Toward a Systematic Classification of Textile Damages

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ABSTRACT: The accuracy of textile damage analyses was evaluated by laboratory tests carried out by trained experts. The analyzed damages were prepared by various methods, including stabbing, cutting, shooting, heating/burning, etc. A number of damages were aged by household washing and tumble-drying procedures, addition of blood, or burying. The samples were analyzed by routine laboratory evaluation. The results indicate that the properties of a damage provide a good indication of the way a textile had been damaged. Nevertheless, scoring of the answers is not straightforward. Results indicated that examiners evaluated damages on different levels of specificity and thereby showed the latent need for a more systematic approach to damage classification. The second part of the current contribution therefore presents the classification scheme we developed. This classification scheme aims to guide examiners during examination and accommodates the vast majority of textile damages observed in forensic casework. Each of the proposed classes is defined, relevant literature in each of the classes is reviewed, and the characteristics that can be expected after different damaging actions are explained. Finally, we share some ideas for further investigations.

INTRODUCTION

Many incidents result in the damaging of textile materials. Those textile damages carry properties that reflect their causes, and their analysis can be informative in the reconstruction of an incident. Hence, the analysis of textile damages is offered as a service by many forensic laboratories.

Analysis of damages is currently based on examination by an analyst, in most cases aided by light microscopes or scanning electron microscopy (SEM) [23,51,58]. Recently, analysis by atomic force microscopy (AFM) has been proposed [7]. Although such analyses are sophisticated, their interpretation is provided by an examiner in a subjective way. Indeed, analysis of textile damages is considered an expertise where the examiner needs ample experience. Experience can be gained via training, casework, simulation experiments [61], carrying out laboratory tests, and literature studies.

Due to the level of expertise needed in the evaluation of damages, laboratory testing is not straightforward. Only a single study on the validity of damage investigations is known to the authors. In that study [4], examinations by trained forensic experts are compared to those by people without formal training in forensics. The scope of the cited study is limited and does not provide an informative answer regarding the validity of damage investigations reported by forensic investigators. Therefore, we prepared a set of several damaged textiles. These were examined by different experienced examiners in order to judge the reliability of their evaluations. The inflicted damages and the evaluation methodology are presented in Section I below.

Our results, presented in Section II, indicated that the specificity of the evaluation is very important. A verdict on the cause of a textile damage can be perfectly true, but so imprecise as to be uninformative. A more specific answer may be more useful to the police force or the courts, but may be prone to errors or uncertainty.

Section III details a classification scheme that may assist examiners in considering different levels of specificity. It presents a review of studies into textile damages, providing information on the observations that can be expected after different actions that may cause damage to a textile. In addition, we will share some thoughts on future studies.

The classification scheme is based on literature, casework, and other studies carried out at the Netherlands Forensic Institute (The Hague, The Netherlands). It is possible that some damaging actions are omitted, if we have never encountered or considered them. We look forward to additions, so that a closed set of damaging actions can be constructed. We would like to emphasize that our approach does not reduce the subjective nature of the evaluation. It cannot replace proper training and experience, but rather guides and facilitates investigations.

I. ANALYSIS OF DAMAGES

The work described in this section was initiated as a study into the validity of textile damage investigations carried out in our laboratory. Several textiles were selected, damaged, in some cases aged, and investigated by trained examiners. To the knowledge of the authors, the current study is the first systematic study on the validity of examination of various damages. This experimental section

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Tom G. Schotman gained his B.Sc. degree in forensic chemistry from the Avans University of Applied Science (Breda, The Netherlands) in 2012. During his studies, he worked on trace evidence and quality assurance projects at Staffordshire University (Staffordshire, UK) and the Netherlands Forensic Institute. Since 2013, he works at the Netherlands Forensic Institute where he analyzes microtraces and materials using microscopy, LA-ICP-MS, and other techniques.

Tom has a strong interest in analysis, especially microscopic analysis, of trace evidence. He has worked on several cases and has published three papers on the analysis of fibers and textiles. In addition to his forensic interests, he owns two border collies and is a part-time shepherd.

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Radha Samlal-Soedhoe received her B.Sc. degree in biochemistry from the Higher Laboratory Education at Delft Technical University (Delft, The Netherlands). Since 2005, she has been working on the recovery of glass, fibers, and textiles in the Department of Microtraces at the Netherlands Forensic Institute. She is a certified reporting officer.

Prior to her current position Radha worked in the Food Specialties Division of DSM (Geleen, The Netherlands), a global science-based company active in health, nutrition, and materials, on the recombinant gene conversion of industrial organisms. After this, she joined the Erasmus University in Rotterdam (Rotterdam, The Netherlands) to work on the treatment of cystic fibrosis. In 2000 she joined the Netherlands Forensic Institute's Department of Biology as a forensic examiner on DNA traces. She also was involved in CODIS: the National DNA-database. Her current research interests are on textile damage investigations and on the combined recovery of traces by experts from different fields. This last project has recently led to the publication of the following article; Samlal-Soedhoe R, Willemstein LM, Baiker M, van der Weerd J: Combined recovery of biological and fibre traces; *Sci Justice* 57:174; 2017.

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Jaap van der Weerd received his B.Sc. and M.Sc. degrees from Wageningen University (Wageningen, The Netherlands), where he studied molecular sciences, specializing in physical chemistry with a focus on spectroscopy. He then obtained his Ph.D. from the University of Amsterdam (Amsterdam, The Netherlands) following his studies on the aging of old masters' paints by imaging microspectrometry and microscopy. He carried out projects on the analysis of coins, pharmaceuticals, and historical documents during postdoctoral projects at University College London (London, UK) and Imperial College London (London, UK). In 2006, he joined the Netherlands Forensic Institute, and has since been involved in the analysis of microtraces. Dr. van der Weerd is a certified reporting officer on casework involving microtraces, especially those from textiles and paints. In addition, he is responsible for the quality assurance and accreditation of a number of methods used in casework. He is also responsible for a number of R&D projects.

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