Unveiling Roland Oliveira's photographic images: development of an unrolling and flattening treatment for silver gelatine 35 mm negative films

Revelando as imagens fotográficas de Roland Oliveira: desenvolvimento de um tratamento de desenrolamento e planificação para negativos 35 mm em gelatina e prata

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Abstract

The photographic collection by the sports photographer Roland Oliveira (1920-2007), belonging to Sport Lisboa e Benfica, is comprised of an estimate of 40000 images captured in 35 mm silver gelatine negative film, which are currently rolled and stiffened.

This study has strived to survey the current procedures undertaken by Portuguese institutions concerning the conservation of these type of materials, by conducting a questionnaire. It became evident that new treatments to allow the flattening of rolled films were needed. Therefore, a conservation treatment was developed to unroll and restore the original flatness of the negatives under study. The main purpose of the treatment was to enable proper handling, digitization and storage of this collection. The developed procedure was based on a de-shrinking process (chamber with vapours of glycerol, acetone and water) adapted from the conservation of motion-picture film literature, combined with flattening under weights. This paper discusses the adopted methodology which allowed to achieve positive results.

KEYWORDS
Unrolling
Flattening
De-shrinking
Cellulose acetate negatives
35 mm films
Physical deformation

Resumo

A coleção de fotografia do repórter Roland Oliveira (1920-2007), pertencente ao Sport Lisboa e Benfica, contem cerca de 40 000 negativos de gelatina e prata 35 mm, que se encontram enrolados e endurecidos.

O presente estudo procurou fazer um levantamento dos atuais procedimentos de conservação e restauro levados a cabo em instituições portuguesas detentoras deste tipo de materiais, através da realização de um questionário. Tornou-se assim evidente a necessidade de desenvolver tratamentos que permitam a planificação de películas enroladas. Como tal, desenvolveu-se um tratamento de desenrolamento e planificação, de forma a restaurar o estado inicial do conjunto de negativos em estudo e possibilitar o seu manuseamento, digitalização e acondicionamento adequado. Este baseou-se num processo de *de-shrinking* (câmara de vapores de glicerol, acetona e água), adaptado da bibliografia de conservação e restauro de películas cinematográficas, combinado com a planificação sob pesos. Este artigo discute a metodologia adotada, que permitiu alcançar resultados positivos.

PALAVRAS-CHAVE
Desenrolamento
Planificação
De-shrinking
Negativos em acetato de celulose
Películas 35 mm
Deformação física

Introduction

Roland Oliveira's collection

Roland Carlos Oliveira (1920-2007) was born in São Vicente Island (Cape Verde) and raised in Lisbon (Portugal). Ever since he was a child, he dreamed of becoming a photographer. At the beginning of his life, he used to photograph everyday life objects, people, and places, and soon started to compete for photography contests. In the early 1940s, during World War II, he worked as a deck boy aboard the *Anna N. Goulandris* ship, which allowed him to get in contact with other cultures and places by traveling around the world [1].

Still in the 1940s, António Sequeira, one of the Portuguese Football Federation directors, invited him to photograph sports events. Thenceforth, his presence became more and more usual in the stadiums, together with other well-known sports photographers, such as Amadeu Ferrarri and, later, his son Nuno Ferrarri [1]. Throughout his carrier, he collaborated with several national publications, such as *Stadium*, *Mundo Desportivo*, *O Século* and *Diário de Notícias*. As a member of Sport Lisboa e Benfica (SLB) he worked for the newspaper *O Benfica* and the magazine O Benfica Ilustrado, from the 1950s onwards. Thus, Roland Oliveira would become one of the most important Portuguese sports photographers of his time.

A few years after his death, Roland Oliveira's family donated his entire photographic collection to the Documentation and Information Center (CDI) from SLB. This collection comprises about 80000 images that represents the history of SLB, its different types of sports, several events, key moments and personalities, therefore representing one of the most important documental assets of the club (Figures 1).

From the 1950s to the 1970s, he mostly used medium formats (120 or 220 mm) for his production. The collection contains more than 11000 6 × 6 cm silver gelatine negatives with cellulose acetate (CA) base. Roland Oliveira started to use 35 mm format from the late 1960s, allowing him to capture more exposures per roll. This set is comprised of an estimate of 40000 silver gelatine negatives (100 ft. reels) and more than 18000 chromogenic negatives, both with CA base. Some chromogenic reversal films and prints can also be found in his collection.

The photographs were gathered at Roland Oliveira's house (Lisbon, Portugal), without any environmental control, before being integrated to the facilities at CDI. The collection is currently

Figure 1. Photographs by Roland Oliveira from SLB collection: *a*) *O Benfica Ilustrado*'s cover, nº 3, 1957; *b*) Álvaro Frade, SLB wrestling athlete, 1955, 6 × 6 cm silver gelatine negative with celulose acetate base; *c*) Eusébio da Silva Ferreira and José Augusto Torres, SLB football players, undated, silver gelatine print.

stored under controlled conditions: 18 °C and 55 % of relative humidity (RH). However, these conditions are insufficient to preserve CA based materials, which require an environment with very low temperature and RH (cold storage) [2].

The collection started to be studied and treated in 2015. The 6 × 6 cm silver gelatine negatives presented signs of CA degradation, commonly known as 'vinegar syndrome', having been considered a priority set in terms of conservation. The base is prone to react with atmospheric water producing acetic acid as a by-product (hydrolytic reaction), with a typical vinegar odour [3]. Therefore, the negatives have been cleaned, described in a database, digitized, and conditioned inside aluminium bags to be placed in no-frost freezers and slow down the degradation reactions.

Nevertheless, the 35 mm silver gelatine films contain images from a time with little representation in CDI (1970s and 1980s), and its treatment is also pressing. The negatives have been maintained unprotected, tightly rolled together in groups, until the present day (Figures 2). The inadequate packaging and storage have caused permanent deformation. In addition, CA films tend to shrink, stiffen, and become more brittle as result of the degradation pathway of the plastic base [3]. Plasticizers added to CA during manufacture to enhance the qualities of the base, are prone to migrate into the surface of the film leading to its gradual size reduction and embrittlement. The loss of plasticizer increases in acidic conditions, such as those developed upon ageing [4]. Shrinkage may also happen over time, due to the evaporation of residual solvents, casting and release agents remaining from manufacture and processing of the film [5]. Unfortunately, changes in the chemical and physical condition of the films have a negative impact on the use of the images, limiting their handling and access. Therefore, a conservation treatment was pursed to unroll and restore the original flatness of these negatives.

Methods to flatten rolled 35 mm film

Although deformation is commonly reversed within the restoration process of photographic prints using humidification and/or flattening under weights [6-10], only two references to similar treatments conducted to photographic films could be found [11-12]. However, the literature focusing on the conservation of motion-picture films commonly refers to 'de-shrinking' or 're-dimensioning' treatments (the term 'de-shrinking' used by Paul Read and Mark-Paul Meyer [13] was adopted by the authors of this paper).

The description of these treatments was first published by Leonard A. Green, assistant director from the National Film Board of Canada [14]. De-shrinking was developed to enable extremely shrunken film to be printed and projected [15]. As film shrinks, the analogue printers and projectors using sprocket teeth that fit the perforations of the film are no longer able to run the reel throughout the mechanism [16]. During the treatment, both cellulose nitrate (CN) and CA are able to be softened and slowly expand to approach

Figure 2. Set of rolled 35 mm silver gelatine negative films (100 ft. reels).

their original dimension [15]. De-shrinking can be achieved by placing a reel in an enclosed atmosphere containing vapour of a mixture of solvents and/or water, during a certain amount of time. The process can be accelerated by increasing the temperature of the room or by decreasing the pressure of the chamber [13, 15, 17]. Different solutions have been used, such as: i) acetone, glycerol and water, ii) glycerol, camphor/methyl phthalate and acetone, and iii) water [13]. According to the literature, the first is the most efficient solution. The second can reduce the treatment time but might lead to deleterious effects on the film base [13]. The humidity chamber is the longest treatment and is especially useful to correct irregular shrinkage [15]. The treated film should be copied within a short timeframe because the de-shrinking effect is only temporary [5, 13, 17]. Although it has been widely and successfully used in the past, there are no studies focusing on the effects of the treatment on the long-term preservation of films [13, 15]. Currently, the most suitable procedure to deal with cinematographic films showing considerable shrinkage is to reprint the material using an optical printer specially equipped to run degraded film [13, 17]. Nevertheless, according to Diana Little, et al [18], despite the advances in film scanning technology, shrinkage and brittleness can contribute to reduce digitization quality.

Regarding other fields such as the conservation of modern and contemporary art, some tests have been made to correct deformation in CA based materials, namely with application of a combination of heat and pressure [19-20]. Although some have shown promising results, photographs are composite materials and the use of this type of solutions might put at risk the emulsion layer and, consequently, the photographic image.

The conservator Katrin Pietsch was able to successfully flatten CN and CA negatives from different photographic collections, using humidity chambers [12]. However, previous tests conducted to Roland Oliveira's photographic films using humidification did not succeed. In her Master thesis, Sandra Lopes applied a de-shrinking treatment to a photographic collection [11]. Based on her experiments, extremely degraded CA microfilms showing stiffness, brittleness and physical deformation were successfully unrolled using a solution of acetone, glycerol and water. Lopes also tested humidification and a vapour chamber with a mixture of water and acetone, but these treatments did not show any positive results [11].

Thus, based on the equivalency between photographic and motion-picture materials and inspired by the work started by Lopes, a de-shrinking process adapted from the literature was developed to unroll and restore the original flatness of Roland Oliveira's 35 mm silver gelatine negative films. This paper discusses the adopted methodology and its results. Considering the lack of studies focusing on the flattening of negative films, a questionnaire was made to Portuguese institutions to understand the current procedures concerning the conservation of these type of materials.

Materials and Methods

Questionnaire

A questionnaire was prepared using google forms, in order to understand how Portuguese institutions deal with 35 mm film collections showing deformation. The questionnaire was sent by email to about 120 national museums and archives. The aim of the study was to present a total of 31 questions, focusing on: i) institution and staff responsible for the film collections (5 questions), ii) characterization of the film collections (7 questions), iii) environmental conditions of the storage facilities (5 questions), iv) conservation treatments conducted to films (6 questions), v) storage and packaging of the films (5 questions), and vi) digitization (3 questions). The questionnaire was built based on checkbox type questions, simple or in tables (when several attributes were to be assessed at the same time). For each question, more than one option could be selected.

Unrolling and flattening methodology

A set of 35 mm silver gelatine negative film (Kodak safety film 5036, 100 ft.) from Roland Oliveira's collection was used to test a methodology to unroll and flatten the rolls. The negatives were in fair condition, mainly showing permanent deformation (rolled), slight stiffness, dirt, and microbiological contamination.

Before treatment, each roll was cut in strips of 6 frames with a scissor. Superficial dirt and debris were gently removed from the strips using air bulb and a soft hairbrush. The strips were then cleaned on both sides using ethanol 96 % applied with a cotton swab, to remove the present fungi.

Considering that humidity chambers previously tested at SLB and by other authors [11] that did not show any results, and glycerol, camphor/methyl phthalate and acetone might conduct to hazardous results, these treatments were not tested. Therefore, the de-shrinking solution used to unroll the negatives was a mixture of acetone, glycerol, and distilled water (1:1:3, v:v:v) [11, 13].

After cleaning, the strips from a same roll were gathered and identified with a number (written with a pencil in a piece of paper accompanying the different stages of the process). The rolls were arranged in a glass vat, which was placed inside a closed polypropylene (PP) box containing the solution, to create a vapour chamber (Figures 3). The solution fully covered the base of the box. The chamber was maintained at room temperature (ca. 18 °C) during the treatment. Different times of exposure to the vapour were tested, from one to 24 hours. After exposure, the strips were removed from the chamber and left inside an empty covered PP box for one hour, to allow the film to release excess of adsorbed solvents. The box was then uncovered for extra 30 minutes. Finally, the strips were placed between interleaving material (non-woven polyester, Bondina) and blotting paper, emulsion down, under weights (glass plate) (Figures 4). Several sandwiches with the materials were overlaid under the weight. The strips were left to flatten for at least two consecutive days.

Examination of the films

The strips were examined with a digital microscope (AD7013MZT Dino-Lite Premier 20 × - 200 ×) before the restoration process, after cleaning and after the unrolling and flattening treatment, to evaluate the impact of the tested treatments on the photographic image.

Results and Discussion

Questionnaire

50 institutions answered the questionnaire, all of them holding photographic (mainly) and/or cinematographic (residual) collections. These were mostly archives (49 %) and museums (25 %), but also private collections (9 %), libraries (5 %), documentation centres (5 %), foundations (3 %), among other cultural institutions (4 %). The professionals who responded included: archivists (31 %), conservators (24 %), collection managers (11 %), librarians (7 %), historians (7 %), museum specialists (7 %), researchers (4.5 %), photographers (4.5 %), among others (4 %). Thus, only a quarter of the forms were filled by qualified people from the conservation field. From the overall obtained answers, only the results concerning the treatment of 35 mm films are presented hereafter.

Regarding cleaning treatments applied to the films, most of the respondents have reported to carry out dry cleaning (applied with air bulb and/or brush) and chemical cleaning (with distilled water and/or ethanol). Chemical cleaning has been used to remove dirt and/or stop microbiological contamination (Figures 5). These cleaning solutions were tested in the collection under study, to remove superficial dirt and fungi present in the films before unrolling and flattening. After testing different proportions of ethanol in water, it was decided to use ethanol 96 %, applied with a cotton swab. Although the use of ethanol 70 % has proven to be more effective in the deactivation of microbiological contamination [21], this solution was found to promote colourless stains and/or changes in the morphology of the emulsion during the present study, due to the greater amount of water in the solution.

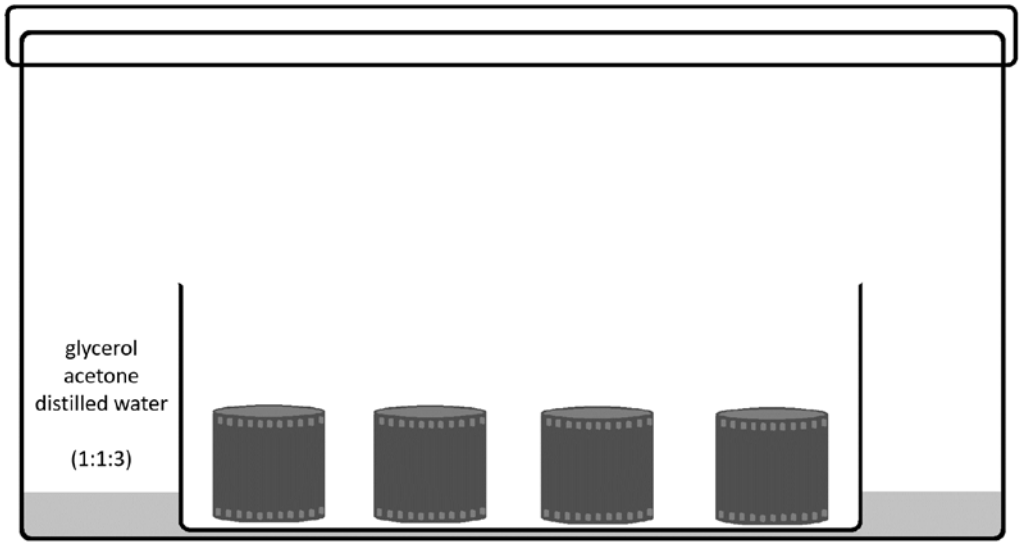

Figure 3. Vapour chamber.

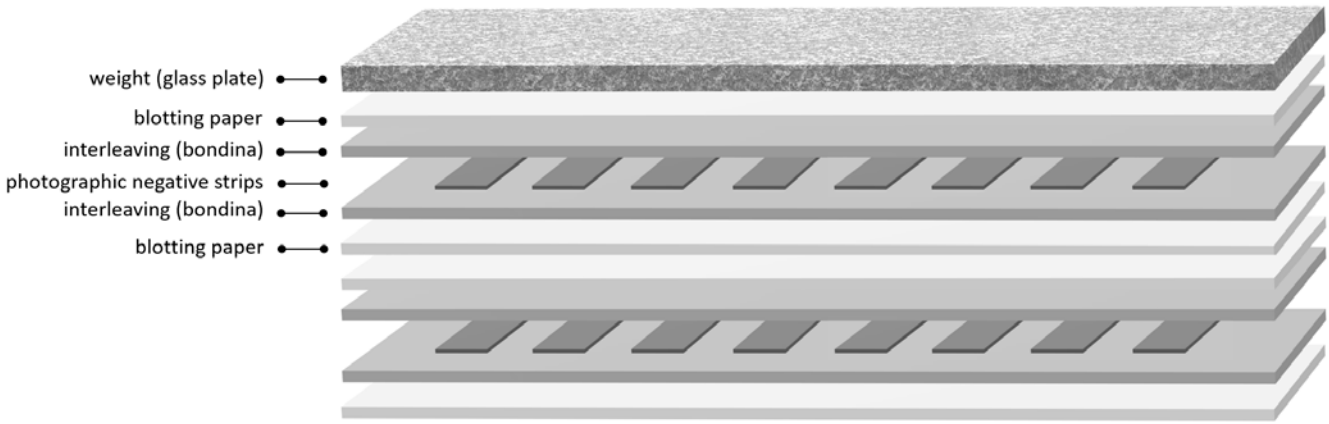

Figure 4. Flattening of the strips after exposure to solvents in the vapour chamber.

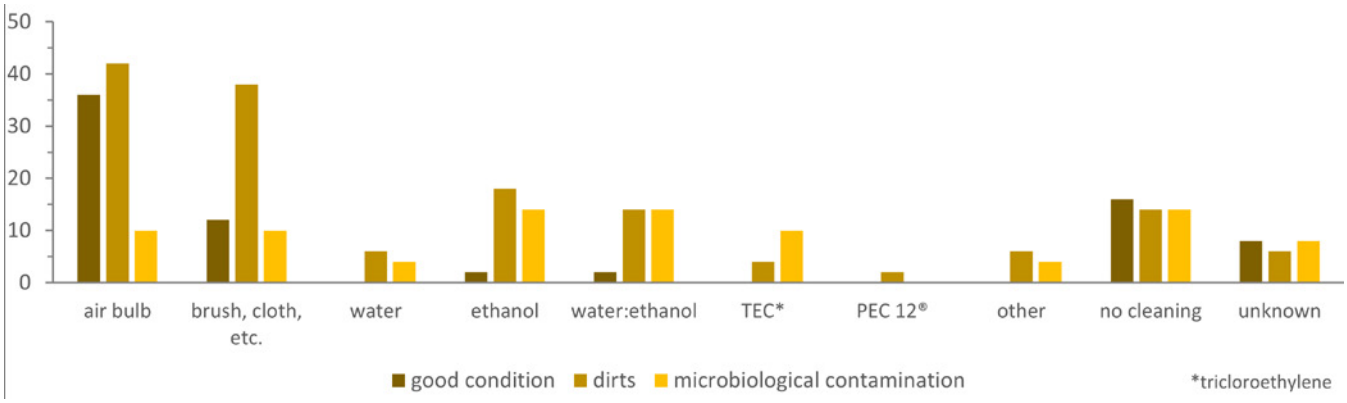

Figure 5. Types of cleaning (dry and chemical) procedures applied in the films (%).

As other photographers, Roland Oliveira kept his 35 mm negatives rolled and uncut. Although there are solutions for re-housing rolled negatives, these imply considerably more storage space than individual strips of negatives arranged inside envelopes or sleeves. Cutting rolled negatives is a common procedure among photographers and photographic laboratories to enable their handling, printing, and storage. This same technique has been sometimes adopted by photograph conservators to allow proper storage and digitization. According to the conducted survey, 44.5 % of the institutions holding rolled film, cut the films into strips (6 frames) as a current procedure. The respondents mostly justified this procedure by saying that it helps handling, improves packaging and storage space, facilitates digitization and image observation. Additionally, there is evidence that rolled film age faster than unrolled film due to the greater accumulation of degradation products [12]. Therefore, and considering the high number of rolled 35 mm silver gelatine negatives in the collection, it was decided to cut them into 6 frame strips. Beforehand, the original condition of the negatives was documented.

Based on the conducted survey, the most common ways to try to correct physical deformation in rolled films are packaging (44 %), horizontal flattening under weights (28 %), humidification with blotting paper (12 %) and humidification chamber (9 %). Nevertheless, 35 % of the institutions have reported not to perform any type of treatment in films with this type of degradation. According to the results of the questionnaire, a great part of the institutions (71 %) is not familiar with de-shrinking methods and none have been practicing it. Almost all institutions found it relevant to develop new and efficient solutions to unroll and flatten films showing physical deformation. Thus, considering that previous tests conducted to Roland Oliveira's photographic films using humidification were not successful and the literature that was found (presented in the introduction), de-shrinking seemed the most promising technique to unroll and flatten the negatives from the collection under study.

Unrolling and flattening process

The cleaned strips were placed inside a solvent-saturated atmosphere (closed box) containing a mixture of acetone, glycerol, and distilled water. The treatment is based on the affinity of the solvents with the CA base and gelatine emulsion. Glycerol, an alcohol composed of three hydroxyl groups, is used to soften the base, acting as a plasticizer [5]. This compound can easily be absorbed by the CA base, promoting the separation of the molecular chains and having the macroscopic effect of de-shrinking the polymer. Acetone is an organic compound with low boiling point (56 °C). It has affinity with both CA base and glycerol, therefore acting as a vehicle for transportation of the plasticizer into the polymer matrix. Water is added to the mixture, in higher proportion, for two reasons. Firstly, to enable the dissolution of glycerol which is a viscous liquid. Secondly, to allow the swelling of the gelatine emulsion. Being highly hydrophilic, the contact with water allows the emulsion to follow the relaxation of the base [11]. According to the literature, the treatment is only temporary meaning that, after exposure to the vapour, the action of this mixture of compounds is reversed and the solvents are released from the film [5, 13, 17].

Since the aim of the present study was to unroll and flatten the negatives from the collection, the films were forced to acquire a planar structure after relaxation inside the vapour chamber. To allow to evaporate solvents and a slow acclimatization, the strips were kept inside an empty box before flattening. Then, the strips were sandwiched with blotting paper to absorb residual moisture, interleaved with non-woven polyester to avoid adhesion to the paper, and flattened under weights to promote the desired rearrangement of the polymer chains. According to Read and Meyer, the time of exposure of motion-picture films to the vapour of solvents range from a few months, when the chamber is kept at 10 ˚C, to a few weeks, when kept at 30 °C [13]. Based on the research conducted by Lopes to microfilms, only a few hours at ca. 25 °C are necessary to achieve good results [11]. The discrepancy between the treatment time used for motion-picture films and photographic films might be explain by the longer length of rolled film normally composing a cinematographic reel. On the other hand, the aim of Lopes study was to unroll the photographic strips and not to re-dimension them [11]. In other words, the time to achieve a total de-shrinking is probably higher than the time to reach

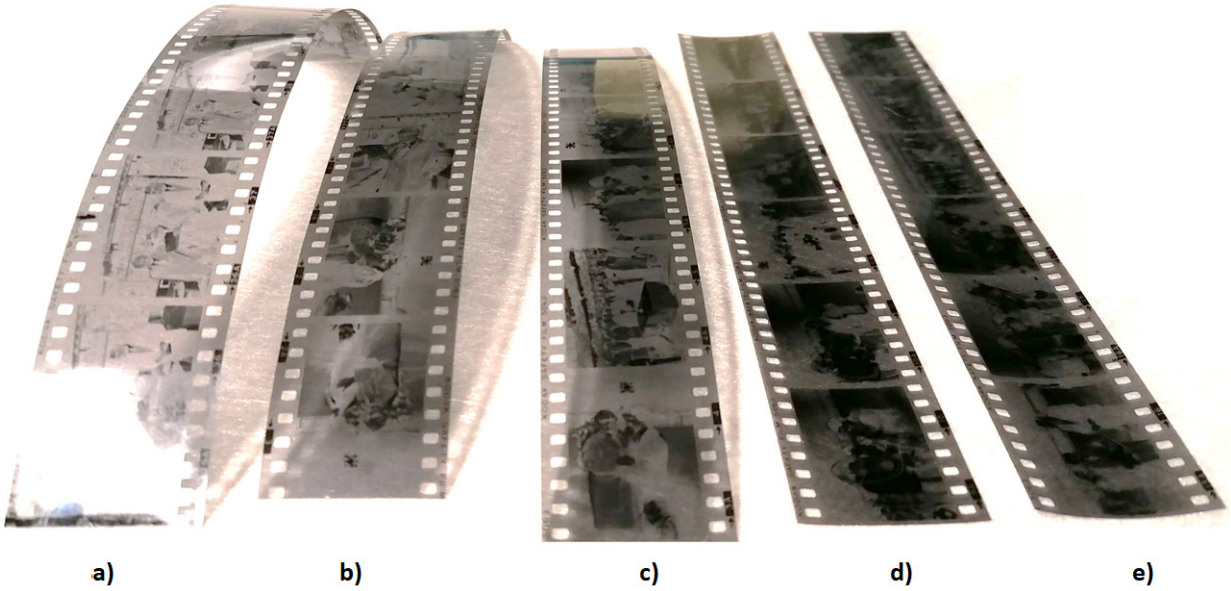

Figure 6. Tests made to different negative strips, gradually increasing the time of exposure to the vapour chamber: *a*) 1 hour, *b*) 2 hours, *c*) 3 hours, *d*) 4 hours, and *e*) 5 hours.

Figure 7. Negative strip: *a*) before treatment; *b*) after unrolling and flattening.

a satisfactory flattening. In the present study, the strips of negatives were monitored every hour and it was possible to observe, at the naked eye, the gradual suppleness of the films (Figures 6). After 5 hours at ca. 18 ºC, most of the films became visibly relaxed. However, it was necessary to keep them for about 24 hours in the vapour chamber followed by 48 hours of flattening under weights, to achieve optimal and permanent results (Figures 7). Most of the films for which the time of exposure to the solvents and/or the time of flattening under weights was reduced maintained a certain distortion.

Possible adverse effects were assessed by observing the negatives with a digital microscope before treatment, after cleaning and after the unrolling and flattening process (Figure 8).

As can be been in Figure 8, mechanical cleaning with a soft hairbrush together with chemical cleaning with ethanol 96 % was very effective. On the one hand, cleaning avoided the dirt to be absorbed by the swelled emulsion layer during the unrolling process. On the other hand, it has removed microbiological contamination (fungi) present on both sides of the film. In some cases, residual fungi remained attached to the gelatine emulsion and/or CA base. Nevertheless, the effect of the ethanol should be enough to stop their activity. Additionally, a cleaned image provides a better matrix for digitization. However, the cleaning action must be gentle and not repeated for more than two times, otherwise some abrasion can occur. Based on the collected microscopy images and on the observation at the naked eye, the developed unrolling and flattening treatment did not create any damage on the image of the negatives.

After treatment, the negatives were placed inside acid-free paper envelopes specially designed to store 35 mm strips (Figure 9). The strips can now be easily handled and digitized in high-resolution with the flatbed scanner available at CDI, enabling the study and dissemination of the images from the collection. Considering the intrinsic instability of CA based materials and the insufficient storage conditions from CDI, the envelopes with negatives will be sealed inside aluminium bags and stored in no-frost freezers to extend the lifespan of the films [2].

In future work, measurements such as pH and hardness should be performed, before and after treatment, to assess possible changes in the proprieties of the negatives. Infrared spectroscopy, among other analytical techniques, could be used to understand the influence of the treatment at a molecular level. The unrolling and flattening procedure should also be tested in chromogenic films and see if the same treatment can be performed.

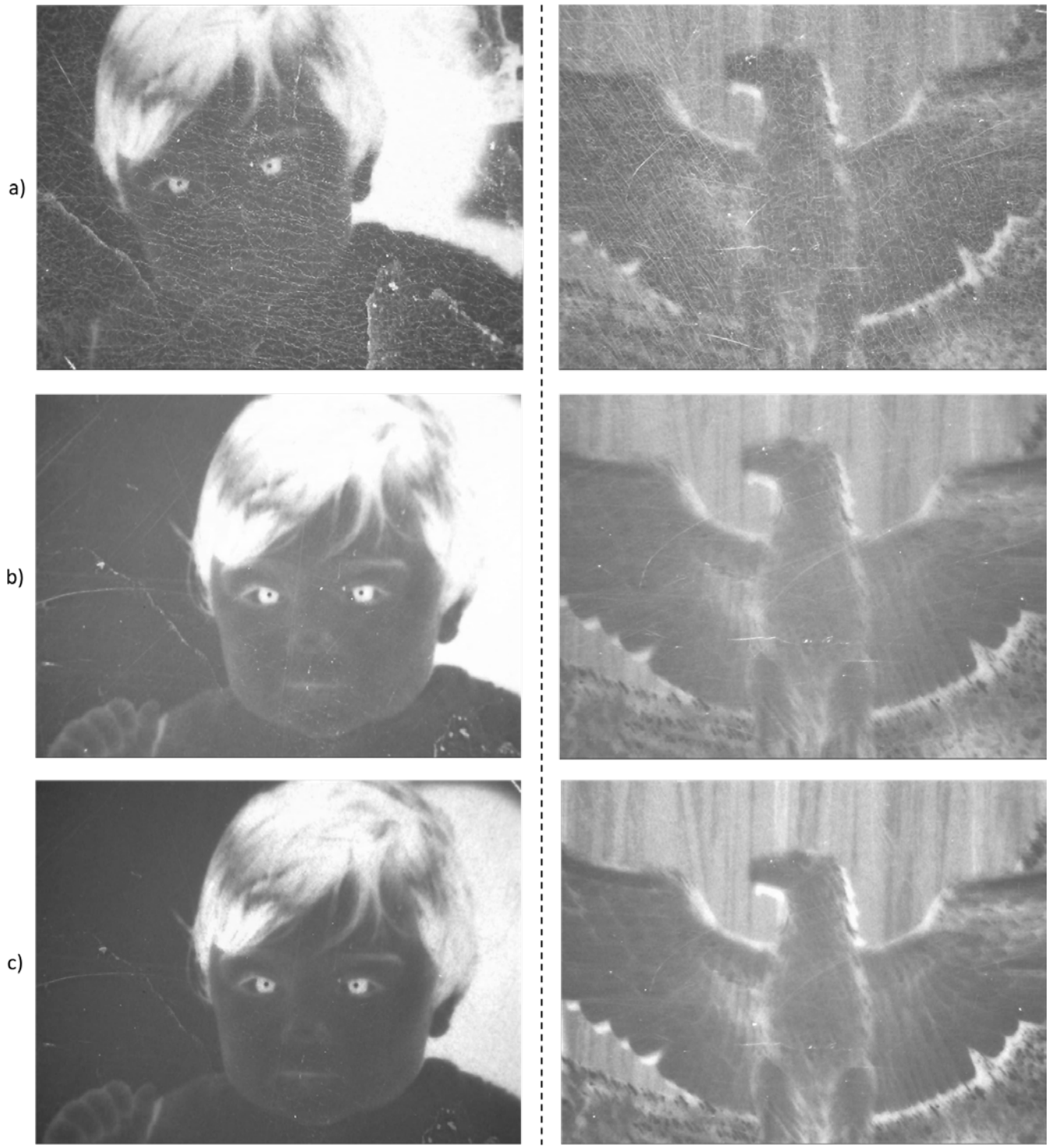

Figure 8. Microscopy images of two negatives (50 ×): *a*) before treatment, *b*) after cleaning, *c*) after unrolling and flattening.

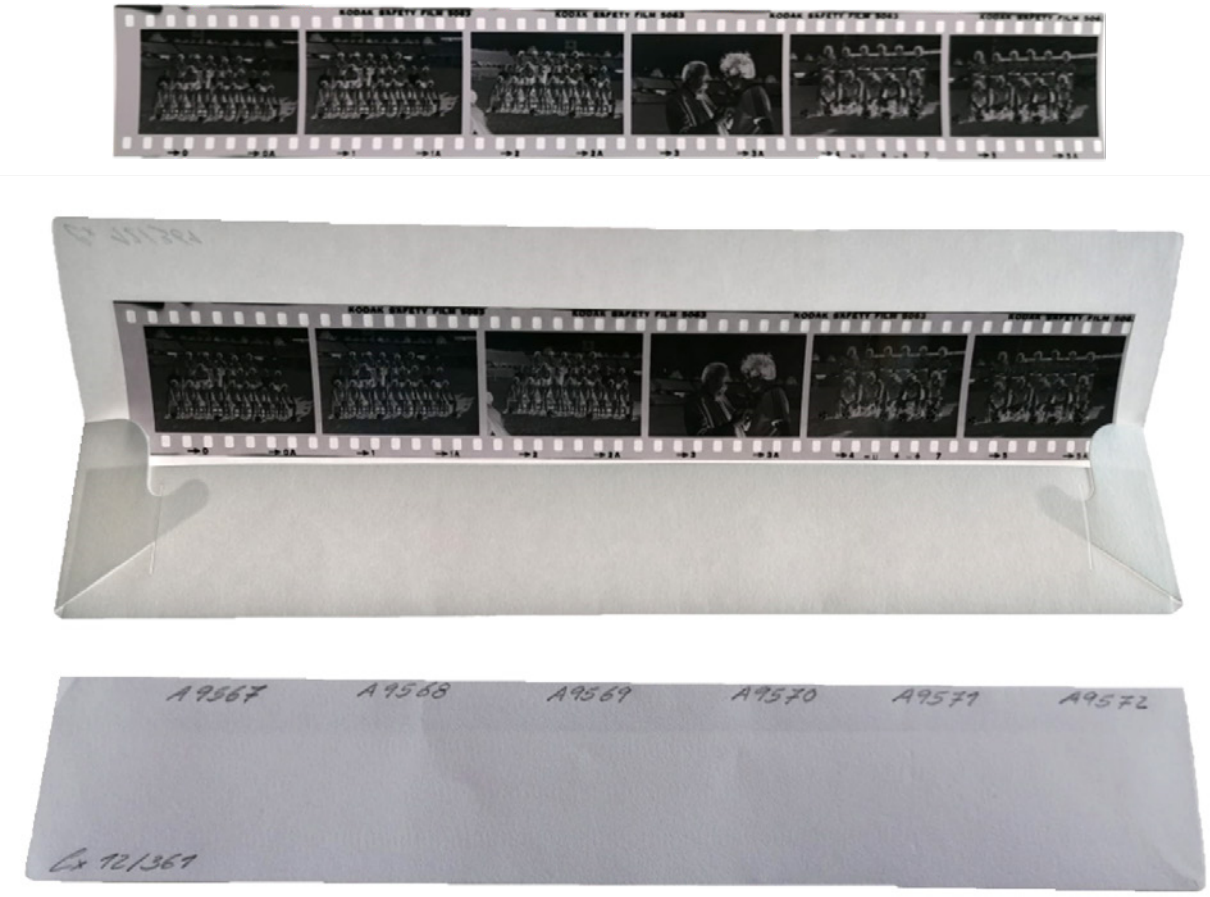

Figure 9. Strips of negatives stored inside acid-free paper envelopes.

Additional precautions should be taken due to the susceptibility of chromogenic dyes to solvents and water. To evaluate the efficiency of the developed methodology on the long-term preservation of the films, artificial ageing tests could be carried out with treated and untreated samples.

Conclusions

The conservation procedures carried out in film collections belonging to Portuguese institutions was surveyed, showing the need to develop new strategies for the preservation of rolled films. A treatment to unroll and flatten films was pursued. The developed technique was successfully implemented for Roland Oliveira's 35 mm silver gelatine negative films. For the time being, about 2600 images were treated. The flatness of the rolled negatives was restored after 24 hours of exposure to solvents inside a vapour chamber (with glycerol, acetone and distilled water, 1:1:3, v:v:v), and 48 hours of flattening under weights. Additionally, the applied cleaning procedure (mechanical cleaning with a soft hairbrush and chemical cleaning with ethanol 96 %) allowed to remove the microbiological contamination present in the negatives. The negatives can now be easily handled and digitized in order to be studied and disseminated to the public at large. Nevertheless, more tests should be performed in the future to test the efficiency of the treatments on the long-term preservation of the films.

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