H_2O$).

Carmine is the generic name term applied to insect lakes – kermes and cochineal – however, due to the predominance of cochineal as an insect lake since the seventeenth century, it commonly stands for a cochineal lake [33]. Cochineal is a red dyestuff derived from various species of the scale insects Coccoidea, belonging to *Dactylopiidae* and *Porphyrophora*. Carminic acid ($C_{22}H_{20}O_{13}$), an anthraquinone, is the primary dyestuff in cochineal [33]. The most common way to prepare this pigment is by precipitating a hot aqueous extract of cochineal with iron-free alum [35]. A lake pigment was typically prepared through the extraction of the dye from its animal source, in this case, and precipitating it in solution with inorganic salts (mordants) at neutral or slightly acidic pH. Mordants bind to a particular functional group in the dye molecule to form a metal-dye complex and turning the water-soluble dye into an insoluble pigment [36,37]. Carmine from cochineal has a strong red crimson hue and offers great transparency [26].

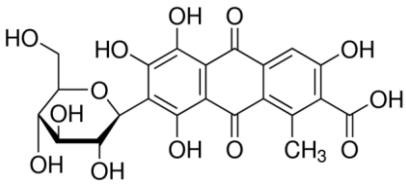


Figure 6. Molecular structure of carminic acid [34].

3.3.3. Yellow colour

Despite the use of complementary analytical techniques, it was not possible to identify the yellow colourant. Nevertheless, the absence of Raman signal and the similarities between the EDXRF

spectra of the glass and the yellow paint can indicate the presence of an organic colourant. The infrared analysis was consistent with the previous techniques and only revealed the presence of degradation products associated with the organic media used, as discussed in 3.4. Future work will be necessary in order to fully identify the nature of the yellow colour.

3.3.4. Black colour

The μ-Raman spectrum of the black colour is shown in Figure 7, displaying two characteristic bands situated at 1336 and 1585 cm^{-1}. The shape of the μ-Raman spectrum and position of the characteristic bands, generally at c. 1580 and 1350 cm^{-1} indicates the presence of a carbon-based black pigment [38,39]. The absence of a band at 950 cm^{-1} [39] can dismiss the possibility of the use of ivory black, but to understand if, for example, a lamp black pigment was used, as mentioned by Groom [12] and Rintoul [17], more analyses will be needed. The μ-EDXRF analysis did not reveal the presence of phosphorus which corroborates this conclusion. The spectra of the black colour revealed to be very similar to the spectra of the glass reinforcing the organic nature of the pigment.

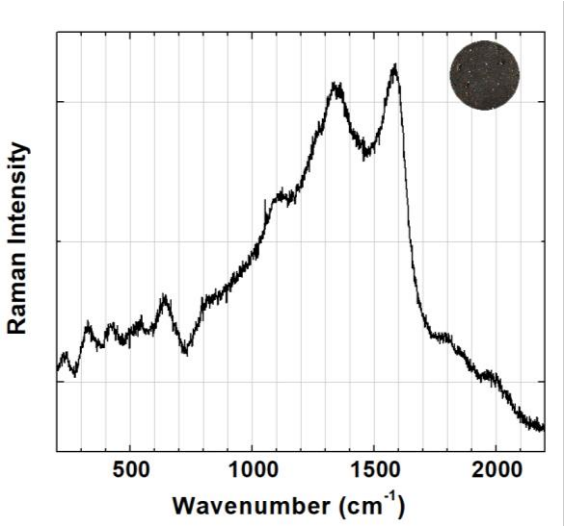


Figure 7. Raman spectrum of the black colour identified as a carbon-based black pigment.

The term carbon-based black refers to a broad group of black or brown pigments mainly composed of carbon [25]. As presented in Table 2, lamp black and ivory black were the two carbon-based black pigments most commonly mentioned in the historical written sources on magic lantern slides and the identification of the black colour present in the slides matches these two pigments rather than asphalt. Lamp black, composed of more than 90% carbon, is an ancient pigment prepared by burning oils, resins and, in particular, rosin and pitch and the ashes are collected on a cooler surface [25,33]. Ivory black is also used since ancient times and derives from the carbonisation of ivory, but it can also refer to other bone types. Ivory is composed of organic and inorganic materials: the organic matrix is mainly constituted by collagen and small amounts of lipids and the inorganic phase (~60% total) is mainly phosphorus, calcium, magnesium and a small amount of carbonate [25,33].

3.3.5. Green colour

As expected, due to the absence of references to green pigments in historical written sources from the nineteenth century, the green colour analysed appears to be a mixture of yellow and blue. This suggestion is corroborated by the UV-Vis spectrum (Figure 8A) through the existence of a broad band at 600-1000 nm (with maximum absorption at 690 nm), which is characteristic of Prussian blue, and by

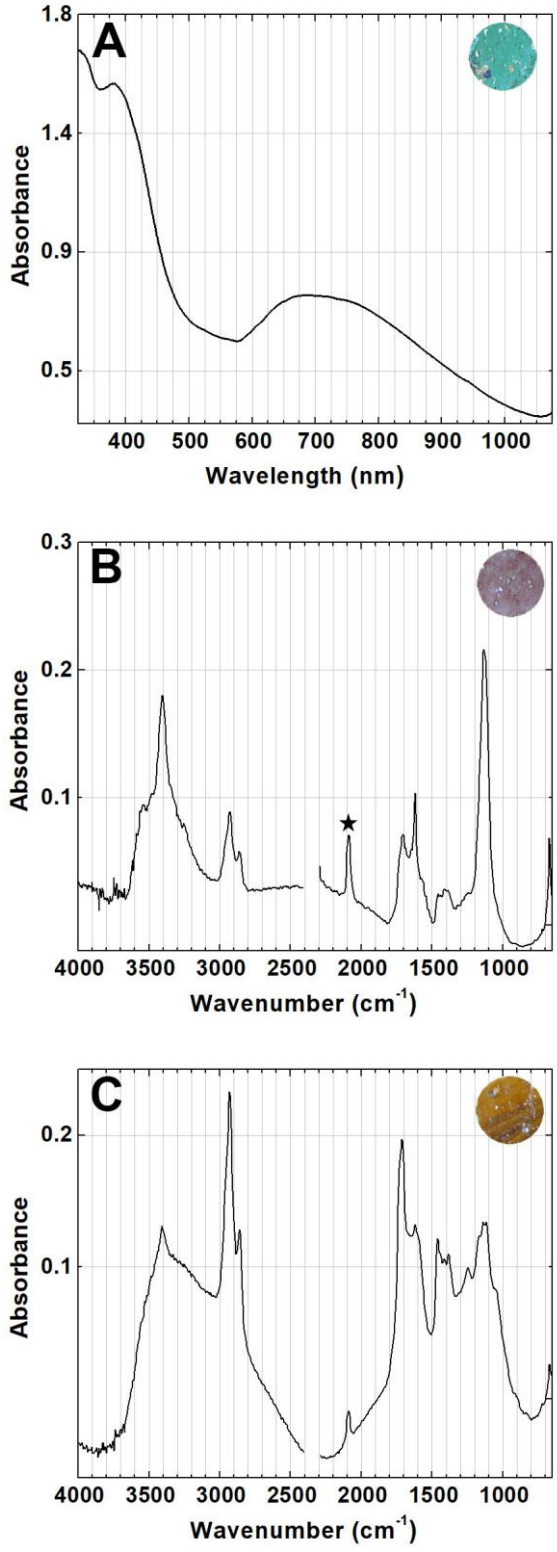


Figure 8. A) UV-Vis spectrum of the green colour, a mixture of the organic yellow and Prussian blue; Infrared spectra of the **B)** purple colour, a mixture of the red and Prussian blue (★); and **C)** brown colour, a mixture of blue, yellow and red.

the presence of the band at 380 nm that corresponds to the yellow pigment (UV-Vis spectrum displayed in Figure 50A in Appendix V).

3.3.6. Purple colour

The infrared spectrum of the purple colour (note that this colour is present exclusively in the slide MUL/MUHNAC UL000066) reveals that it is a mixture of red and blue, as the spectrum displayed in Figure 8B is very similar to the infrared spectra of the red (Figure 5B) with the addition of a band at 2090 cm^{-1}, characteristic of Prussian blue [40].

3.3.7. Brown colour

Despite the suggestions of some nineteenth-century authors on how to paint transparencies on the magic lantern slides, regarding the use of ochres or earth pigments to paint the brown areas, all the brown hues analysed revealed to be a mixture of the primary colours (blue + yellow + red). This can be seen in the spectrum of Figure 8C, which has characteristic peaks of each three colours. It could be suggested that the oil paint tube used already had this mixture, but an extensive study on ochre samples from nineteenth-century oil paint tubes proved that pure ochre brown pigments were available on the market [41]. It comes as a surprise that these type of pigments were not used in these slides, especially considering how many times they were advised by the nineteenth-century authors, which could suggest that these would not allow obtaining the desired transparency, and the artists found other solutions to achieve more transparent and brighter brown shades.

3.4. Characterisation of the binder/organic media

The infrared analyses revealed a complex fingerprint in all colours, as may be seen in Figures 5B and 8. Analyses performed on a drop of a transparent resinous material found at the surface of the slide MUL/MUHNAC UL000067, as well as in a varnish found in its colourless area, enabled the identification of a terpenoid resin such as shellac. Their infrared spectra display a CH stretching profile with bands at 2930 and 2856 cm^{-1}, a broad C=O stretching band centred at 1716 cm^{-1}, an NH bending/CC stretching band at 1637 cm^{-1}, and C-O stretching bands of carboxylic acids at 1253 and 1040 cm^{-1} (Figure 9B) [42,43]. However, the presence of other binding media cannot be excluded, and further analyses, such as Pyrolysis-Gas Chromatography/ Mass Spectrometry (Py-GC/MS), should be carried out in order to fully characterise the organic media present and their role in the painting process [44].

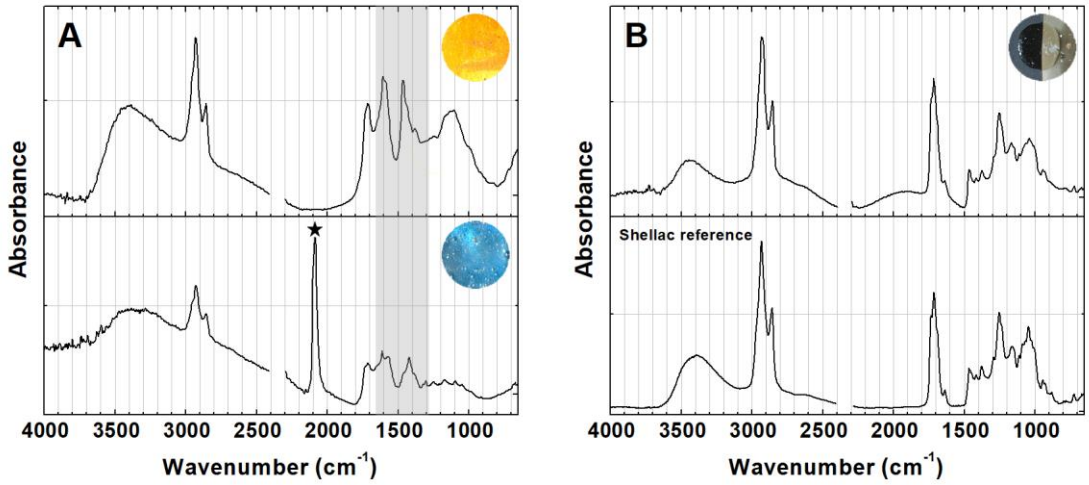


Figure 9. Infrared spectra of **A)** the yellow and blue (★ Prussian blue) colours, where the region of degradation products such as carboxylates and oxalates is highlighted; and **B)** the transparent resinous material found at the surface of the slide (MUL/MUHNAC UL000067) compared to a reference of shellac (Kremer).

Shellac is a natural terpenoid resin derived from the resinous secretion of the lac insect (*Lacifer lacca*) that has a very complex composition with mixtures of different mono- and poly-esters of hydroxyaliphatic and sesquiterpenoid acids [44]. During the nineteenth century, methods for decolorizing shellac resin, such as chemical bleaching, were developed and one of the resulting products was commonly known as white lac varnish. This varnish was advised by many nineteenth-century authors on painting materials, due to its transparency, hardness and durability [45]. There is also a reference to its use in Groom's manual: "[…] having perfected the outline, we secure it by passing over the face of the glass a thin wash of lac varnish […]. The varnish may be employed at the various stages, and at the finish of the work, to fix the colours." [12]. However, not all authors recommended the use of this material, specifically because shellac has a dark, orange-brown tint, associated to coloured components – in which is included lac dye – that were not completely removed during the extraction of the resin from the crude lac [46].

Figure 9A presents the infrared spectra of the yellow and blue colours, where the COO^- stretching absorption region of metal carboxylates is highlighted. The first shows two strong, broad bands centred at 1605 and 1464 cm^{-1} that may be assigned to COO^- stretching and CH_2 bending vibrations of metal carboxylates, respectively [47]. The second also displays bands at 1570 and 1420

cm^{-1}, attributable to metal carboxylates, in addition to bands at 1612, 1323 and 1304 cm^{-1}, which may be assigned to COO^- stretching vibrations of metal oxalates [48]. Unfortunately, the clear identification of the type of carboxylate and oxalate was not possible. In this case, it must be taken into consideration that different terpenoid acids may be part of the carboxylate structures [49-51].

It is noteworthy that, although the infrared spectra show signs of degradation products, no major conservation problems are macroscopically visible. This is most likely because the slides were kept in storage, mostly at the dark, and with no significant changes of relative humidity and temperature, at MUHNAC, for many years. This likely prevented photochemical reactions. Therefore, it is suggested that the slides should be kept in similar conditions, protected from light, and with no fluctuations of environmental conditions, as it is recommended in Chapter 4.

3.5. Cleaning test

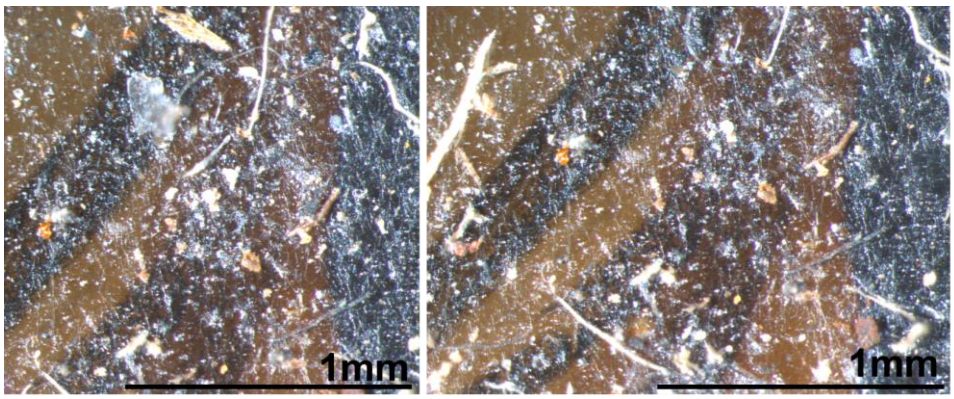
Glass is usually cleaned with a 1:1 mixture of distilled water: ethanol [52,53] which shows to be an efficient cleaning technique; however, due to the presence of cold paint in the slides, no aqueous method can be applied. The method mentioned can only be used to clean glass in areas where there is no sign of paint. Cleaning is an irreversible action that removes unwanted soiling and decay products from the surface of an object [54]. Therefore, and given the heavy presence of dirt that prevents the correct visualisation of the slides as well as the possible attraction of pests, an alternative method was tested.

Figure 10. Detail (stereomicroscope photography) of the dirt at the surface of the slide MUL/ MUHNAC UL000066.

The cleaning test performed with the air blower intended to be the first approach on the interventive conservation of the slides. One of the primary motivations that justifies this intervention is related to interpretation purposes: a magic lantern slide is an object that necessarily needs to have a transparent support in order to be perceived at its fullest by projecting the painted images. With dust and particulate matter blocking the glass support and paints, the projection and visualisation of the slides are compromised. The accumulation of dirt on top of pictorial layers can also deceive the colours, making them appear duller and less bright. Besides that, the majority of the dirt accumulated seems to be organic which can attract pests and increase the risk of high relative humidity. The dirt present at the surface of the glass slides is very significant and disturbs the viewing of the painted subjects. Figure 10 shows a detail of the intense particulate observed, revealing that it could not be as superficial as it seemed initially, but more softened and adhered to the paint.

The air blower (previously detailed in subsection 2.3.) was the chosen tool to perform the first cleaning test since it was considered the least invasive method to remove superficial dirt since no material was in direct contact with the slide. The results obtained were not efficient since the air blower only dispersed the larger particles to other areas of the slide (Figure 11). Therefore, this cannot be

considered an effective method to clean the superficial dirt in magic lantern slides. In figure 10, in the brown area, it can be seen a fibre that is painted brown which suggests the fibre was deposited during the painting of the slide, making the cleaning of these fibres impractical and possibly undesired as they can be perceived as a historical trace of the moment of the slide painting. It could also have been possible that during the projection the paints softened and caught fibres and particles that remained trapped. However, a significant concern of the authors of the historical written sources was the cleanliness of the glass support prior to painting.



A) B)

Figure 11. A) before the cleaning test with the air blower and **B)** after the cleaning test. Only major particulate was removed.

It is suggested that the air blower cleaning can be complemented with the use of a conservation vacuum cleaner (with controlled intensity regulated at the minimum suction and, for example, a gauze attached to the end of the nozzle to collect the dirt) in order to prevent the spreading of the particles to other areas of the slide. Another method that can be tried out is the use of a gentle brush, again complemented with the use of the vacuum cleaner to gather the dirt. This method can only be employed in slides that are in good conservation state, showing no signs of detachment of the pictorial layer or instability in the binder/paint system.

4. Preventive conservation guidelines for collections of magic lantern slides

The other goal of the project in which this work is integrated, after the material characterisation, is the development of preventive conservation guidelines, also pioneer for this type of collection. These guidelines are proposed considering the lack of literature on the preservation of magic lantern slides, as well as the surveys submitted to national and international museums that hold these collections.

The survey was sent to 53 institutions with 19 formal answers and was designed to gather information about: a) the institution answering the inquiry form; b) the collection the institution currently holds; c) conditions of exhibition; d) conditions of storage and e) conservation and restoration general information and procedures. Table 3 summarises the key-answers of the survey. The complete questions and answers to the survey can be consulted in Appendix VII.

Table 3. Key-answers to the survey answered by the 19 participating institutions.

a)	There is always someone responsible for the magic lantern slides collection (conservator together with a curator).
b)	The number of slides varies deeply, staring in 50 and going to 50.000 slides; mainly from the 19th century; divided by representation or typology.
c)	58% of the institutions have magic lantern slides in exhibition; environmental conditions controlled: RH at 40-60%; temperature at 15-20^{o}C; lighting intensity <50 lux; LED lamps are predominately used; UV radiation is avoided by the absence of windows or by blocking them. Glass display cases are the most common exhibition equipment, followed by closed wooden cabinets.
d)	100% of the institutions have magic lantern slides stored; environmental conditions controlled: RH at 40-60%; temperature at 15-20^{o}C; lighting intensity at 100-150 lux; fluorescent lights are the most used to light the storage space; UV radiation is blocked by having no windows. The most common storage equipment is metal cabinets. Slides are not in direct contact with the storage equipment: 50% use anti-acid paper. If a box is used, it is usually a closed wooden one. 47% have the slides individually wrapped; 74% keep them vertically stored.
e)	53% do not regularly monitor the slides; 63% have implemented IPM; 53% still have magic lantern projection shows, in which 32% use slides from their collections. The slides are digitalised and kept in a virtual database. General surface dirt is flagged as the most common pathology; Wearing and tearing of the paper tape, abrasion in preferential direction and loss and/or tearing of the framing tape are signed as common damages; apparent microorganism presence in the glass support and pictorial layer detachment are the least common damages.

Several caretakers of these collections contacted during this study showed interest in filling the gap on the lack of knowledge regarding this particular cultural heritage and were explicitly interested in guidelines for the conservation of the slides. Please note that the guidelines and recommendations in this work are the first proposal and will be developed in the future along with an in-depth study of all the components that may be present in a magic lantern slide. It is essential to keep in mind that magic lantern slides are composite objects composed of different materials – in most cases, glass, wood, painting materials, metallic parts and (adhesive) paper – which makes it a challenge to establish a compromise in terms of preservation conditions for such diverse materials. However, general good practices can be suggested to contribute to the preservation of these collections.

The first step should be the surveying of the collection while keeping an inventory database associated with the conservation state of the slides. Digitalisation or photography of the magic lantern slides is also a very important effort as it enables the digital preservation of the slides as well as access to copies for research and online viewing, while at the same time reducing the need for handling the

original slide. Additionally, the primary preservation strategy is also achieved through the control of the environmental conditions of storage and/or display, which ensure the objects are available to endure for the maximum length of time possible. Also important is the regular monitoring of the collection which also includes the maintenance and monitoring of Integrated Pest Management. Each institution must have an emergency preparedness plan ready to activate.

It is a common practice in some museums to provide magic lantern slides projections' shows for the public in a way to keep alive the tradition of these performances. However, it is not recommended to use original slides that belong to the institutions' collection as they can be damaged during projection. Instead of using original slides for this purpose, replicas could be made. At Portuguese Cinematheque – Cinema Museum, Lisbon, Portugal, projections are held frequently for children resorting to the photography of slides and colour printing them in acetate sheets according to the slide dimensions, enclosing them in card frames. Sometimes the colours are retouched which allows for a projection closer to the original one. This technique avoids the manipulation and exposure to aggressive projection conditions of the original slides, namely the simple and slipping slides; for rackwork or pulley slides that have more complex movement mechanisms, there is yet to be figured a way to replicate these types of slides [55].

Regarding the organisation of magic lantern slides collections, these can be sorted in various ways, such as date, representation (fairy-tale, humorous, religious, educational, etc.), typology (size, format, sets, etc.), production technique (hand-painted, printed, photographic), producer or country of production, catalogued by donor, etc. Although each institution has its criteria for managing the collections, a first division must be done regarding the production technique since the three production techniques for the execution of the slides will reflect in different conservation needs. For instance, photographic slides, similarly to photographic collections, benefit from lower temperatures for their long-term preservation, as chemical reactions occur faster with higher temperatures [56,57]; hand-painted slides can reveal pictorial layer detachment or vanishment that require strict control of light intensity, relative humidity and/or temperature. If possible, the next criterion to be applied should be a division by typology. This is useful in terms of storage space optimisation but also because it makes possible to store together slides that belong to sets or chronicle of events; it might also be a good indicator of the usage of the slides, for example, if the slides were smaller they could have been used in a toy lantern and if they were bigger they could have been used in big performances. Lastly, representation is also a good category to organise the magic lantern slides as it facilitates following the different themes and subjects represented.

4.1. Risk assessment and identification

This work intends to evaluate the main risks to which this type of collection is usually exposed to; however, a full risk assessment and the calculation of their magnitude was outside the scope of this work. Risk is defined as the chance of an undesirable change happening [58].

This work focuses on the risks that might be more problematic to the slides under study, belonging to MUHNAC. Since there is a wide variety of magic lantern slides either produced with different techniques

and constituent materials, in different countries, or with distinct movement mechanisms and subjects represented, it would be nearly impossible to assess the risks common to each type of slide.

Recapping the ten deterioration agents – physical forces, fire, water, criminals, pests, pollutants, light and radiation, incorrect temperature, incorrect relative humidity and dissociation [58] – it is possible to identify those that are more prone to affect the hand-painted slides from MUHNAC and within those deterioration agents which ones might affect each material of the slide, developing a scale considering the risk assessment.

Physical forces, fire, water, pests, light and radiation, incorrect relative humidity, temperature and pollutants are the main deterioration agents that may endanger the collection studied. These agents were evaluated considering each material that constitutes the magic lantern slides, establishing a risk assessment scale presented in Table 4. The deterioration agent that has a great impact on the conservation of the slides affecting their whole integrity is dissociation: this includes loss of objects and/or their associated data and the loss in value of even one item is enough to reduce the value of the collection as a whole [59]. This problem is especially dramatic in sets of magic lantern slides that are incomplete, belonging to collections – either missing slides which ceases the follow-up action of the story told in the different slide collection set or slides that present missing parts that are essential for the interpretation of their subject. For last, criminal action is linked with the safety of the objects and might also be related to the interpretation of a complete set of slides – in countless auctions sites, isolated slides belonging to sets are being sold separately, thus contributing to the loss of the context of the corresponding set. These last two deterioration agents are not featured in table 4 as they affect a magic lantern slide as a whole and it is not quite possible to separate their damage by material.

Table 4. Risk assessment for the MUHNAC'S magic lantern slides collection, considering each material components. Based on [62].

	Physical forces	**Fire**	**Water**	**Pests**	**Light and radiation**	**Incorrect RH**	**Incorrect temperature**	**Pollutants**
Glass support	3	2	2	1	1	2	1	3
Painting materials	3	3	3	2	3	3	3	3
Wood frame	2	3	3	3	2	2	1	2
Metal nails	2	2	2	1	1	2	1	2
Adhesive paper tape	2	3	3	3	3	2	1	2

1. Low risk; 2. Concerning risk; 3. High risk.

4.2. Control of environmental conditions

One of the most important measures to implement is the control of the environmental conditions at the display and storage areas, keeping permanent monitoring of the parameters. Magic lantern slides are mixed objects constituted by different materials with different behaviours, so it is challenging to find a balance in relative humidity (RH) and temperature that accommodates all materials.

4.2.1. Relative Humidity (RH)

Low RH causes loss of moisture in organic materials which makes them shrink and it may also cause them to become brittle and lose their strength [57]. This phenomena applies to the paints, the paper tape and the wood frame. High RH causes organic materials to swell and can also enable the proliferation of micro-organisms and insects [57]. Severe problems arise from fluctuations of RH: mixed organic materials suffer due to the rate and amount by which they expand and contract; this might be a critical issue to glass slides since they have an inorganic support that reacts very differently to changes in RH than the subsequent paint layers and varnish, the latter being more moisture-sensitive than the glass. Glass has been seen as a stable material not affected by RH changes but Koob et al. (2018) have shown that when glasses are exposed to continuous wide fluctuations in RH (and temperature), they can be at risk [60].

The main problem to any collection with organic materials is related to the fact that over the years, materials become familiarised to a particular level of RH and if this is suddenly reduced, the loss of moisture from organic materials can cause shrinkage [57]. Therefore, it is crucial to gradually change the RH levels so that the material has time to adapt to new conditions. A compromise between so many different materials is difficult to achieve, so more important than suggesting RH range values, it is suggested that fluctuations do not exceed 5%. The ideal values for RH would situate between 40-50% (i.e. 45%±5%), never exceeding 60% as mould growth can occur [61].

4.2.2. Temperature

Temperature is directly related to RH and so temperature fluctuations also cause materials to expand and contract rapidly, introducing stress on the object [57]. Temperature too high can increase the flexibility of natural resins and cause many resins and coatings to become softer, prone to be marked by fingerprints and to absorb dust more easily; it can also cause the failure of adhesives. Besides, as referred before, the rate of chemical deterioration increases with temperature meaning that, in general, lower temperatures should be practised when possible, especially in storage areas [61]. Low temperatures can make certain materials more brittle and likely to crack and flake; varnishes, wood and oil paints need to be handled carefully [57]. Again, it is essential to avoid extreme fluctuations in temperature, particularly for composite objects. It can be suggested to maintain the temperature at 15-25^{o}C (i.e. 20^{o}C±5^{o}C).

4.2.3. Light and radiation

Organic materials are by far most prone to photochemical deterioration. The two main types of damage caused by light and radiation – that have cumulative and irreversible effects – are the fading of dyes and pigments and structural embrittlement of materials [57]. Paper and wood are considered to be highly light-sensitive materials, followed by oil paintings and materials with organic protective coatings which are moderately light-sensitive; glass and metal are considered to be less sensitive to light [57]. Damage from light can be limited by reducing a) UV and IR radiation, b) exposure time and c) illumination levels. UV radiation can be eliminated by blocking natural light (either with the absence of windows or by blocking them with curtains), installing UV filtering material over windows or use UV

filtered coated light sources. IR radiation can be avoided by not using incandescent spotlights, keeping light sources away from objects as they can raise the temperature near them and by using air circulation systems to help control heat build-up [61]. Exposure time should be regulated as well as implementing the rotation of objects. Installation of motion detectors in exhibit areas that only activate when visitors are present can also be an excellent way to reduce the time magic lantern slides are exposed to light. It is crucial to keep in mind that exhibitions, in their core, fulfil the goal of displaying cultural heritage to the public, so there has to be a balance between the ideal light levels and lighting that allows for the appropriate observation by the visitors. Light Emitting Diode (LED) lamps currently seem to be the best option to use in museum environments [57,61,62]. Quartz or halogen lights should be avoided as they produce excessive UV and IR [62]. Regarding illumination levels, the lower the better, but especially for exhibition rooms, it can be suggested these situate between 50-100 lux, a range that comprises the maximum value for extremely light-sensitive materials and the maximum value for moderately light-sensitive materials [61], while also considering that the objects are going to be viewed by visitors that need to have adequate lighting conditions in order to observe the collections exposed.

4.3. Guidelines for display

It is recommended to display the magic lantern slides collection using stable and neutral equipment, namely made of metal (steel) with see-through glass doors and the glass slides should never be in direct contact with the display equipment. Since the most common way to exhibit the slides is by having them vertically displayed, it is crucial to assure the slides being exposed are not in a bad conservation state, for example showing signs of pictorial layer flaking or detachment. Another way the slides could be displayed would be by having them horizontally laid in a light table that only lights up when visitors come nearby, with an acrylic or glass protection on top. Wooden cases or other equipment should be avoided as wood, oak in particular, emits Volatile Organic Compounds (VOC) as do composite wood boards such as MDF (Medium Density Fibreboard), which are often found in more recent cases [57]. In particular to the glass substrate, pollutants such as formic acid, acetic acid and formaldehyde were found to be emanated by wood and these compounds can react with soda silicate glasses, forming crystalline sodium formate at the surface and cause chemical and structural changes in the glass [63]. RH, temperature and illumination levels should be controlled not only in the exhibition room but, if possible, also inside the display cases. It is safer to light display cases externally rather than having an internal light; this reduces the risk of heat build-up inside the case resulting from the lamps and avoids fluctuations in RH [57].

4.4. Guidelines for storage

Likewise suggested for display, it is recommended to use storage equipment composed of chemically stable and neutral materials that protect objects from environmental and physical risks. Metal open shelving units can be a good option; museum quality storage is usually made of powder-coated steel with an epoxy, acrylic or polyester finish [62]. As mentioned for display cases, wooden cabinets, shelving units or other storage equipment should be avoided due to the emission of VOC. An important detail to remember in storage areas is to keep the furniture raised off the floor at least 10 cm as

protection from flooding as well to facilitate the cleaning of the floors and inspection for pests [62]. The direct contact of the magic lantern slides with the storage equipment is not recommended. Depending on the conservation state of the slides, an ideal layered storage system is presented in Figure 12, where each layer adds protection to the slides.

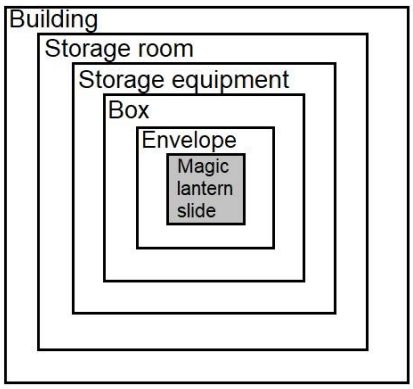


Figure 12. Protective layered storage system for magic lantern slides collections. Adapted from [64].

Assuming the slides are being stored by sets, the previous system can be applied by packaging each slide in a custom-made acid-free paper envelope and kept inside a box with other slides. The box can be custom-made as well, made out of archival quality acid-free board with neutral pH or honeycomb-structured core polypropylene plaque box. However, this vertical method of storage is only recommended for slides that do not display severe damages. The best way to store magic lantern slides that are in a more critical condition is by having them horizontally laid, not stacked, and with nothing on top of the painted surface, ideally stored in drawers.

In case it is not possible to apply a layered system and the storage equipment is to be padded with some material to avoid direct contact, polyester film, like Melinex®, should not be the first option due to its high electrostatic energy that may attract dust particles or paint flakes. Polyethylene foam usually has a rougher texture, so if it is used, it should be certified that the painting side is not in contact with the foam. A thinner polyethylene foam (Cell-aire®) might be a better option as it offers less abrasion and has a smoother texture. Tyvek® paper (made of high-density polyethylene fibres) despite being soft to the touch, might cause some fibres to be stuck in glass or wood edges. Acid-free paper or card can also be used as a padding material, making sure the fibres are not too dispersed that can cause abrasion and being entrapped in sharp edges of the glass, for example.

5. Conclusions

The magic lantern was an instrument for image projection with high impact culturally, historically and socially between the seventeenth and nineteenth centuries, marking the beginning of the “pre-cinema period”. During the nineteenth century, several books with instructions on how to paint transparencies on glass for magic lanterns were published. These essential sources were consulted and provided insights on which painting materials and techniques can be expected to be found on the historical magic lantern slides.

In this work, five hand-painted magic lantern glass slides from the Museum of Natural History and Science of the University of Lisbon were studied and characterised by complementary analytical techniques. The glass substrate was characterised via EDXRF, matching the soda-lime silicate glass type, and then quantified in oxide weight percentage. The comparison of the results obtained with English flat window glass studies allows the suggestion that the glass was produced between 1870 and 1930, due to the low content of arsenic (<0.2 wt%) and the similarity of the general composition with that of window glass from that period. It is possible to narrow the production range of this collection between 1870 and 1900, considering the 'standardised size' of the slides and the similarity of the subject represented with other English magic lantern slides.

Through spectroscopic techniques, it was possible to identify the following colourants: Prussian blue, an anthraquinone red lake pigment of animal origin (such as cochineal) and a carbon-based black pigment. The yellow was obtained from an organic colourant whose identification was not yet possible. These results are in agreement with the majority of the historical written sources consulted. The remaining colours were found to be mixtures of the primary ones. This was expected for the green since none of the nineteenth-century sources mentioned a green pigment, which suggests this colour was obtained by mixing blue and yellow. The purple colour was identified as a mixture of red and blue which also matches with the information in several manuals since only a minority of the authors mentions purple pigments, rather mentioning the mixture of red and blue to achieve this colour.

By means of infrared analyses, it was possible to identify a complex matrix where the presence of a terpenoid resin such as shellac was detected. This resin could have been used as a varnish and/or binding media; however, the presence of other binders, such as oil and/or polysaccharide gums, cannot be excluded. Degradation products such as metal carboxylates were also detected in the paints, but fortunately, no macroscopic signs of alteration in their conservation state are presently observed which means the slides should continue to be stored in the dark, avoiding photochemical reactions to manifest macroscopically.

Preliminary preventive conservation guidelines were suggested for these collections, concerning RH, temperature, lighting, display and storage. A summary of these guidelines is presented in Table 5 below.

Table 5. Brief summary of the preventive guidelines suggested: Establishing a compromise between the different materials of a magic lantern slide.

RH: 45%±5%; < 60% always avoiding abrupt fluctuations;
Temperature: 20ºC±5ºC always avoiding extreme fluctuations;
Light and radiation: LED lamps; intensity at 50-100 lux;
Display: steel equipment with see-through glass doors; avoid wooden cases; environmental conditions controlled in the exhibition room;
Storage: avoid direct contact of the magic lantern slides with the storage equipment (e.g. thin polyethylene foam); 1) layered storage system: envelope (neutral paper or thin polyethylene foam) → box (archival quality board with neutral pH or honeycomb-structured core polypropylene plaque) → storage equipment (metal open shelving units, avoid wooden cabinets); 2) horizontal storage in drawers.

This collection will be further investigated to deepen the understanding of the techniques and materials used. The paint layers will be examined in cross-section to perceive how they were applied. SERS and HPLC-DAD will be used to fully characterise the red and yellow organic colourants and mass spectrometry techniques, such as Py-GC/MS, will be applied to advance the knowledge on the binders and varnishes used.

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7. Appendices

7.1. Appendix I – Condition Reports of the Five Hand-Painted Magic Lantern Slides

CONDITION REPORT – HAND-PAINTED MAGIC LANTERN SLIDE UL000065

Department of Conservation and Restoration
Laboratory of Stained-Glass – VICARTE

FCT DCR Inventory number: FCT CV C05 2018
Entry date: 19/10/2018
Supervisor: Márcia Vilarigues
Report author: Beatriz Rodrigues

IDENTIFICATION

Institution/owner: National Museum of Natural History and Science of University of Lisbon
Address: Rua da Escola Politécnica 56/58, 1250-102 Lisbon, Portugal
Contacts: General – +351 213921800; geral@museus.ulisboa.pt
Collection responsible: catarina.mateus@museus.ulisboa.pt
Location of the objection in the institution: History of Science Technical Storage 2
Category: Magic lantern
Denomination: Glass slide
Institutional inventory number: MUL/MUHNAC UL000065
Weight: 122,38g
Photography:

Figure 13. Hand-painted single slipping glass slide MUL/MUHNAC UL000065 from MUHNAC-ULisboa (still image) photographed with normal and transmitted light simultaneously.

Figure 14. Hand-painted single slipping glass slide MUL/MUHNAC UL000065 from MUHNAC-ULisboa (movable image resulting from the operation of the slipping glass) photographed with normal and transmitted light simultaneously.

Dimensions:

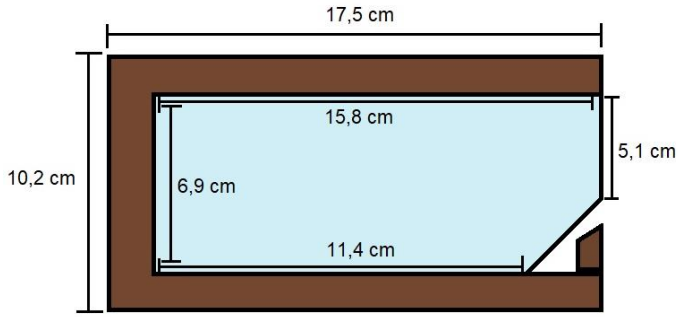


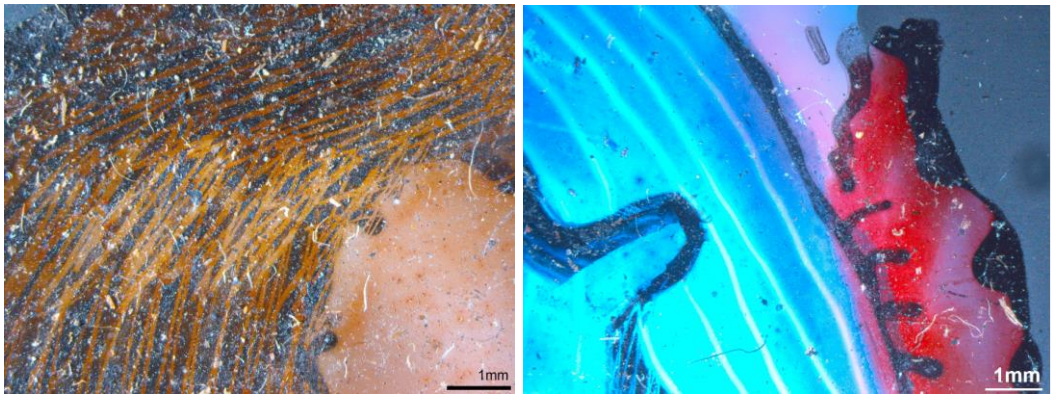
Figure 15. Scheme of the dimensions of the magic lantern slide (in centimetres).

Description: Hand-painted glass slide for magic lantern projection. Rectangular shaped slide with a glass mounted to the wood frame and another glass on top, the slipping glass. The right side is opened with the wood cut-out in a specific angle in order to allow for the movement of the slipping glass, in that direction. Three metal nails – two at the top and one at the bottom – are fixed to the wood frame and serve the propose of securing the slipping glass. The mounted glass has an opaque black background painted and the part of the subject that is motionless. In this case, these elements are the human figure body and what seems to be a kitchen background. The slipping glass, separated from the mounted glass by a paper tape painted black is the one to be pulled in and out to achieve the movement action, by grabbing the orange tape glued to this glass. The slipping glass is painted – on the side of the glass facing the mounted glass – with the part of the drawing that intends to appear moving when handled; this corresponds to the eyes and arms of the human figure. The painted scene depicts a masculine figure in profile, apparently cooking in a kitchen. The man has a light skin colour with freckles in his face and rosier spots on his cheeks and nose. The hair is brown, spiky and he wears a collar with a red scarf and a blue and white striped jacket – on top of that a white apron. In his hands, that are coloured in a darker tone than his face, he holds what seems to be a wooden kitchen utensil which is inside a white bowl. This bowl sits on top of a brown counter or table and next to it is a knife, painted with a blade in light blue and the hold in black. At the background, there is a piece of furniture that resembles a dresser drawer and on top of is visible a green bottle with horizontal stripes and a reddish tag at the bottle's neck, as well as a cylindrical shaped blue object on the left side. By moving the slipping glass, a small movement occurs in the eyes and lips of the figure, moving forward. The arm that holds the kitchen utensil also moves. In general, five colours are painted: blue, red, black, green and brown. Two paper labels are glued to the wood frame, one at the front (“M.C.U.L. inv. nº 65”) and the other at the back (“2.500.-“).
Authorship: Unknown.
Manufacturer: Unknown.
Production place: Possibly England.
Marks and inscriptions: None.
Date: Nineteenth century. By means of µ-EDXRF analysis, the glass was characterised and its oxides quantified and compared to English flat glass studies [10,11], indicating they were possibly produced between 1870 and 1930. Additionally, considering the standardised size of the slides and the similarity of the subjects represented with other nineteenth-century English slides, it was possible to narrow the period of production of this collection between 1870 and 1900.

TECHNICAL CHARACTERISATION

Component materials: Glass, paints, wood, metal, adhesive paper tape.
Decoration technique: Nineteenth-century historical written sources report that magic lantern slides were painted mainly with watercolours or oil colours. Through µ-FTIR analyses, the latter case seems to be present and it was also possible to identify the presence of a terpenoid resin such as shellac. This resin could have been used as a varnish and/or binding media; however, the presence of other binders cannot be excluded. Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours opposing to the opaque black background that surrounds the subjects, which could imply the presence of a varnish or a resin-like material. The white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area, adding detail. The intensity of the brushstroke is also variable according to the desired effect of lighter of darker

details. Equally interesting is another technique observed which is similar to stained glass, namely in grisaille – the technique of “opening lights” in which the black background seems to be scraped off to reveal another colour beneath (Figure 16A). This seems to demonstrate that the outline was made simultaneously with the black background and that creative techniques and materials were employed to achieve several effects, as well as the application of thin objects to create more interesting patterns.



A) B)

Figure 16. Detail (stereomicroscope photography) of **A)** the black background scraped off, to allow the passage of light in the areas where the brown colour was afterwards applied giving a more realistic effect to the hair and **B)** the detail applied in the black outline and creation of the white stripes effect, which seems to have been achieved with a thin object.

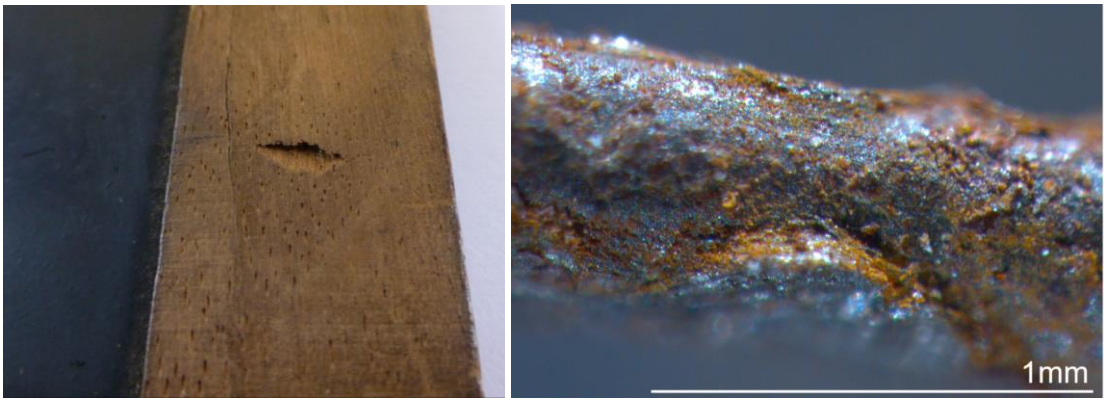
Manufacture technique: The glass sheet was most probably done by the cylinder or the crown technique. The wood frame appears to be manufactured in parts and then glued together.

CONDITION

Conditions of the provenance location: The magic lantern slide was in MUHNAC’s storage with the other four slides that belong to this set, horizontally, separated with Cell-aire®. The storage used is a movable compact metal rack and the storage room is always locked (it has an alarm and restricted access) except for two days of the week when volunteers work on the inventory database system or when exceptionally the collections need to be accessed by the staff for monitoring, cleaning, moving or when external access is provided. During the cold seasons, a dehumidifier is daily turned on and the illumination of the room consists of LED lamps.
Conservation assessment: In general, it can be considered that this slide is in good condition since there are no damages that affect his integrity or interpretation. Since this is a composite object, the different materials should be considered to the conservation state of the slide and how they contribute to the (in)stability of the object.
Glass: The glass support is in very good condition. It only shows substantial dirt at the surface.
Paint: Even though the infrared analyses performed identified the presence of degradation products such as metal carboxylates, at the macroscopic level, no significant damages are noticeable in the painting layer. Small lacuna is visible in the black background, shown in figure 17.

Figure 17. Detail showing the areas of lacuna in the black background of the slide (light green circles).

Wood: The wood frame is in good condition, without damages that endanger its stability. It shows small black stains similar to paint, mainly at the front, that could have been caused during the painting of the glass. As referred above, there are two paper labels glued to the wood, and in the back, there is also a small cavity (about 5mm in extension) on the right side, as well as a fissure (Figure 18A).
Metallic parts: The metal nails show signs of corrosion and dirt (Figure 18B).



A) B)

Figure 18. Detail of **A)** the small cavity visible in the right side of the back of the wood frame and **B)** (stereomicroscopy photography) of the corrosion present at the metal nail.

Adhesive paper tape: The paper tape glued to the glass to allow the movement action is in poor condition. The majority of it was lost on the front side of the glass slide, remaining only at the back.

Previous interventions: Unknown.

CONDITION REPORT – HAND-PAINTED MAGIC LANTERN SLIDE UL000066

Department of Conservation and Restoration
Laboratory of Stained-Glass – VICARTE

FCT DCR Inventory number: FCT CV C06 2018
Entry date: 19/10/2018
Supervisor: Márcia Vilarigues
Report author: Beatriz Rodrigues

IDENTIFICATION

Institution/owner: National Museum of Natural History and Science of University of Lisbon
Address: Rua da Escola Politécnica 56/58, 1250-102 Lisbon, Portugal
Contacts: General – +351 213921800; geral@museus.ulisboa.pt

Collection responsible: catarina.mateus@museus.ulisboa.pt
Location of the objection in the institution: History of Science Technical Storage 2
Category: Magic lantern
Denomination: Glass slide
Institutional inventory number: MUL/MUHNAC UL000066
Weight: 148,08g
Photography:

Figure 19. Hand-painted single slipping glass slide MUL/MUHNAC UL000066 from MUHNAC-ULisboa (still image) photographed with normal and transmitted light simultaneously.

Figure 20. Hand-painted single slipping glass slide MUL/MUHNAC UL000066 from MUHNAC-ULisboa (movable image resulting from the operation of the slipping glass) photographed with normal and transmitted light simultaneously.

Dimensions:

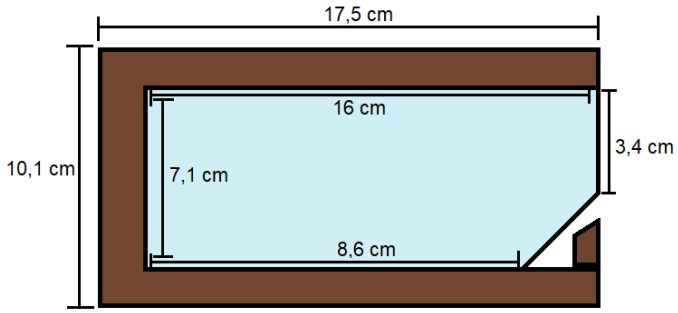


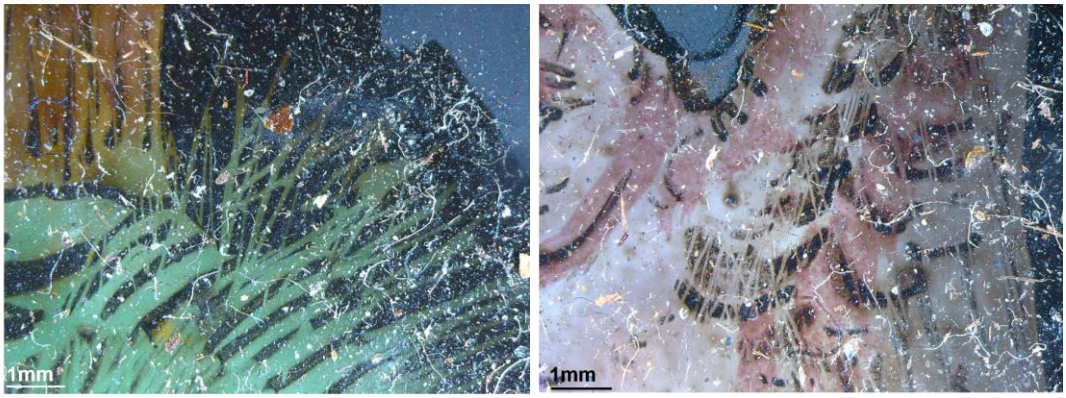
Figure 21. Scheme of the dimensions of the magic lantern slide (in centimetres).

Description: Hand-painted glass slide for magic lantern projection. Rectangular shaped slide with a glass mounted to the wood frame and another glass on top, the slipping glass. The right side is opened with the wood cut-out in a specific angle in order to allow for the movement of the slipping glass, in that direction. Two metal nails – one at the top and one at the bottom – are fixed to the wood frame and

serve the propose of securing the slipping glass. The mounted glass has an opaque black background painted and the part of the subject that is motionless. In this case these elements are the human figure and the fence. The slipping glass, separated from the mounted glass by a paper tape painted black is the one to be pulled in and out to achieve the movement action, by grabbing the orange tape glued to this glass. The slipping glass is painted – on the side of the glass facing the mounted glass – with the part of the drawing that intends to appear moving when handled; this corresponds to a different head of the human figure and a bird that appears. The painted scene depicts a masculine figure seated frontally on top of a fence. The man has a light skin colour, wears a smile showing his teeth and has rosier cheeks. The hair is brown, spiky to the sides and he wears a light red hat. His shirt is of a light yellow/ brownish colour and a greenish handkerchief on his neck. Purple details can be observed on the shirt and his right hand holds a yellow object while his left hand secures a pointy knife with a black hold and light blue blade. The man wears blue pants that are rolled up, showing details of purple and light yellow/ brown merged with the white roll-up. His boots are black and reveal a slight heel, complemented with black shoelaces. The brown fence the man is seated on lays over a piece of bright green grass with two green herb plants. An object that resembles an axe is lying on the grass, in brown colour with an engraved "V". By moving the slipping glass, a different expression appears on the man's face, this time looking horrified by the appearance of a large bird that sits on the fence. This bird has its brownish/ purple wings and beak open, revealing a red tongue. In general, six colours are painted: blue, red, black, green, brown and purple. Two paper labels are glued to the wood frame, both at the front ("M.C.U.L. inv. nº 66" and "2.500.-").
Authorship: Unknown.
Manufacturer: Unknown.
Production place: Possibly England.
Marks and inscriptions: None.
Date: Nineteenth century. By means of μ-EDXRF analysis, the glass was characterised and its oxides quantified and compared to English flat glass studies [10,11], indicating they were possibly produced between 1870 and 1930. Additionally, considering the standardised size of the slides and the similarity of the subjects represented with other nineteenth-century English slides, it was possible to narrow the period of production of this collection between 1870 and 1900.

TECHNICAL CHARACTERISATION

Component materials: Glass, paints, wood, metal, adhesive paper tape.
Decoration technique: Nineteenth-century historical written sources report that magic lantern slides were painted mainly with watercolours or oil colours. Through μ-FTIR analyses, the latter case seems to be present and it was also possible to identify the presence of a terpenoid resin such as shellac. This resin could have been used as a varnish and/or binding media; however, the presence of other binders cannot be excluded. Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours opposing to the opaque black background that surrounds the subjects, which could imply the presence of a varnish or a resin-like material. The white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area, adding detail. The intensity of the brushstroke is also variable according to the desired effect of lighter of darker details. Equally interesting is another technique observed which is similar to stained glass, namely in grisaille – the technique of "opening lights" in which the black background seems to be scraped off to reveal another colour beneath (Figure 22A). This seems to demonstrate that the outline was made simultaneously with the black background and that creative techniques and materials were employed to achieve several effects, as well as the application of sharp objects to create more interesting patterns.



A) B)

Figure 22. Detail (stereomicroscope photography) of **A)** the black background scraped off to reveal the green colour underneath and **B)** the detail applied like scratches, which seems to have been achieved with a sharp object, to add detail to wings of the bird.

Manufacture technique: The glass sheet was most probably done by the cylinder or the crown technique. The wood frame seems to be manufactured in parts and then glued together.

CONDITION

Conditions of the provenance location: The magic lantern slide was in MUHNAC's storage with the other four slides that belong to this set, horizontally, separated with Cell-aire®. The storage used is a movable compact metal rack and the storage room is always locked (it has an alarm and restricted access) except for two days of the week when volunteers work on the inventory database system or when exceptionally the collections need to be accessed by the staff for monitoring, cleaning, moving or when external access is provided. During the cold seasons, a dehumidifier is daily turned on and the illumination of the room consists of LED lamps.

Conservation assessment: In general, it can be considered that this slide is in good condition since there are no damages that affect his integrity or interpretation. Since this is a composite object, the different materials should be considered to the conservation state of the slide and how they contribute to the (in)stability of the object.

Glass: The glass support is in very good condition. It only shows substantial dirt at the surface.

Paint: Even though the infrared analyses performed identified the presence of degradation products such as metal carboxylates, at the macroscopic level, no significant damages are noticeable in the painting layer. Small lacuna is visible in the black background, shown in figure 23.

Figure 23. Detail showing the areas of lacuna in the black background of the slide (light green circles).

Wood: The wood frame is in good condition, without damages that endanger its stability. It shows small black and white stains similar to paint (Figure 24), mainly at the back, that could have been caused during the painting of the glass. As referred above, there are two paper labels glued to the wood frame.

Figure 24. Detail of the black and white stains on the back of the wood frame of the slide.

Metallic parts: The metal nails show signs of corrosion and dirt.

Adhesive paper tape: The paper tape glued to the glass to allow the movement action is in fair condition, with small losses of the tape in the edge of the glass.

Previous interventions: Unknown.

CONDITION REPORT – HAND-PAINTED MAGIC LANTERN SLIDE UL000067

Department of Conservation and Restoration
Laboratory of Stained-Glass – VICARTE

FCT DCR Inventory number: FCT CV C07 2018
Entry date: 19/10/2018
Supervisor: Márcia Vilarigues
Report author: Beatriz Rodrigues

IDENTIFICATION

Institution/owner: National Museum of Natural History and Science of University of Lisbon
Address: Rua da Escola Politécnica 56/58, 1250-102 Lisbon, Portugal
Contacts: General – +351 213921800; geral@museus.ulisboa.pt
Collection responsible: catarina.mateus@museus.ulisboa.pt
Location of the objection in the institution: History of Science Technical Storage 2
Category: Magic lantern
Denomination: Glass slide
Institutional inventory number: MUL/MUHNAC UL000067
Weight: 116,42g
Photography:

Figure 25. Hand-painted single slipping glass slide MUL/MUHNAC UL000067 from MUHNAC-ULisboa (still image) photographed with normal and transmitted light simultaneously.

Figure 26. Hand-painted single slipping glass slide MUL/MUHNAC UL000067 from MUHNAC-ULisboa (movable image resulting from the operation of the slipping glass) photographed with normal and transmitted light simultaneously.

Dimensions:

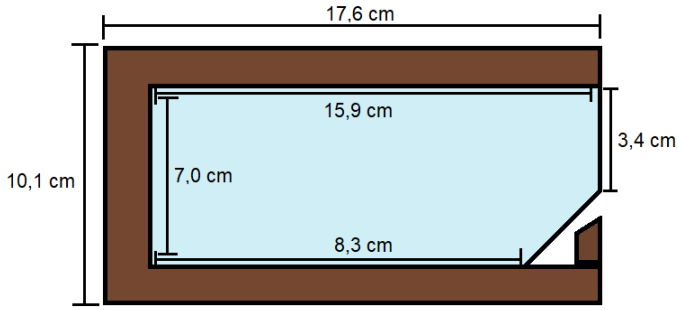


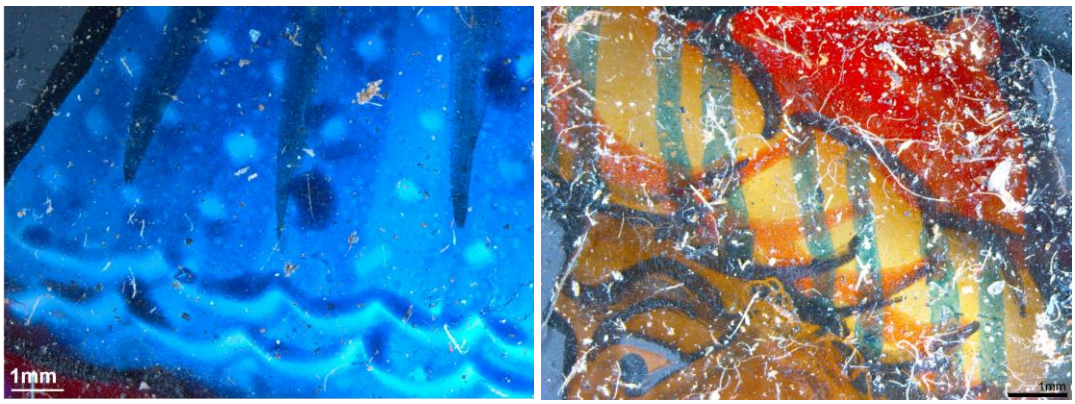
Figure 27. Scheme of the dimensions of the magic lantern slide (in centimetres).

Description: Hand-painted glass slide for magic lantern projection. Rectangular shaped slide with a glass mounted to the wood frame and another glass on top, the slipping glass. The right side is opened with the wood cut-out in a specific angle in order to allow for the movement of the slipping glass, in that direction. Two metal nails – one at the top and one at the bottom – are fixed to the wood frame and serve the propose of securing the slipping glass. The mounted glass has an opaque black background painted and the part of the subject that is motionless. In this case, these elements are the human figure and the statue that sits on what seems to be a stone column. The slipping glass, separated from the mounted glass by a paper tape painted black is the one to be pulled in and out to achieve the movement action, by grabbing the orange tape glued to this glass. The slipping glass is painted – on the side of

the glass facing the mounted glass – with the part of the drawing that intends to appear moving when handled; this corresponds to another set of arms that appear on the statue. The painted scene depicts a standing masculine figure in profile, with his arms crossed over his chest, slightly leaning front. The man has a brown skin colour and a serene facial expression. The hair is covered with a hat similar to a turban, red on the top and with an intricate yellow pattern with blue and red lines painted diagonally over the yellow. The man wears a long blue vestment with a white dotted pattern and a red belt around his waist, with a yellow end with small black stripes. Under the blue vestment, he wears red pants. His shoes and yellow and pointy, with a small heel. The man is facing the statue, painted a light grey tone, almost white, that has an inanimate yet calm expression. The arms of the statue are crossed over the chest and its legs are crossed as well. The statue sits over a yellow base, on top of a grey cylindric column with painted black veins to imitate stone. By moving the slipping glass, a different set of arms pointing upwards appears over the statue, as well as a pair of black eyes. At the same time, the masculine figure scarily bends down, his hands crossed over his throat and chest. In general, five colours are painted: blue, red, black, yellow and brown. Two paper labels are glued to the back of the wood frame ("M.C.U.L. inv. nº 67" and "2.500.-").
Authorship: Unknown.
Manufacturer: Unknown.
Production place: Possibly England.
Marks and inscriptions: None.
Date: Nineteenth century. By means of µ-EDXRF analysis, the glass was characterised and its oxides quantified and compared to English flat glass studies [10,11], indicating they were possibly produced between 1870 and 1930. Additionally, considering the standardised size of the slides and the similarity of the subjects represented with other nineteenth-century English slides, it was possible to narrow the period of production of this collection between 1870 and 1900.

TECHNICAL CHARACTERISATION

Component materials: Glass, paints, wood, metal, adhesive paper tape.
Decoration technique: Nineteenth-century historical written sources report that magic lantern slides were painted mainly with watercolours or oil colours. Through µ-FTIR analyses, the latter case seems to be present and it was also possible to identify the presence of a terpenoid resin such as shellac. This resin could have been used as a varnish and/or binding media; however, the presence of other binders cannot be excluded. Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours opposing to the opaque black background that surrounds the subjects, which could imply the presence of a varnish or a resin-like material. The white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area, adding detail. The intensity of the brushstroke is also variable according to the desired effect of lighter of darker details. It can be observed the use of creative techniques to achieve several effects, such as the drawing of different patterns (Figure 28A) and the juxtaposition of colours to create more intricate patterns and give detail to the subject (Figure 28B).



A) B)

Figure 28. Detail (stereomicroscope photography) of **A)** two different patterns in the blue vestment (dots and waves) and **B)** the juxtaposition of blue, red and yellow colours, creating a more intricate pattern.

Manufacture technique: The glass sheet was most probably done by the cylinder or the crown technique. The wood frame seems to be manufactured in parts and then glued together.

CONDITION

Conditions of the provenance location: The magic lantern slide was in MUHNAC's storage with the other four slides that belong to this set, horizontally, separated with Cell-aire®. The storage used is a movable compact metal rack, and the storage room is always locked (it has an alarm and restricted access) except for two days of the week when volunteers work on the inventory database system or when exceptionally the collections need to be accessed by the staff for monitoring, cleaning, moving or when external access is provided. During the cold seasons, a dehumidifier is daily turned on and the illumination of the room consists of LED lamps.

Conservation assessment: In general, it can be considered that this slide is in good condition since there are no damages that affect his integrity or interpretation. Since this is a composite object, the different materials should be considered to the conservation state of the slide and how they contribute to the (in)stability of the object.

Glass: The glass support is in good condition. It has substantial dirt at the surface, with a bigger deposit of dirt on the left corner of the glass (Figure 29).

Figure 29. Deposit of dirt on the slipping glass (yellow circle).

Paint: Even though the infrared analyses performed identified the presence of degradation products such as metal carboxylates, at the macroscopic level, no significant damages are noticeable in the painting layer. Small lacuna is visible in the black background, shown in Figure 30 and a flaked area in the red pants is also seen.

Figure 30. Detail showing the areas of lacuna in the black background of the slide (light green circles) and a flaked area in the red (dark green circle).

Wood: The wood frame is in good condition, without damages that endanger its stability. It shows small black stains similar to paint, mainly at the back, that could be caused during the painting of the glass. As referred above, there are two paper labels glued to the back of the wood frame (Figure 31).

Figure 31. Photography of the back of the wood frame, showing black stains and the glued paper labels.

Metallic parts: The metal nails show signs of corrosion and dirt.
Adhesive paper tape: The paper tape glued to the glass to allow the movement action is in good condition, showing a small tear at the front.

Previous interventions: Unknown.

CONDITION REPORT – HAND-PAINTED MAGIC LANTERN SLIDE UL000068

Department of Conservation and Restoration
Laboratory of Stained-Glass – VICARTE

FCT DCR Inventory number: FCT CV C08 2018
Entry date: 19/10/2018
Supervisor: Márcia Vilarigues
Report author: Beatriz Rodrigues

IDENTIFICATION

Institution/owner: National Museum of Natural History and Science of University of Lisbon
Address: Rua da Escola Politécnica 56/58, 1250-102 Lisbon, Portugal
Contacts: General – +351 213921800; geral@museus.ulisboa.pt
Collection responsible: catarina.mateus@museus.ulisboa.pt
Location of the objection in the institution: History of Science Technical Storage 2
Category: Magic lantern
Denomination: Glass slide
Institutional inventory number: MUL/MUHNAC UL000068
Weight: 129,80g
Photography:

Figure 32. Hand-painted single slipping glass slide MUL/MUHNAC UL000068 from MUHNAC-ULisboa (still image) photographed with normal and transmitted light simultaneously.

Figure 33. Hand-painted single slipping glass slide MUL/MUHNAC UL000068 from MUHNAC-ULisboa (movable image resulting from the operation of the slipping glass) photographed with normal and transmitted light simultaneously.

Dimensions:

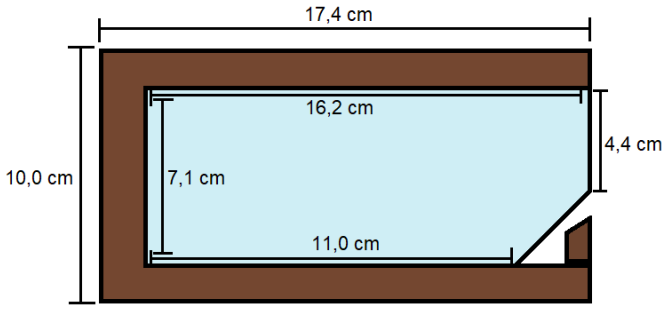


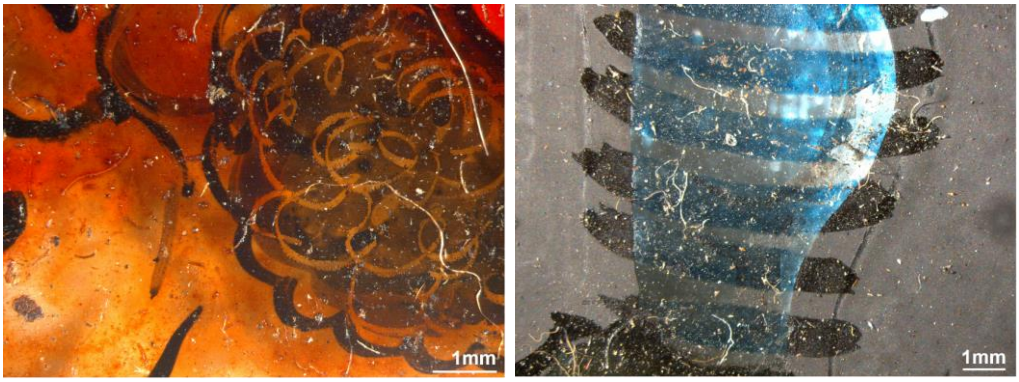
Figure 34. Scheme of the dimensions of the magic lantern slide (in centimetres).

Description: Hand-painted glass slide for magic lantern projection. Rectangular shaped slide with a glass mounted to the wood frame and another glass on top, the slipping glass. The right side is opened with the wood cut-out in a specific angle in order to allow for the movement of the slipping glass, in that direction. Two metal nails – one at the top and one at the bottom – are fixed to the wood frame and serve the propose of securing the slipping glass. The mounted glass has a black opaque background painted and the part of the subject that is motionless. In this case, these elements are the human figure holding a plate with a pig's head. The slipping glass, separated from the mounted glass by a paper tape painted black is the one to be pulled in and out to achieve the movement action, by grabbing the orange tape glued to this glass. The slipping glass is painted – on the side of the glass facing the mounted glass – with the part of the drawing that intends to appear moving when handled; this corresponds to a different set of heads, another pig head and another human head. The painted scene depicts a large masculine figure in profile. The man has a light skin colour with freckles in his face and rosier spots on his cheeks and nose, smiling. The hair is brown and curly, partly covered by a red hat and he wears a yellow shirt. In his hands, he holds a white and blue striped plate that has a pig's head. The pig is light brown and has a slightly horrified yet inanimate expression. The man wears red pants and on top of them, there is an apron with a vertical pattern of white and blue stripes, with a black knot at the waist. Over the pants, he wears horizontal white and blue striped socks and black shoes with a small heel. By moving the slipping glass, the heads switch: the man's head lays over the plate and a different pig head appears. This time, the pig has a brighter expression and appears to be smiling, happy that the places have turned. In general, five colours are painted: blue, red, black, yellow and brown. Two paper labels are glued to the back of the wood frame ("M.C.U.L. inv. nº 66" and "2.500.-").
Authorship: Unknown.
Manufacturer: Unknown.
Production place: Possibly England.
Marks and inscriptions: None.
Date: Nineteenth century. By means of μ-EDXRF analysis, the glass was characterised and its oxides quantified and compared to English flat glass studies [10,11], indicating they were possibly produced between 1870 and 1930. Additionally, considering the standardised size of the slides and the similarity

of the subjects represented with other nineteenth-century English slides, it was possible to narrow the period of production of this collection between 1870 and 1900.

TECHNICAL CHARACTERISATION

Component materials: Glass, paints, wood, metal, adhesive paper tape.
Decoration technique: Nineteenth-century historical written sources report that magic lantern slides were painted mainly with watercolours or oil colours. Through µ-FTIR analyses, the latter case seems to be present and it was also possible to identify the presence of a terpenoid resin such as shellac. This resin could have been used as a varnish and/or binding media; however, the presence of other binders cannot be excluded. Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours opposing to the opaque black background that surrounds the subjects, which could imply the presence of a varnish or a resin-like material. The white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area, adding detail. The intensity of the brushstroke is also variable according to the desired effect of lighter of darker details. Equally interesting is another technique observed which is similar to stained glass, namely in grisaille – the technique of "opening lights" in which the black background seems to be scraped off to reveal another colour beneath (Figure 35A). This seems to demonstrate that the outline was made simultaneously with the black background and that creative techniques and materials were employed to achieve several effects, as well as the well-thought drawing of, for example, black lines before painting with other colours on top, to achieve different patterns and adding detail (Figure 35B).



A) B)

Figure 35. Detail (stereomicroscope photography) of **A)** the black background scraped off, to allow the passage of light in the areas where the brown colour was afterwards applied giving a more realistic effect to the hair and **B)** black lines drawn under the blue pattern of the sock, adding detail to the subject.

Manufacture technique: The glass sheet was most probably done by the cylinder or the crown technique. The wood frame seems to be manufactured in parts and then glued together with a resinous material (Figure 36A).

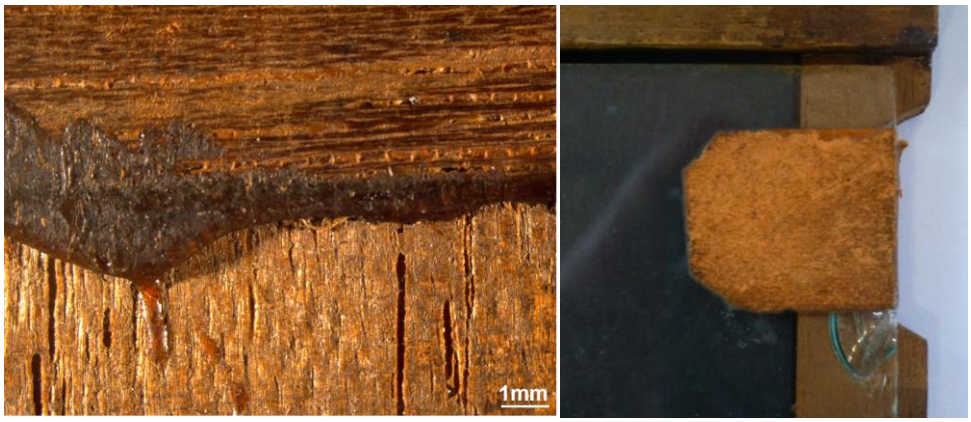


Figure 36. Detail **A)** (stereomicroscope photography) of dark resinous-like residues between two parts of the wood frame that seem to have been used to glue them together and **B)** the chipped glass, partially covered by the orange paper tape.

Conditions of the provenance location: The magic lantern slide was in MUHNAC's storage with the other four slides that belong to this set, horizontally, separated with Cell-aire®. The storage used is a movable compact metal rack and the storage room is always locked (it has an alarm and restricted access) except for two days of the week when volunteers work on the inventory database system or when exceptionally the collections need to be accessed by the staff for monitoring, cleaning, moving or when external access is provided. During the cold seasons, a dehumidifier is daily turned on and the illumination of the room consists of LED lamps.
Conservation assessment: In general, it can be considered that this slide is in fair condition since there are no damages that affect his integrity or interpretation but there are some pathologies that draw considerable attention and need to be monitored in the future. Since this is a composite object, the different materials should be considered to the conservation state of the slide and how they contribute to the (in)stability of the object.
Glass: The glass support is in fair condition. It shows substantial dirt at the surface and a chip with about 1 cm diameter on edge, next to the orange paper tape (Figure 36B).
Paint: Even though the infrared analyses performed identified the presence of degradation products such as metal carboxylates, at the macroscopic level, only a few damages are noticeable in the painting layer. Small lacuna is visible in the black background, and some detachment can also be seen in some colours (Figure 38).

Figure 37. Detail showing the areas of lacuna in the black background of the slide (green circles). The detachment of the pictorial layer is marked in pink circles.

Wood: The wood frame is in poor condition, with damages that might compromise its stability in the future so they must be monitored carefully. Visible dark stains, similar to paint smudges, are visible in the wood (front and back) as well as scratches and small fissures at the edges. A resinous-like material is especially accumulated in the joining areas of the wood frame and a lacuna is seen on the back of the wood frame. Besides having two paper labels glued to the back of the wood frame, what seems to be paper tape is glued to the front and back of the wood (Figure 39).

Figure 38. Photography of the back of the wood frame, showing black stains, the glued paper labels as well as a piece of paper tape (top left corner) and a lacuna (top right corner).

Metallic parts: The metal nails show signs of corrosion and dirt.
Adhesive paper tape: The paper tape glued to the glass to allow the movement action is in fair condition, with small losses of the tape especially in the edge of the glass.
Previous interventions: Unknown.

CONDITION REPORT – HAND-PAINTED MAGIC LANTERN SLIDE UL000069

Department of Conservation and Restoration
Laboratory of Stained-Glass – VICARTE

FCT DCR Inventory number: FCT CV C09 2018
Entry date: 19/10/2018
Supervisor: Márcia Vilarigues
Report author: Beatriz Rodrigues

IDENTIFICATION

Institution/owner: National Museum of Natural History and Science of University of Lisbon
Address: Rua da Escola Politécnica 56/58, 1250-102 Lisbon, Portugal
Contacts: General – +351 213921800; geral@museus.ulisboa.pt
Collection responsible: catarina.mateus@museus.ulisboa.pt
Location of the objection in the institution: History of Science Technical Storage 2
Category: Magic lantern
Denomination: Glass slide
Institutional inventory number: MUL/MUHNAC UL000069
Weight: 126,53g
Photography:

Figure 39. Hand-painted single slipping glass slide MUL/MUHNAC UL000069 from MUHNAC-ULisboa (still image) photographed with normal and transmitted light simultaneously.

Figure 40. Hand-painted single slipping glass slide MUL/MUHNAC UL000069 from MUHNAC-ULisboa (movable image resulting from the operation of the slipping glass) photographed with normal and transmitted light simultaneously.

Dimensions:

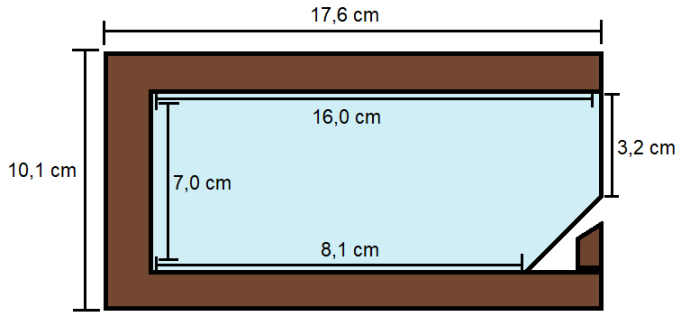


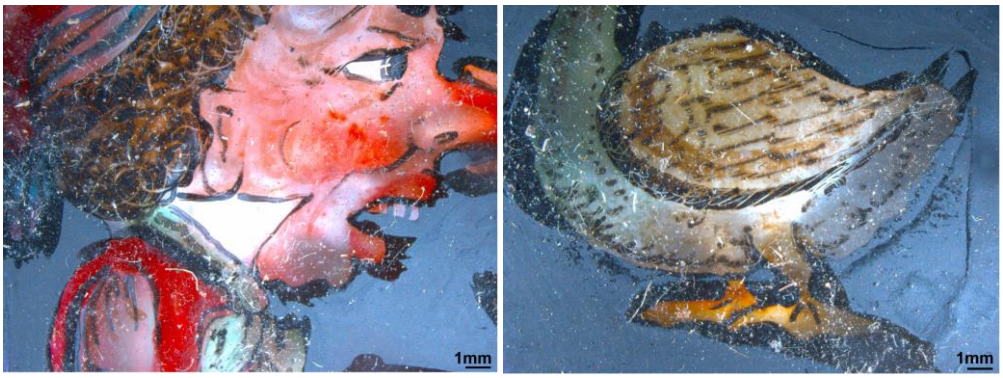
Figure 41. Scheme of the dimensions of the magic lantern slide (in centimetres).

Description: Hand-painted glass slide for magic lantern projection. Rectangular shaped slide with a glass mounted to the wood frame and another glass on top, the slipping glass. The right side is opened with the wood cut-out in a specific angle in order to allow for the movement of the slipping glass, in that direction. Two metal nails – one at the top and one at the bottom – are fixed to the wood frame and serve the propose of securing the slipping glass. The mounted glass has an opaque black background painted and the part of the subject that is motionless. In this case, these elements are the human figure body and the fence. The slipping glass, separated from the mounted glass by a paper tape painted black is the one to be pulled in and out to achieve the movement action, by grabbing the orange tape glued to this glass. The slipping glass is painted – on the side of the glass facing the mounted glass – with the part of the drawing that intends to appear moving when handled; this corresponds to the human figure holding a knife and a duck. The painted scene depicts a standing masculine figure in profile. The man has a light skin colour with freckles in his face and rosier spots on his cheeks and large, pointy nose, also wearing a somewhat shocked expression, with his mouth opened, the teeth showing. The hair is brown and curly, partly covered by a red hat with white and blue stripes. He wears a white collared shirt with a green handkerchief on his neck and a red button vest on top of the shirt. The pants are blue with a white and blue striped apron over them and his shoes are red with a small heel. In front of the man is a duck that looks scared, with its eyes wide open. The beak is light brown and the neck is green, progressively getting lighter, ending almost in white. The wings are brown with darker tones and the paws are orange. By moving the slipping glass, the scared duck disappears, and another appears, this time attacking the nose of the man. The duck has an angry expression and his wings are opened. In general, five colours are painted: blue, red, green, orange and brown. Two paper labels are glued to the wood frame, one at the front (“M.C.U.L. inv. nº 69”) and the other at the back (“2.500.-“).
Authorship: Unknown.
Manufacturer: Unknown.
Production place: Possibly England.
Marks and inscriptions: None.
Date: Nineteenth century. By means of µ-EDXRF analysis, the glass was characterised and its oxides quantified and compared to English flat glass studies [10,11], indicating they were possibly produced

between 1870 and 1930. Additionally, considering the standardised size of the slides and the similarity of the subjects represented with other nineteenth-century English slides, it was possible to narrow the period of production of this collection between 1870 and 1900.

TECHNICAL CHARACTERISATION

Component materials: Glass, paints, wood, metal, adhesive paper tape.
Decoration technique: Nineteenth-century historical written sources report that magic lantern slides were painted mainly with watercolours or oil colours. Through µ-FTIR analyses, the latter case seems to be present and it was also possible to identify the presence of a terpenoid resin such as shellac. This resin could have been used as a varnish and/or binding media; however, the presence of other binders cannot be excluded. Under the stereomicroscope, it is noticeable that the black outline was drawn first, and the colours were applied on top. A shiny resinous-like appearance is seen over the colours opposing to the opaque black background that surrounds the subjects, which could imply the presence of a varnish or a resin-like material. The white colour is achieved by the absence of paint, which allows the light to pass through entirely. Besides careful brushstrokes of the black outline, brushstrokes of a slightly darker hue of one colour are visible, giving the idea of a shadow or darker area, adding detail. The intensity of the brushstroke is also variable according to the desired effect of lighter of darker details. Equally interesting is another technique observed which is similar to stained glass, namely in grisaille – the technique of "opening lights" in which the black background seems to be scraped off to reveal another colour beneath (Figure 42A). This seems to demonstrate that the outline was made simultaneously with the black background and that creative techniques and materials were employed to achieve several effects, as well as the employment of different techniques to each colour, adding detail to the representation.



A) B)

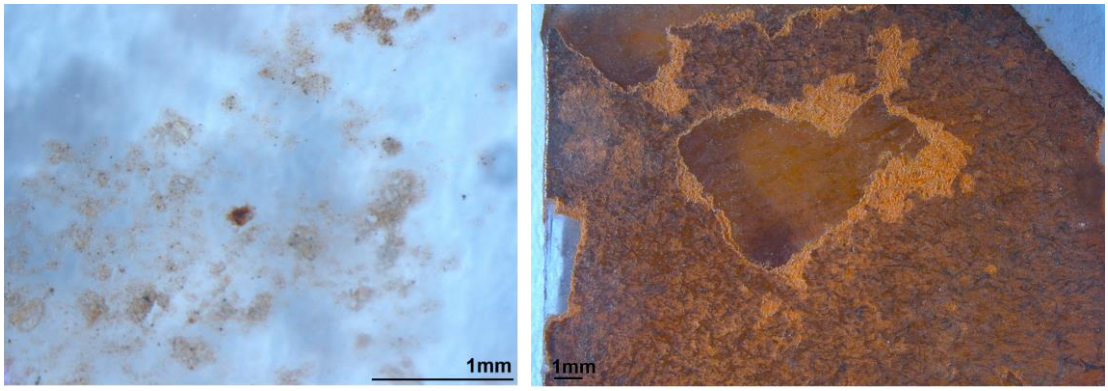
Figure 42. Detail (stereomicroscope photography) of **A)** the black background scraped off, to allow the passage of light in the areas where the brown colour was afterwards applied giving a more realistic effect to the hair and **B)** the variety of techniques employed in each colour (e.g. dots in the green neck, straight lines in the brown wings) to achieve different effects and adding detail to the duck.

Manufacture technique: The glass sheet was most probably done by the cylinder or the crown technique. The wood frame seems to be manufactured in parts and then glued together.

CONDITION

Conditions of the provenance location: The magic lantern slide was in MUHNAC's storage with the other four slides that belong to this set, horizontally, separated with Cell-aire®. The storage used is a movable compact metal rack and the storage room is always locked (it has an alarm and restricted access) except for two days of the week when volunteers work on the inventory database system or when exceptionally the collections need to be accessed by the staff for monitoring, cleaning, moving or when external access is provided. During the cold seasons, a dehumidifier is daily turned on and the illumination of the room consists of LED lamps.
Conservation assessment: In general, it can be considered that this slide is in good condition since there are no damages that affect his integrity or interpretation. Since this is a composite object, the different materials should be considered to the conservation state of the slide and how they contribute to the (in)stability of the object.
Glass: The glass support is in fair condition, showing a substantial amount of dirt at the surface. Besides dust and superficial particles, a particular type of dirt in agglomerates of a brownish colour can be

observed (Figure 43A). The origin of this agglomerates is unknown but can be related to specific conditions or deposits of materials during the projection of this slide.



A) B)

Figure 43. Detail (stereomicroscopy photography) of **A)** the agglomerate dirt at the glass support and **B)** the wearing and loss of the adhesive paper tape.

Paint: Even though the infrared analyses performed identified the presence of degradation products such as metal carboxylates, at the macroscopic level, no significant damages are noticeable in the painting layer. Small lacuna is visible in the black background, shown in figure 44.

Figure 44. Detail showing the areas of lacuna in the black background of the slide (light green circles).

Wood: The wood frame is in good condition, without damages that endanger its stability. It shows scratches and small black stains similar to paint, mainly at the back, that could be caused during the painting of the glass. As referred above, there are two paper labels glued to the wood.
Metallic parts: The metal nails show signs of corrosion and dirt.
Adhesive paper tape: The paper tape glued to the glass to allow the movement action is in poor condition. A big part of it was lost on the front side of the glass slide and at the edge of the glass, also with lacunas at the back (Figure 43B).

Previous interventions: Unknown.

7.2. Appendix II – Equipment and data acquisition

Stereomicroscope
The optical analyses were carried out in a Leica MZ 16 stereomicroscope with a zoom range of 7.1x to 115x, integrated with a Leica digital camera ICD and with fibre optic light system Leica KL 1500 LCD.

Energy Dispersive X-Ray Fluorescence (EDXRF)
The analyses were carried out using a Bruker ARTAX 800 equipped with an air-cooled low-power X-ray tube with a Mo target and Xflash® Peltier cooled silicon drift detector. The spectrometer was operated at 40 kV, 0.6 mA and 360 s acquisition time, in a He atmosphere. At least three different measurements were made in each glass (mounted and slipping glass). The single slipping slides were dismounted by temporarily removing the metal nails that keep the slipping glass in place, to allow the in-situ analysis on both sides of the mounted and slipping glass. No detectable differences between the two sides of all glasses were found, making it possible to assume that none of the glasses was produced with the float glass method and no relevant alkali leaching, associated with the corrosion process of the glass, has occurred.
Quantitative analyses were carried out with the WinAXIL program, making use of spectra obtained from A, B, C and D reference glass composition standards from Corning Museum of Glass (CMoG), Corning, NY, USA [65]. The analytical capability of the equipment is limited to elements with atomic number Z ≥ 13, thus making detection of sodium and magnesium impossible. The concentration of these elements was calculated by the 'matrix by difference', that does not allow the separation of both elements from other light elements that may also exist in the glass. This method is less rigorous because it is not possible to separate both elements from other light elements that may also exist in the glass composition. The error associated with the analysis was calculated for SiO, K_2O, CaO, Fe_2O_3, SrO and SnO_2 is below 5%. Calculated error for MnO, Al_2O_3, ZnO, CoO and CuO is below 10%. For the remaining oxides, the error is below 25%, which was verified by analysing standard glasses (CMoG B and D) under the same experimental conditions as for the samples and experimentally calculating the concentration values of the certified samples. P_2O_5 and other light elements standard deviations calculated by the same method were much higher, and therefore, this is considered to be a semi-quantitative method. The calculated relative accuracy is presented in table 6 below and was calculated according to the formula:

$$\text{Relative Accuracy} = \frac{\text{Glass standard composition} - \text{Measured composition}}{\text{Glass standard composition}} \times 100$$

Table 6. Relative accuracy in percentage (%) calculated considering the CMoG B and D glass standard composition and the measured composition (wt.%).

	Standard composition (wt.%) [65]		**Measured composition (wt.%)**		**Relative accuracy (%)**	
	CMoG B	CMoG D	CMoG B	CMoG D	CMoG B	CMoG D
Na_2O+MgO	18,03	5,14	18,40	47,40	2,05	822,18
Al_2O_3	4,36	5,30	4,60	1,00	5,50	81,13
SiO_2	62,27	55,46	62,00	40,00	0,43	27,88
K_2O	1,00	11,3	1,02	2,00	2,00	82,30
CaO	8,56	14,8	8,64	3,00	0,93	79,73
MnO	0,25	0,55	0,25	0,37	0,00	32,73
ZnO	0,19	0,10	0,20	0,02	5,26	80,00
Fe_2O_3	0,34	0,52	0,35	0,10	2,94	80,77
SrO	0,019	0,057	0,019	0,037	0,00	35,09
SnO_2	0,04	0,10	0,039	0,09	2,50	10,00
TiO_2	0,089	0,38	0,20	0,25	124,72	34,21
BaO	0,12	0,51	0,12	0,60	0,00	17,65
CoO	0,046	0,023	0,049	0,02	6,52	13,04
CuO	2,66	0,38	2,80	0,25	5,26	34,21
P_2O_5	0,82	3,93	0,644	0,13	21,46	96,69
Sb_2O_5	0,46	0,97	0,40	0,02	13,04	97,94

Ultraviolet-Visible Spectroscopy (UV-Vis)
UV-Vis spectra were acquired in absorbance mode using an AvaSpec–2048-SPU portable spectrophotometer with an AvaLight-HAL Tungsten/Halogen as a light source (Avantes). The AvaSoft software controlled the acquisition of the spectra in the 200-1100 nm range. Measurements were performed using a 20ms integration time and with 50 accumulations.

Raman Spectroscopy (Raman)
The analyses were carried out using a Labram 300 Jobin Yvon spectrometer, equipped with a He-Ne laser 17mW operating at 632.8nm. Spectra were recorded as an extended scan. The laser beam was focused with 50× and 100× Olympus objective lens. The laser power at the surface of the samples was attenuated with a density filter D1 (10% of the laser power). The spectra were acquired using 10s laser exposure time for 5 scans.

Fourier Transform Infrared Spectroscopy (μ-FTIR)
Infrared spectra were acquired with a Thermo-Nicolet Nexus spectrophotometer coupled to a Continuμm microscope (15× objective) with an MCT-A detector cooled by liquid nitrogen. Spectra were obtained in transmission mode, between 4000-650cm^{-1}, resolution of 8 cm^{-1} and 128 scans. Spectra are shown here as acquired, without corrections or any further manipulations, except for the occasional removal of the CO_2 absorption at ~2300– 2400 cm^{-1}. Micro-sampling was carried out using a micro-chisel from Ted Pella microtools under the Leica MZ16 stereomicroscope and were compressed using a Thermo diamond anvil compression cell.

7.3. Appendix III – Average composition of the magic lantern glasses analysed via µ-EDXRF with standard deviation, in weight per cent (wt.%) and parts per million (ppm) of oxides

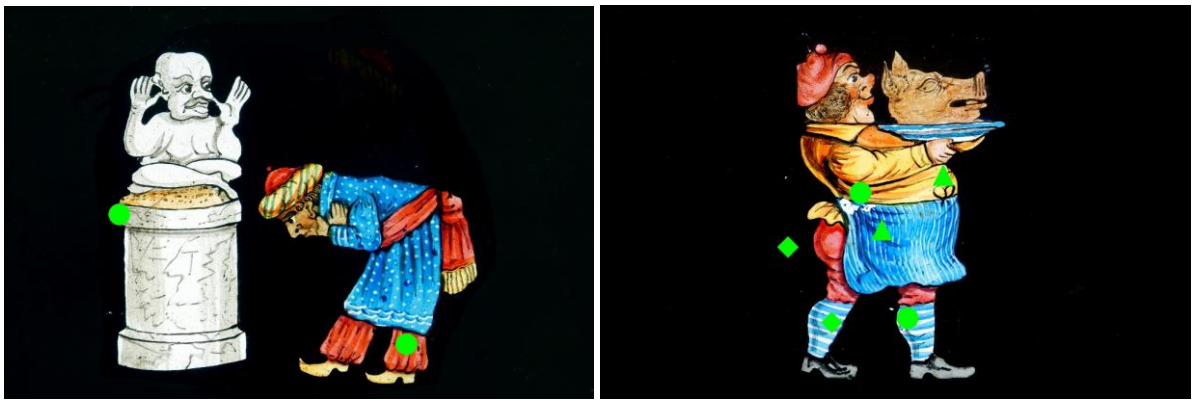
	Na_2O+MgO (wt.%)	Al_2O_3 (wt.%)	SiO_2 (wt.%)	SO_3 (wt.%)	K_2O (wt.%)	CaO (wt.%)	MnO (ppm)	ZnO (ppm)	Fe_2O_3 (wt.%)	As_2O_5 (ppm)	SrO (ppm)	SnO (ppm)	TiO_2 (ppm)
UL65.m.A	8,9±0,3	1,3±0,0	73,3±0,0	0,3±0,0	0,3±0,0	15,5±0,0	70±6	87±1	0,2±0,0	480±35	115±4	723±35	370±10
UL65.m.B	7,9±0,5	1,3±0,0	74,0±0,0	0,3±0,0	0,3±0,0	15,8±0,0	73±3	91±5	0,2±0,0	523±11	116±2	720±10	387±15
UL65.s.A	9,1±0,8	1,3±0,0	74,7±0,0	0,2±0,0	0,2±0,0	14,2±0,0	72±4	61±3	0,3±0,0	400±3	114±2	643±15	363±31
UL65.s.B	10,0±1,5	1,3±0,0	73,7±0,0	0,2±0,0	0,2±0,0	14,1±0,0	80±5	60±2	0,2±0,0	420±10	118±6	647±25	343±83
UL66.m.A	6,4±1,2	1,8±0,0	74,9±0,0	0,3±0,0	0,2±0,0	15,9±0,0	44±4	35±1	0,2±0,0	537±6	136±4	733±38	407±12
UL66.m.B	6,6±0,4	1,7±0,0	75,0±0,0	0,2±0,0	0,2±0,0	15,9±0,0	45±5	34±0	0,2±0,0	540±10	133±1	66±15	387±12
UL66.s.A	22,4±3,1	1,2±0,0	64,6±0,0	0,2±0,0	0,2±0,0	11,3±0,0	28±3	21±3	0,2±0,0	52±3	219±10	500±36	257±6
UL66.s.B	6,2±1,0	1,6±0,0	76,3±0,0	0,3±0,0	0,3±0,0	14,9±0,0	36±3	36±3	0,2±0,0	60±2	274±3	700±10	370±0
UL67.m.A	9,3±0,5	1,8±0,0	73,3±0,0	0,2±0,0	0,2±0,0	14,4±0,0	79±8	34±2	0,2±0,0	52±3	120±3	700±35	343±6
UL67.m.B	9,6±0,9	1,6±0,0	74,0±0,01	0,2±0,0	0,2±0,0	14,2±0,0	78±6	33±2	0,2±0,0	51±6	115±4	637±32	320±0
UL67.s.A	6,9±0,7	2,6±0,0	76,3±0,0	0,2±0,0	0,7±0,0	13,0±0,0	66±5	89±2	0,2±0,0	61±4	117±1	607±15	700±0
UL67.s.B	17,0±14,8	2,6±0,0	64,8±0,2	0,2±0,0	0,8±0,0	14,2±0,0	77±13	116±20	0,3±0,0	64±8	132±21	730±139	767±116
UL68.m.A	8,7±0,6	2,0±0,0	74,3±0,0	0,3±0,0	0,3±0,0	14,2±0,0	65±3	65±3	0,3±0,0	179±5	160±1	610±10	420±17
UL68.m.B	9,4±1,0	1,6±0,0	73,7±0,0	0,3±0,0	0,3±0,0	14,3±0,0	65±6	71±5	0,3±0,0	175±1	159±2	657±25	420±10
UL68.s.A	21,3±1,4	1,7±0,0	65,0±0,0	0,2±0,0	0,2±0,0	11,3±0,0	61±4	44±3	0,2±0,0	340±10	99±4	460±10	273±15
UL68.s.B	21,3±3,2	1,3±0,0	65,7±0,0	0,2±0,0	0,2±0,0	11,2±0,0	59±3	44±4	0,2±0,0	343±21	102±4	453±12	287±15
UL69.m.A	8,0±0,3	1,4±0,0	75,0±0,0	0,3±0,0	0,3±0,0	14,6±0,0	66±1	104±2	0,3±0,0	420±0	167±11	663±6	383±6
UL69.m.B	8,3±1,1	2,0±0,0	74,3±0,0	0,3±0,0	0,3±0,0	14,5±0,0	61±5	93±3	0,3±0,0	423±6	158±4	583±6	400±20
UL69.s.A	7,8±0,5	1,6±0,0	74,3±0,0	0,3±0,0	0,2±0,0	15,5±0,0	41±3	33±3	0,2±0,0	123±6	124±3	720±46	387±15
UL69.s.B	14,5±1,1	1,5±0,0	69,7±0,0	0,3±0,0	0,2±0,0	13,6±0,0	35±2	31±4	0,2±0,0	116±2	117±2	593±12	317±12

m. mounted glass; s. slipping glass; A. side of the glass that has painting; B. side of the glass that does not have painting

7.4. Appendix IV – Mapping of the analysed areas

A) B)

Figure 45. A) Mapping of the analysis performed to the slide MUL/MUHNAC UL000065. UV-Vis spectroscopy analyses (▲): red and green paints. **B)** Mapping of the analysis performed to the slide MUL/MUHNAC UL000066. µ-FTIR spectroscopy analysis (●): purple paint.



A) B)

Figure 46. A) Mapping of the analysis performed to the slide MUL/MUHNAC UL000067. µ-FTIR spectroscopy analyses (●): drop of varnish and red paint. **B)** Mapping of the analysis performed to the slide MUL/MUHNAC UL000066. UV-Vis spectroscopy analyses (▲): blue and yellow paints; and µ-Raman spectroscopy analysis (◆): blue paint.

Figure 47. Mapping of the analysis performed to the slide MUL/MUHNAC UL000069. µ-FTIR spectroscopy analyses (●): brown paint.

7.5. Appendix V – Supplementary spectra

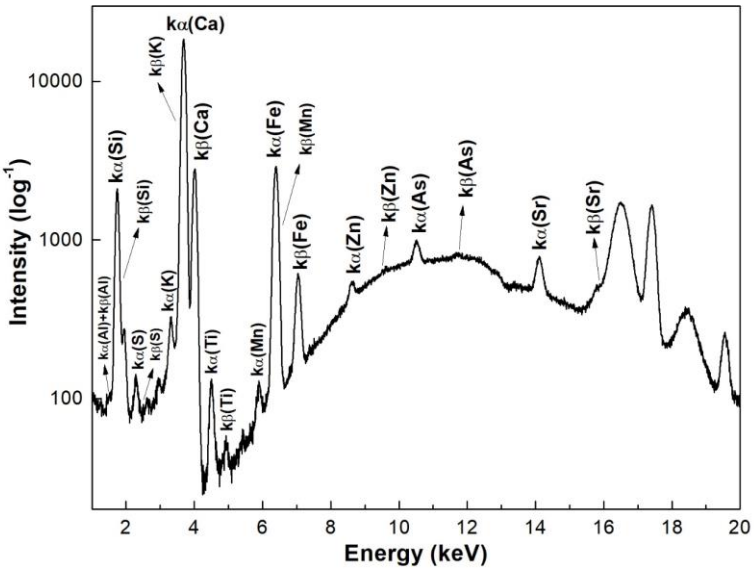


Figure 48. Representative EDXRF spectrum of the glass support of the magic lantern slides (average of three measurements).

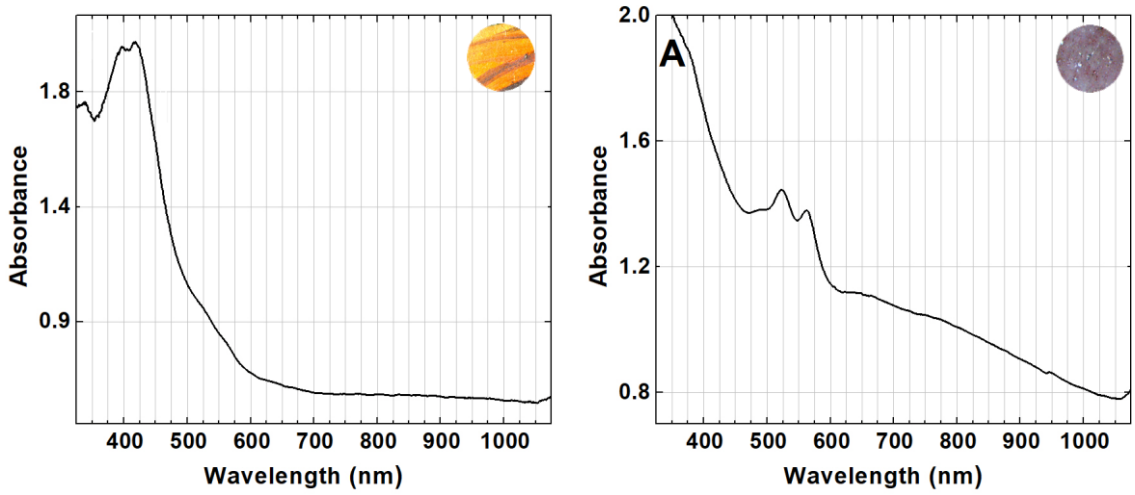


Figure 49. UV-Vis spectra of the **A)** yellow and **B)** purple colours.

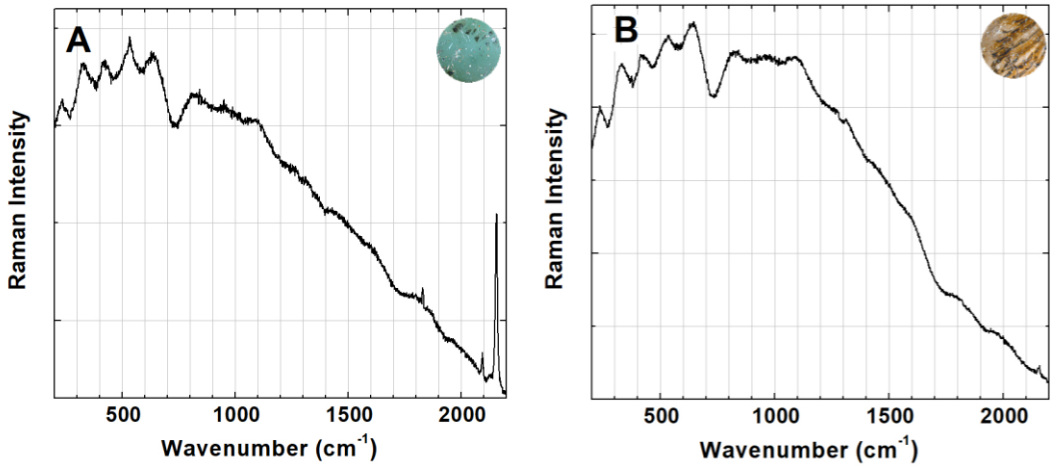


Figure 50. Raman spectra of the **A)** green and **B)** brown colours.

7.6. Appendix VI – Conservation Survey (with answers)

SURVEY – STATE OF THE ART IN THE CONSERVATION OF MAGIC LANTERN HAND-PAINTED GLASS SLIDES

Part I – Survey Context

In the context of the project *Lanterna Magica* – Technology and preservation of painted glass slides for projection with Magic Lanterns developed at the Department of Conservation and Restoration and Research Unit Vicarte – Glass and Ceramics for the Arts at NOVA Faculty of Science and Technology (FCT NOVA), hand-painted magic lantern glass slides from several collections are currently being studied by the PhD fellow Ângela Santos and MSc student Beatriz Rodrigues, under the supervision of Doctor Márcia Vilarigues.

This project will focus on the hand-painted glass slides from several Portuguese collections and aims to characterise the glass substrate and the painting materials applied on it to allow the creation of guidelines specifically for the conservation and exhibition of this type of collections.

Before proposing specific guidelines based on the materials characterisation and ageing properties, it is crucial to gather information about other collections of magic lantern glass slides around the world and better understand how these collections are being preserved in different contexts; this survey aims to fulfil this goal.

Confidentiality Disclaimer:

All the data gathered from this survey will be used strictly for the purposes of dissertation-related work. Only the participating institutions' names will be presented, and all the responses will be anonymised and presented statistically in published materials.

This survey should take you less than 15 minutes to answer.

Institutions to which the survey was sent:

1. National Museum of Natural History and Science (Portugal)
2. Museum of the Moving Image (Portugal)
3. National Archive of the Moving Image (Portugal)
4. Melgaço Museum of Cinema (Portugal)
5. Science Museum of the University of Coimbra (Portugal)
6. Museu del Cinema (Spain)
7. Museo del Precinema - Collezione Minici Zotti (Italy)
8. The National Cinema Museum (Italy)
9. Cinémathèque Française (France)
10. Museum of Contemporary Art Antwerp (Brussels)
11. Royal Albert Memorial Museum (United Kingdom)
12. Bill Douglas Cinema Museum (United Kingdom)
13. University College London (UCL Science Collections) (United Kingdom)
14. Science Museum (United Kingdom)
15. Victoria and Albert Museum (United Kingdom)
16. Victoria & Albert Childhood Museum (United Kingdom)
17. National Science and Media Museum (United Kingdom)
18. University of London – Theatre Collection (United Kingdom)
19. University of Glasgow – Special Collections (United Kingdom)
20. Archive University of Manchester Special Collections (United Kingdom)
21. University of Manchester – Manchester Museum (United Kingdom)
22. University of Sheffield (United Kingdom)
23. History of Science Museum (United Kingdom)
24. Ilfracombe Museum (United Kingdom)
25. Edinburgh Museum of Childhood (United Kingdom)
26. Hecht Collection: Screen Archive South East (University of Brighton) (United Kingdom)

27. Kent Museum of the Moving Image (United Kingdom)
28. March & District Museum (United Kingdom)
29. The Hive (United Kingdom)
30. Nationaal Museum van Wereldculturen (Netherlands)
31. EYE Filmmuseum (Netherlands)
32. Rijksmuseum Amsterdam (Netherlands)
33. Rijksmuseum Boerhaave (Netherlands)
34. Museum Sloten (Netherlands)
35. Speelgoedmuseum Deventer (Netherlands)
36. Museum IJsselstein (Netherlands)
37. Museum De Lakenhal (Netherlands)
38. Camera Obscura Museum zur Vorgeschichte des Films (Germany)
39. Museum Ludwig (Germany)
40. Hammer Museum (United States of America)
41. Museum of the Moving Image (United States of America)
42. The Morgan Library & Museum (United States of America)
43. George Eastman Museum (United States of America)
44. Magic Lantern Castle Museum (United States of America)
45. The Bradford Washburn American Mountaineering Museum (United States of America)
46. Smithsonian National Air and Space Museum (United States of America)
47. Charleston Museum (United States of America)
48. Corning Museum of Glass (United States of America)
49. Digitized Okanagan History (Canada)
50. Historic O'Keefe Ranch (Canada)
51. Rouse Hill House & Farm (Sydney Living Museums) (Australia)
52. National Film and Sound Archive of Australia (NFSA) (Australia)
53. Museum of New Zealand Te Papa Tongarewa (New Zealand)

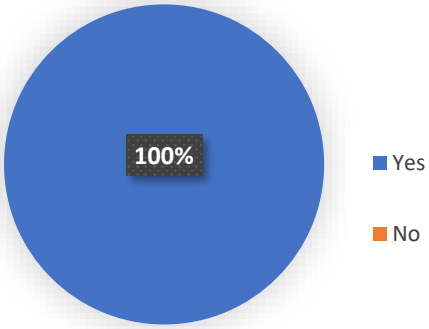
Institutions that answered the survey:

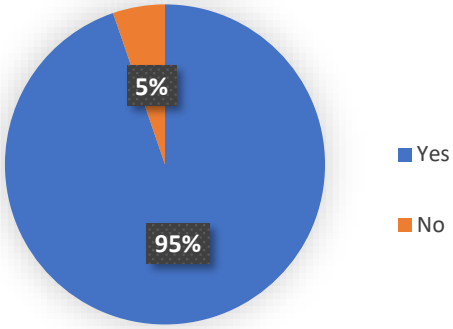
1. National Museum of Natural History and Science (Portugal)
2. Museum of the Moving Image (Portugal)
3. Museo del Precinema - Collezione Minici Zotti (Italy)
4. The National Cinema Museum (Italy)
5. Cinémathèque Française (France)
6. University of Sheffield (United Kingdom)
7. Screen archive South East, School of Media, University of Brighton (United Kingdom)
8. University College London (United Kingdom)
9. Royal Albert Memorial Museum and Art Gallery, Exeter (United Kingdom)
10. Manchester Museum (United Kingdom)
11. National Science and Media Museum (United Kingdom)
12. Museum Sloten (Netherlands)
13. Eye Filmmuseum (Netherlands)
14. Rijksmuseum Amsterdam (Netherlands)
15. Museum De Lakenhal (Netherlands)
16. Speelgoedmuseum Deventer / Deventer Verhaal (Netherlands)
17. Camera Obscura Museum zur Vorgeschichte des Films (Germany)
18. O'Keefe Ranch (Canada)
19. NFSA (Australia)

Part 2 – Survey Questions

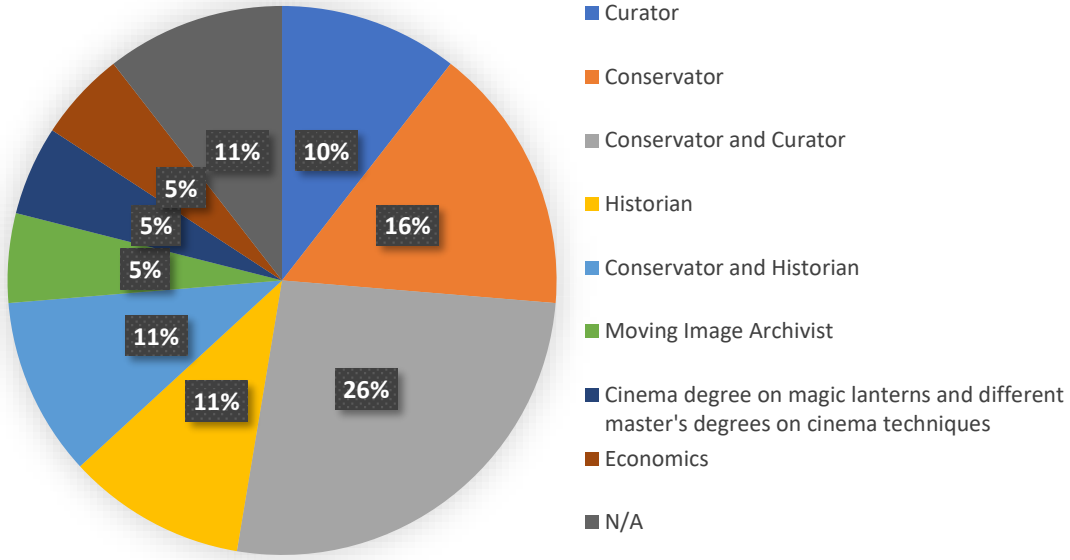
About your institution

1. Does your institution currently have magic lantern glass slides?
2. Does your institution currently have someone responsible for the magic lantern glass slides?



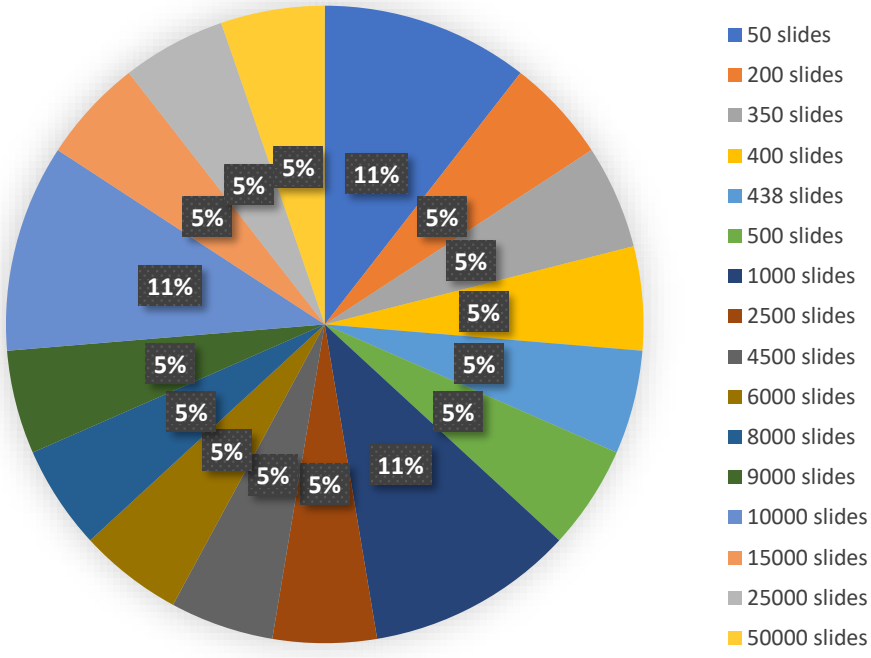


2.1. If the answer to the previous question is yes, please indicate his/her academic training (e.g. conservator, curator, historian, art historian, etc.).



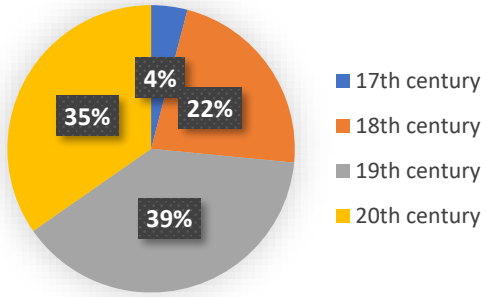
Collection characterisation

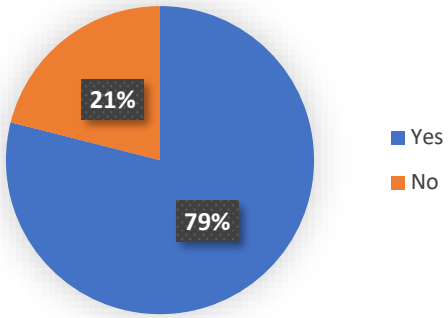
1. What is the estimated number of magic lantern glass slides present in your collection?



2. From which centuries is your collection? (you can select more than one option)

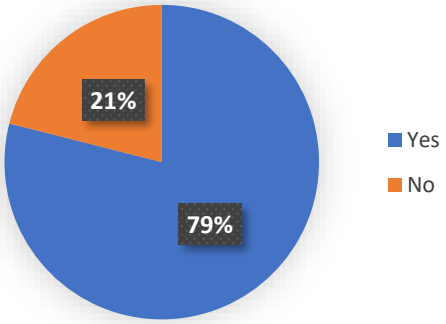
3. Do you have magic lantern glass slides exclusively hand-painted in your collection?

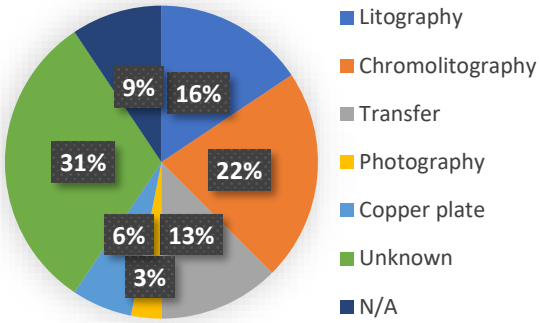




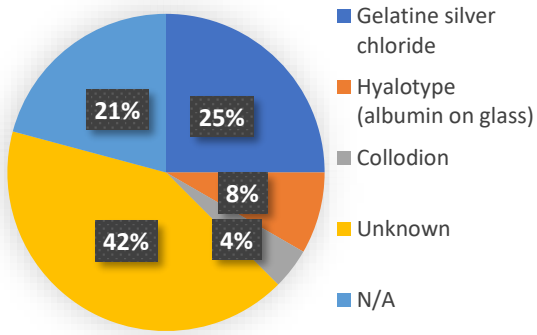
4. Do you have magic lantern glass slides with some type of printing or photographic technique complemented with hand colouring in your collection?

4.1. If the answer to the previous question is yes, please specify the printing techniques (you can select more than one option).

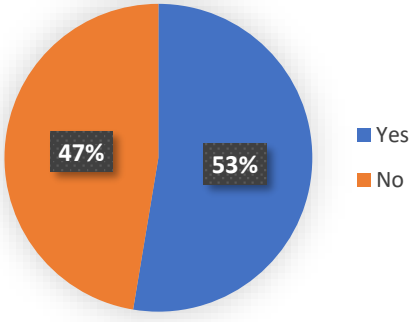




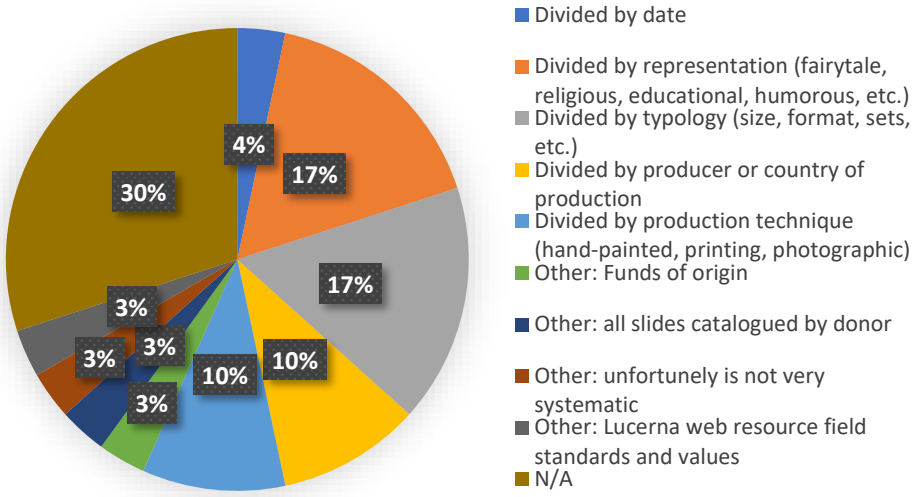
4.2. If the answer to question 4 is yes, please specify the photographic techniques (you can select more than one option).



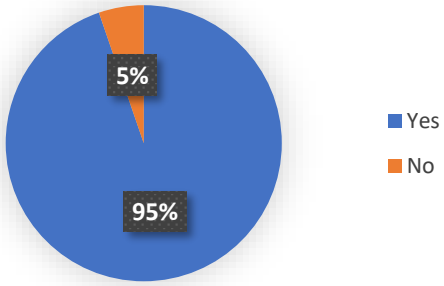
5. Is there any kind of division regarding, for example, typology or specific characteristics of the magic lantern slides?



5.1. If the answer to the previous question is yes, please specify how so.



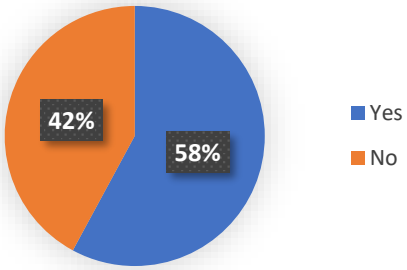
6. Is there any inventory and documentation of these collections within your institution?

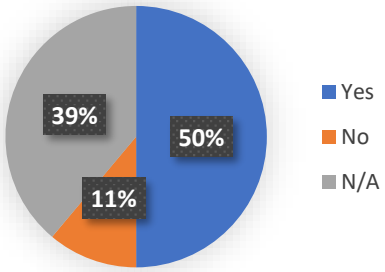


Conditions of exhibition

1. Are there any magic lantern slides currently in exhibition in your institution?

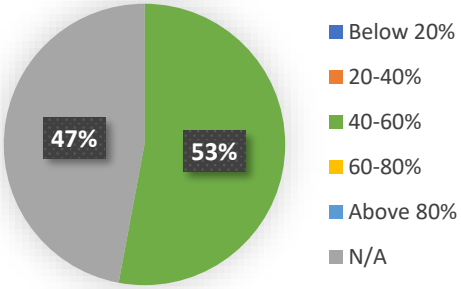
1.1. Is there any control of the environmental conditions in the exhibition room?

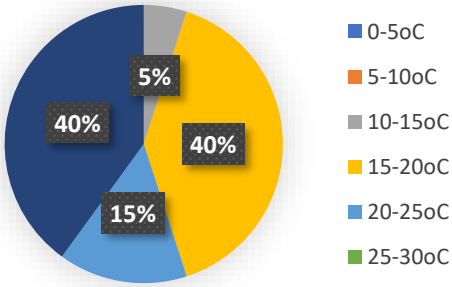




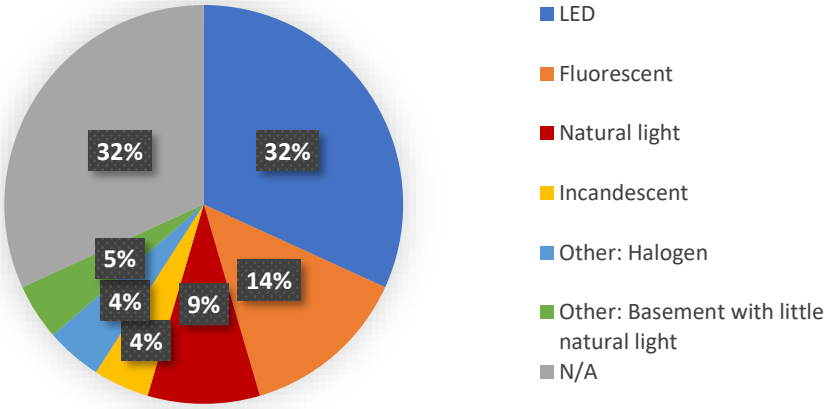
1.1.1. If the answer is yes, please indicate the case that best describes the relative humidity (percentage) conditions in the exhibition room.

1.1.2. Please indicate the case that best describes the temperature (degrees Celsius) conditions in the exhibition room.



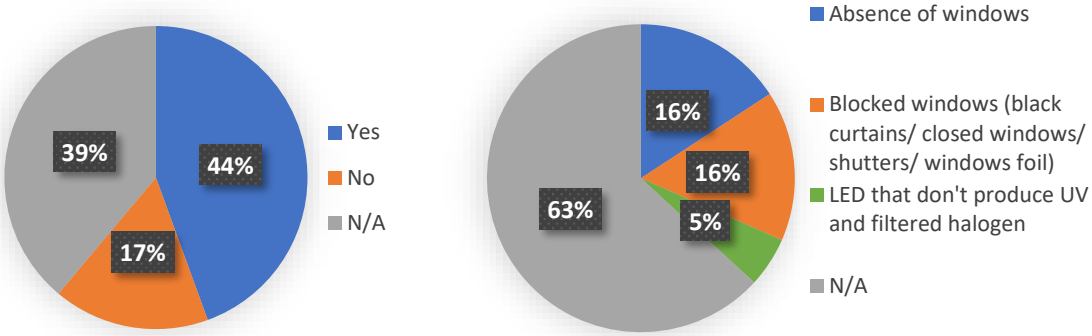


1.2. What is the type of light used to exhibit the magic lantern slides?

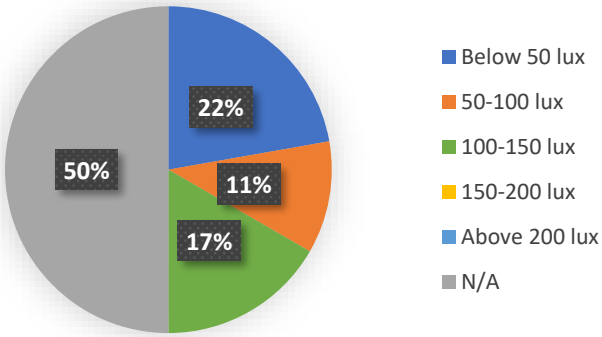


1.2.1. Is the exhibition room protected against UV radiation? (For example, absence of windows or windows with black curtains/ UV filters)

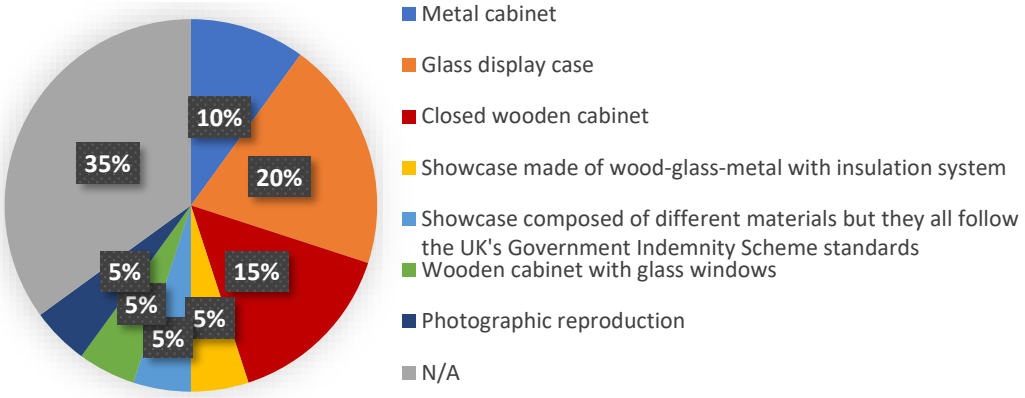
1.2.1.1. If the answer is yes, what type of UV protection is present in the exhibition room?



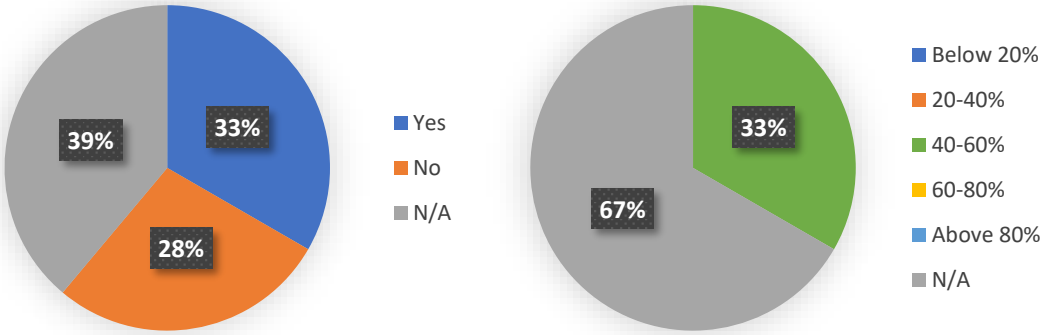
1.2.2. Please indicate the case that best describes the lighting intensity (Lux) in the exhibition room.



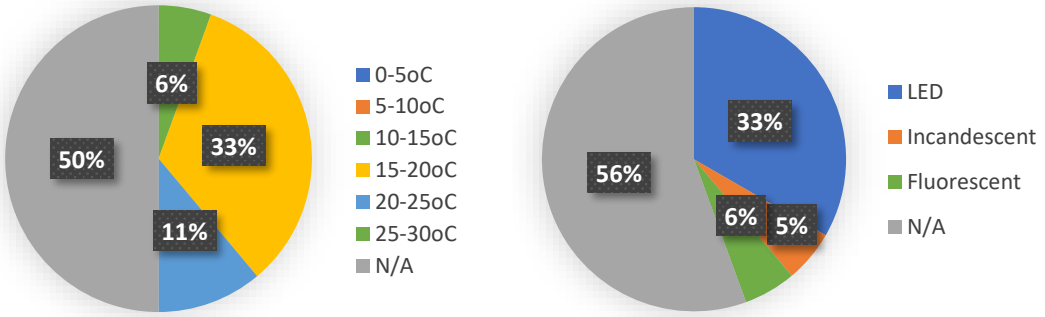
1.3. Regarding the equipment used for the magic lantern glass slides exhibition, which information could you provide about it? (For example, is it a closed wood cabinet, a metal cabinet, a glass display case, etc.)



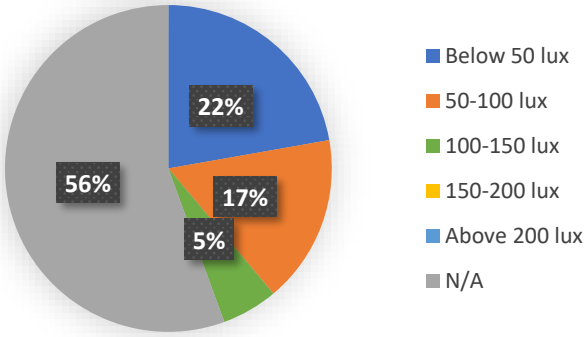
1.3.1. Are the environmental conditions inside the exhibition equipment controlled?
1.3.1.1. If the answer is yes, please indicate the case that best describes the relative humidity (percentage) conditions inside the exhibition equipment.



1.3.1.2. Please indicate the case that best describes the temperature (degrees Celsius) conditions inside the exhibition equipment.
1.3.2. If present, what is the type of light used inside the exhibition equipment?



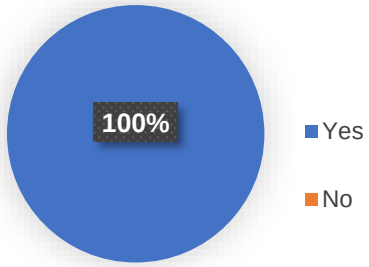
1.3.2.1. Please indicate the case that best describes the lighting intensity (Lux) inside the exhibition equipment.

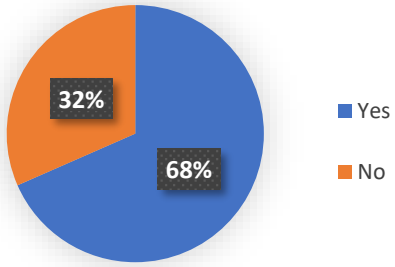


Conditions of storage

1. Are there any magic lantern slides currently in storage in your institution?

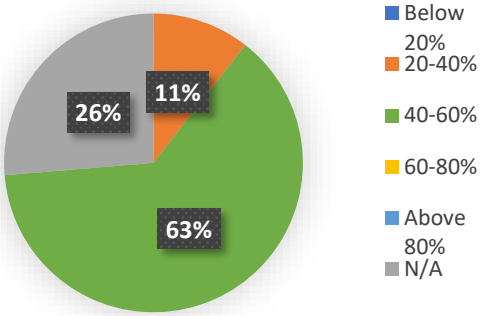
1.1. Is there any control of the environmental conditions in the storage room?

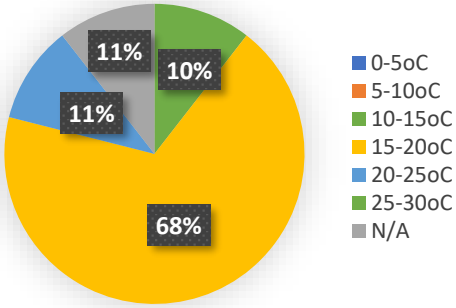




1.1.1. If the answer is yes, please indicate the case that best describes the relative humidity (percentage) conditions in the storage room.

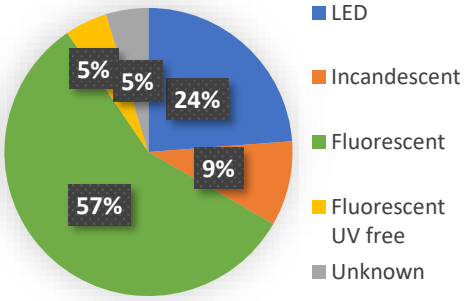
1.1.2. Please indicate the case that best describes the temperature (degrees Celsius) conditions in the storage room.

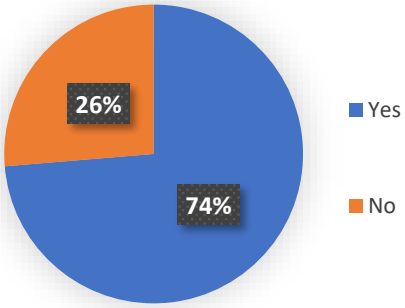




1.2. What is the type of light used in the storage room?

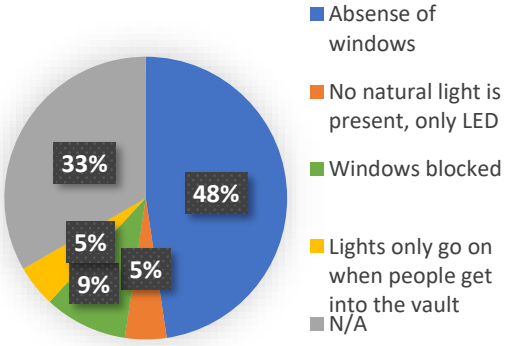
1.2.1. Is the storage room protected against UV radiation? (For example, absence of windows or windows with black curtains/ UV filters)

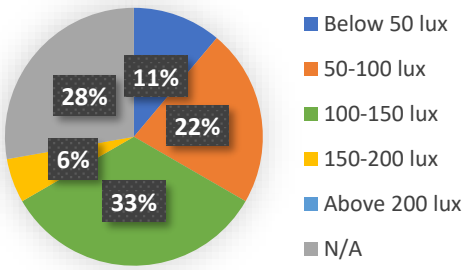




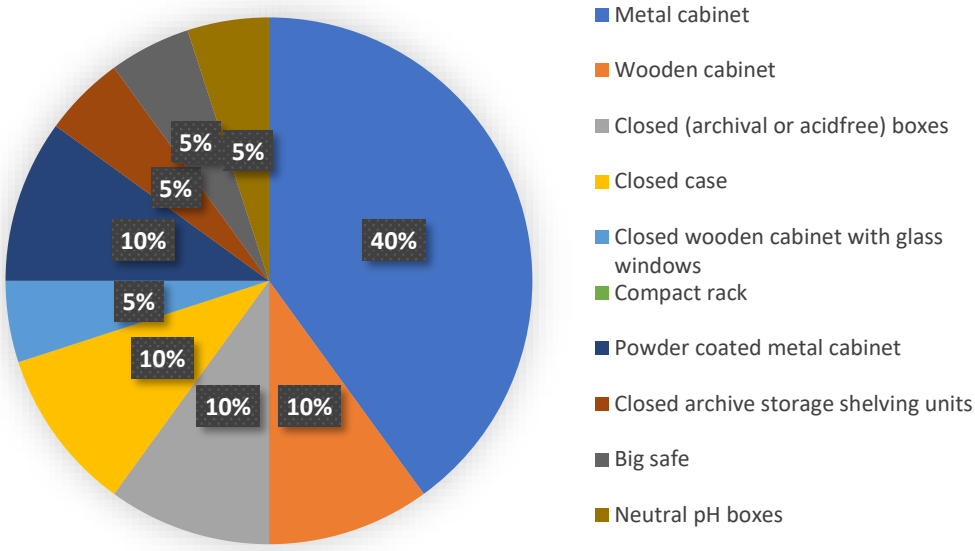
1.2.1.1. If the answer is yes, what type of UV protection is present in the storage room?

1.2.2. Please indicate the case that best describes the lighting intensity (Lux) in the exhibition room.

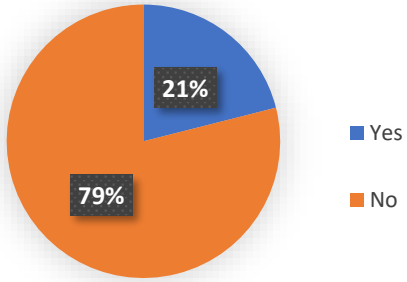




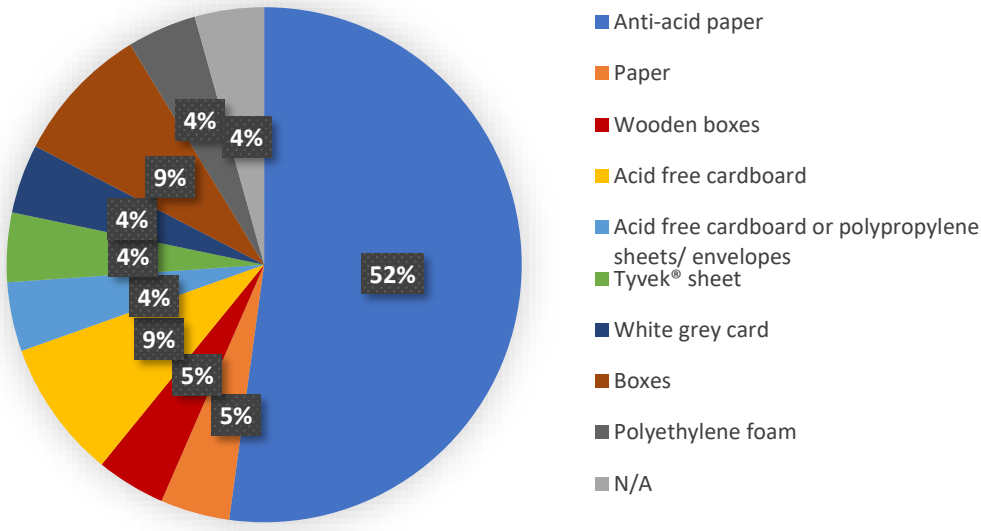
1.3. Regarding the furniture where the magic lantern slides are stored, what information could you provide about it (Are they opened or closed? For example, is it a closed wood cabinet, a metal cabinet, a glass display case, etc.)?



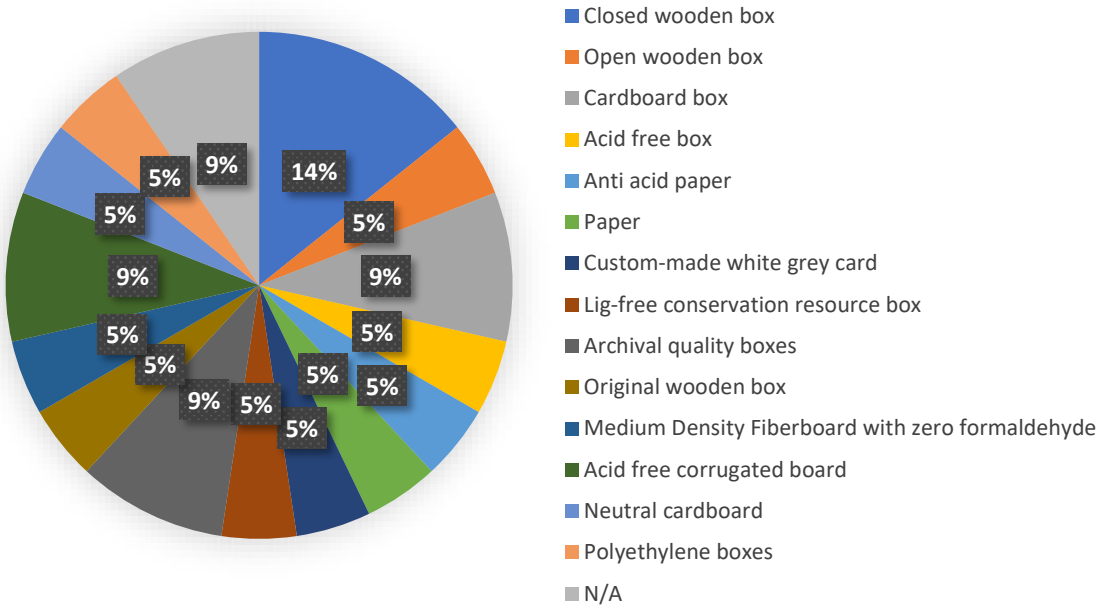
1.3.1. Are the magic lantern slides in direct contact with the surface of the storage furniture?



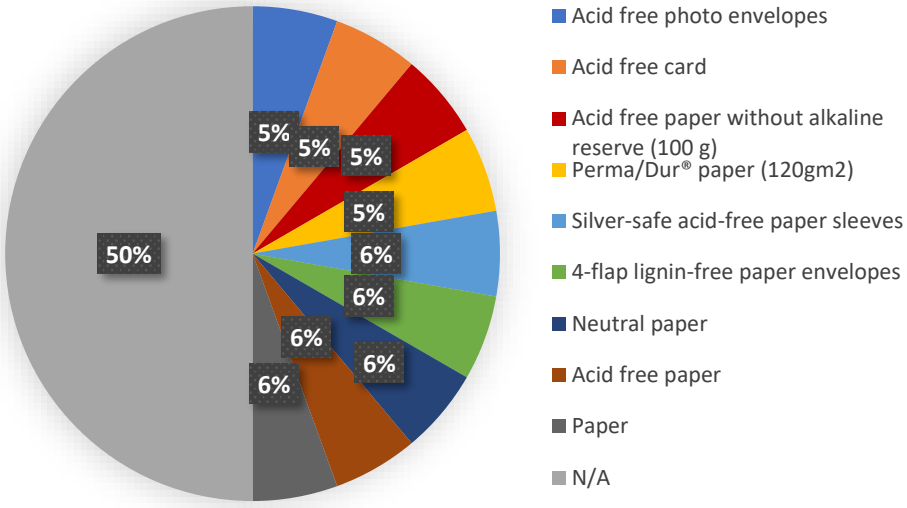
1.3.1.1. If not, which protecting materials are separating the magic lantern slide from direct contact with the furniture surface? (You can select more than one option)



1.3.2. In case the magic lantern glass slides are kept inside a box, can you please specify the material of the box?

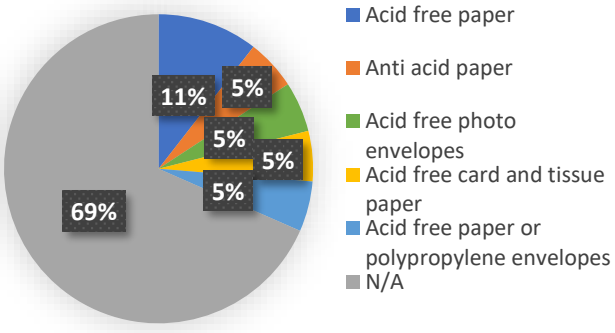


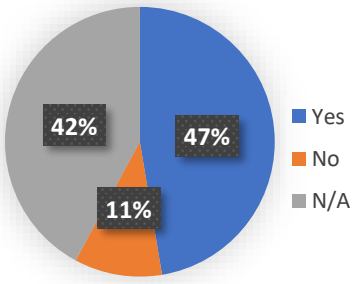
1.3.3. In case the magic lantern glass slides are kept inside an envelope, can you please specify the material of the envelope?



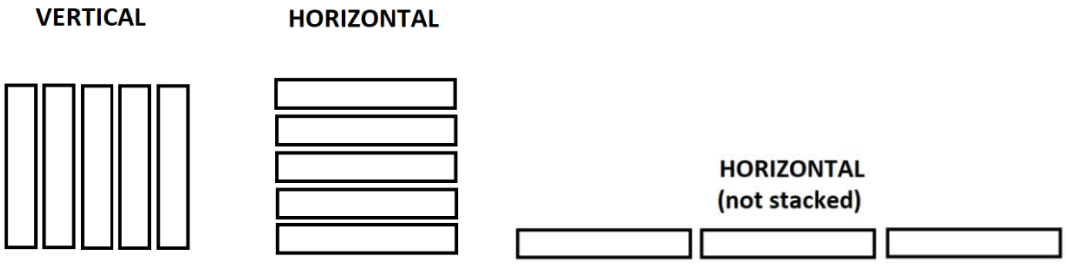
1.3.4. In case the magic lantern glass slides are wrapped, can you please specify in which material this is done?

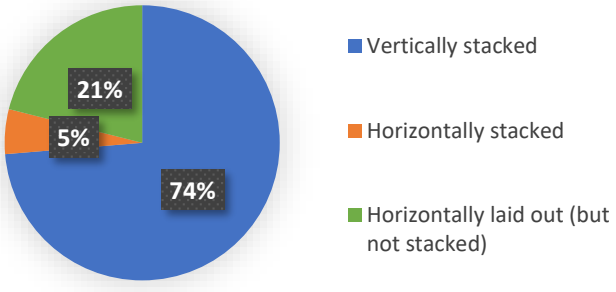
1.3.4.1. If the magic lantern glass slides are wrapped, are they individually wrapped?





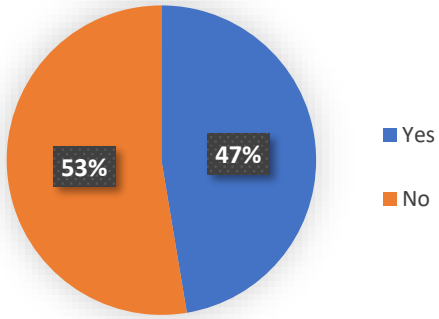
1.4. In the storage area, would you consider the glass slides are positioned like the illustration on the left (vertically stacked) or the right (horizontally stacked)?

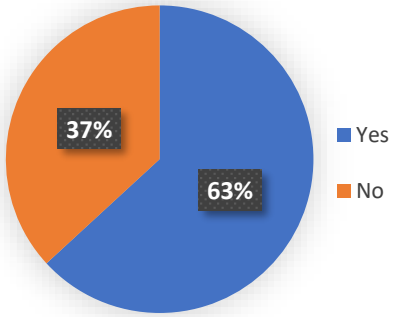




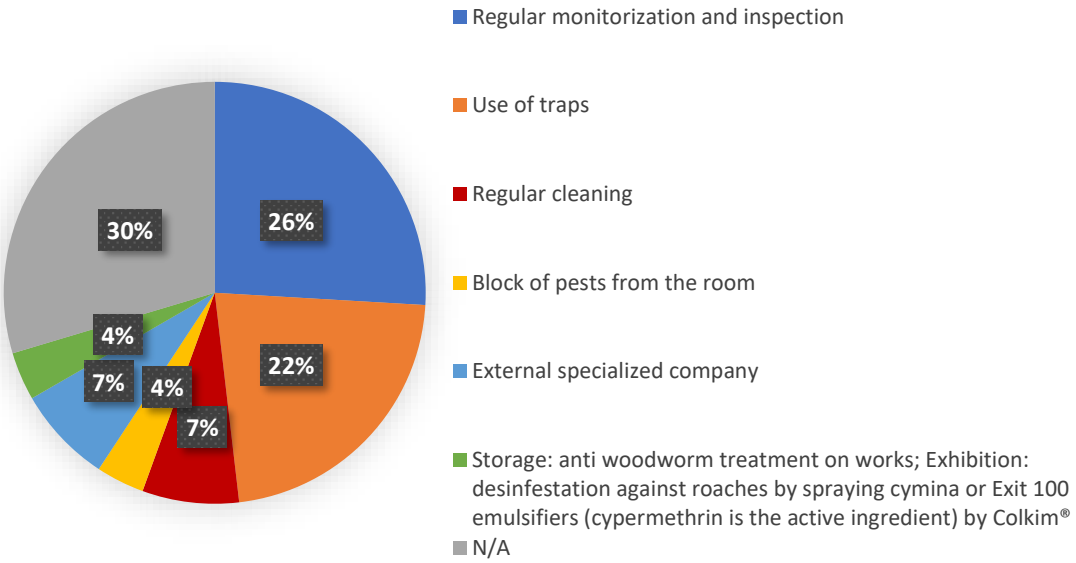
Conservation and Restoration General Information and Procedures

1. Is the magic lantern glass slides collection monitored regularly?
2. Regarding the spaces where your magic lantern slides are kept, whether in exhibition or storage, is there Integrated Pest Management (IPM)?

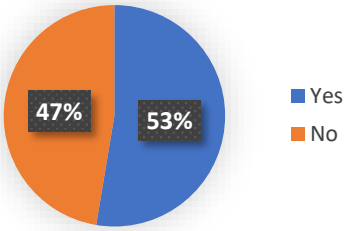


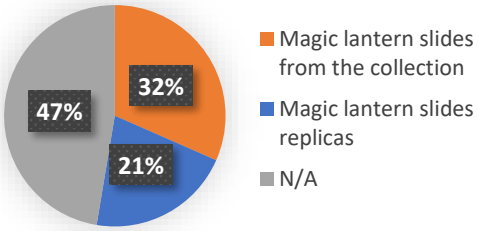


2.1. If the answer to the previous question is yes, can you please specify by which methods the IPM is done?

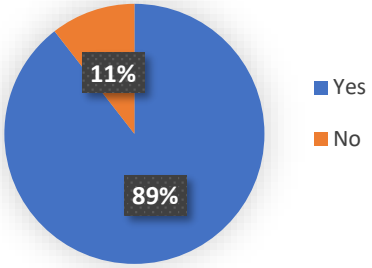


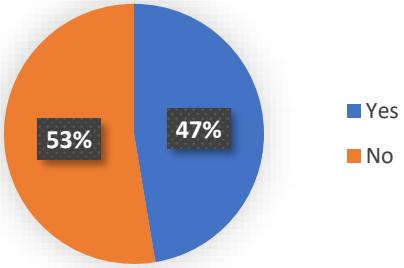
3. Concerning the main function of the glass slides, which were to be projected in the magic lantern apparatus, do magic lantern projection shows occur in your institution?
3.1. If the answer to the previous question is yes, are the glass slides present in the collection used for this purpose or do you have replicas to use in the show?



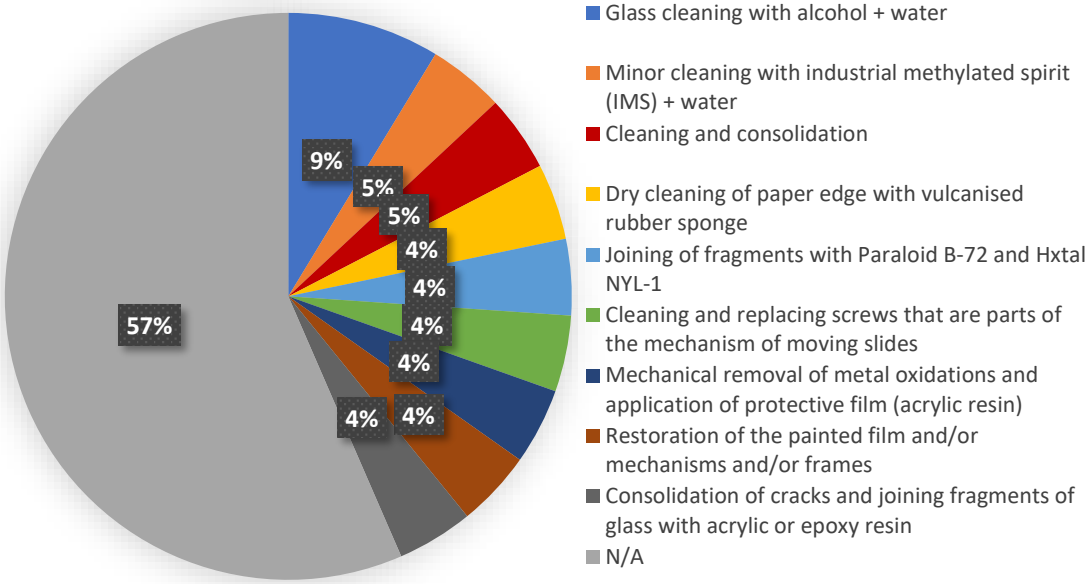


4. Regarding some safeguard conservation procedures for flat objects such as paper, photography or stained glass, were any of the magic lantern slides digitalized and kept in a virtual database?
5. In what concerns restoration procedures, is there any record of an intervention undertook in any of the glass slides?

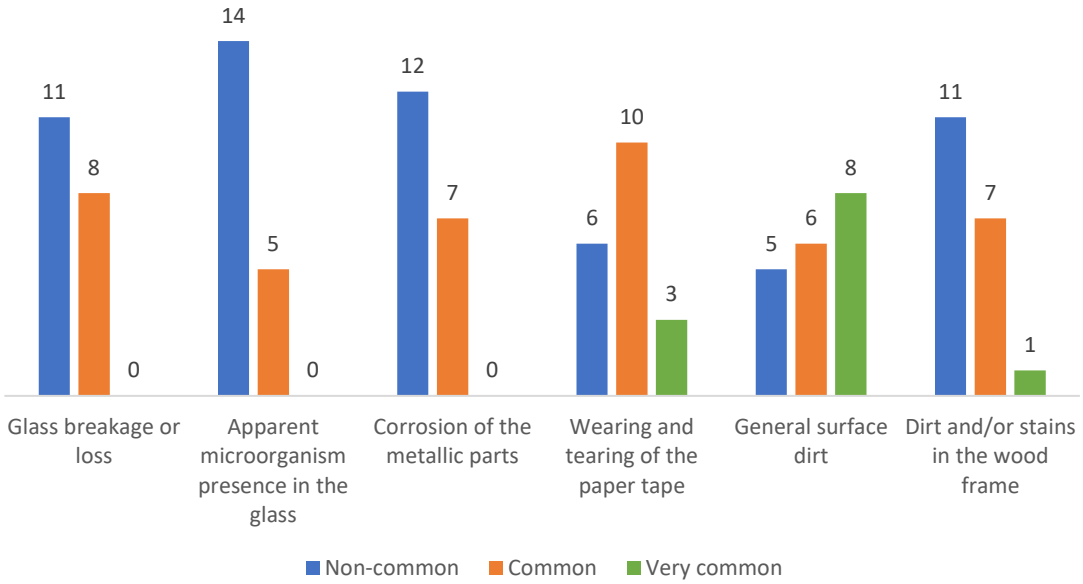


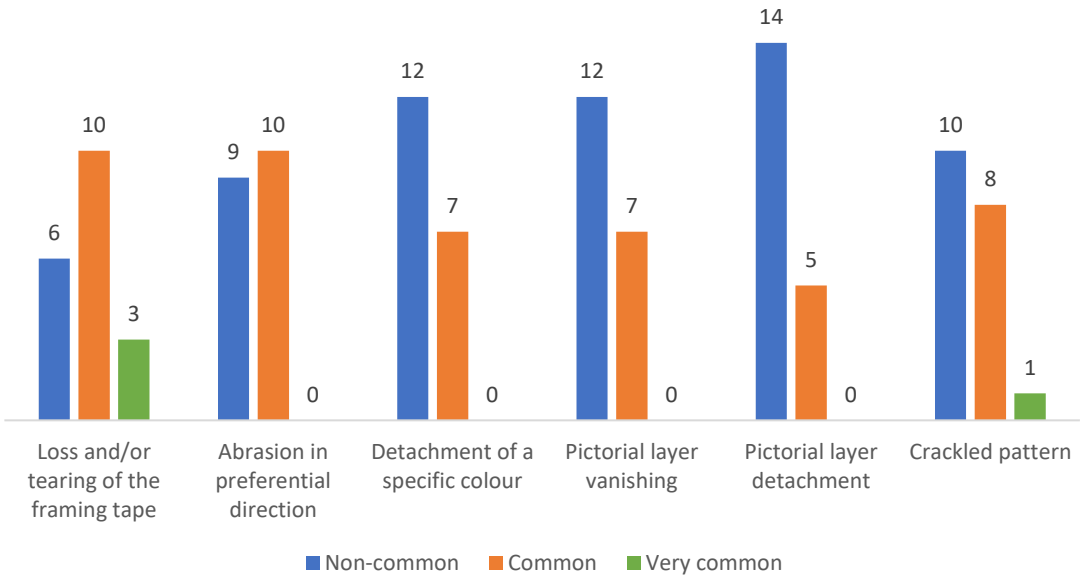


5.1. If the answer to the previous question is yes, can you please specify what type of procedure and which materials were used to restore the slide(s)?



6. Please choose the option that best reflects the degree of damage found in the magic lantern slides from your collection (if present). In the next image, there are example photos of the most common damages found in the magic lantern glass slides from the Museum of Natural History and Science from the University of Lisbon (MUHNAC-ULisboa) and Portuguese Cinematheque's National Archive of the Image in Movement (ANIM) collection.


11
8
0
14
5
0
12
7
0
6
10
3
5
6
8
11
7
1
Glass breakage or loss
Apparent microorganism presence in the glass
Corrosion of the metallic parts
Wearing and tearing of the paper tape
General surface dirt
Dirt and/or stains in the wood frame
Non-common
Common
Very common


6
10
3
9
10
0
12
7
0
12
7
0
14
5
0
10
8
1
Loss and/or tearing of the framing tape
Abrasion in preferential direction
Detachment of a specific colour
Pictorial layer vanishing
Pictorial layer detachment
Crackled pattern
Non-common
Common
Very common