The individuality of fibres used to provide forensic evidence – not all blue polyesters are the same

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Fibres used in forensic casework suffer from a disadvantage common to other forms of trace evidence – it is not possible to state with absolute certainty that they originate from a specific source. Target fibre studies, population studies and research on 'blocks of colour' have effectively demonstrated the polymorphism of textile fibres (particularly man-made ones) and have shown that when a fibre is believed to have a specific putative source, the chance that it has originated from a different source purely by coincidence is extremely remote. A study by Houck MM (Houck MM, Inter-comparison of unrelated fibre evidence. Forensic Science International 2003; 135: 146–149) has shown that no coincidental matching fibres were recovered from items of clothing examined in 20 unrelated crimes. The study involved over two million comparisons. This work goes a step further, and using the example of blue polyester fibres shows that even within a very narrow segment of the whole general fibre population, many examples of a specific colour/type of man-made fibre taken from random sources can be compared and the chance of any two being the same is very low. These studies should help to show the specificity and value of transferred fibres in providing forensic evidence.

Des fibres utilisées dans des cas forensiques souffrent d'un désavantage commun à d'autres formes de traces de contact - il n'est pas possible d'établir avec une certitude absolue qu'elles proviennent d'une source spécifique. Des études de fibres-cibles, des études de populations et de la recherche sur des « blocs de couleurs » ont démontré efficacement le polymorphisme des fibres textiles (en particulier des fibres fabriquées) et ont montré que lorsque une fibre est considérée comme provenant d'une source putative spécifique, la chance quelle provienne d'une source différente, purement par coïncidence, est extrêmement faible. Une étude par Houck MM (Houck MM, Inter-comparison of unrelated fibre evidence. Forensic Science International 2003; 135: 146–149) a montré qu'on ne trouve pas de fibres concordantes par coïncidence, récupérées de pièces de vêtement examinées dans vingt crimes non reliés. Cette étude concernait plus de 2 millions de comparaisons. Le présent travail va une étape plus loin et, en utilisant l'exemple de fibres polyester bleu, montre que même dans un segment très étroit de la population générale des fibres, beaucoup d'exemples de fibres fabriquées d'un type ou couleurs spécifiques, provenant de sources prises au hasard, peuvent être comparés et le risque qu'elles soient identiques est très petit. Ces études devraient permettre de montrer la spécificité et la valeur de fibres transférées comme indices forensiques.

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Wie andere Formen von Mikrospuren auch besitzen Fasern einen Nachteil als forensische Beweismittel – es kann nicht mit absoluter Sicherheit gesagt werden, dass sie nur von einer einzigen Quelle herrühren können. Die Ergebnisse von sog. Target Fiber Studien, Populationsstudien und Untersuchungen zu "Blocks of Colour" belegen eindeutig den Polymorphismus von Textilfasern - insbesondere den von Chemiefasern. Wenn eine Faser einer vermeintlichen Quelle zugeordnet wird, ist es nach diesen Studien sehr unwahrscheinlich, dass die Faser dann zufällig von einer anderen Quelle stammen kann. Eine Studie von Houck (Houck MM, Inter-comparison of unrelatet fibre evidence. Forensic Science International 2003; 135: 146–149) zeigte, dass unter den von Bekleidungsstücken gesicherten Faserspuren bei 20 voneinander unabhängigen Straftaten keine zufälligen Übereinstimmungen vorlagen. Diese Studie beinhaltete über 2 Millionen Faservergleiche. Die vorliegende Arbeit geht einen Schritt weiter. In einem sehr engen Segment der Gesamtfaserpopulation wird am Beispiel von blauen Polyesterfasern aufgezeigt, dass obwohl zahlreiche Faserproben einer bestimmten Kombination aus Faserfarbe und Fasertyp miteinander verglichen werden, die Chance identische Faserproben anzutreffen, sehr gering ist. Diese Studien helfen, den Wert von übertragenen Faserspuren als forensische Beweismittel aufzuzeigen.

Las fibras que se usan en los casos forenses tienen la desventaja, común a otras formas de evidencia de trazas, de que no es posible decir con absoluta certeza que se han originado de una fuente específica. Los estudios de fibras diana, los estudios de población y la investigación de "bloques de color" han demostrado, efectivamente, el polimorfismo de las fibras textiles (particularmente las artificiales) y han demostrado que cuando una fibra se cree proceder de una posible fuente, la posibilidad que tiene de haberse originado en otra fuente diferente, por pura coincidencia, es extremadamente remota. Un estudio de Houck (MM (Houck MM, Inter-comparison of unrelated fibre evidence. Forensic Science International 2003; 135: 146–149) ha demostrado que en items de 20 delitos no relacionados no se recuperaron fibres que coincidieran accidentalmente. Ese estudio incluyó unos dos millones de comparaciones.Este trabajo va un paso más allá y usando el ejemplo de fibres azules de polyester se demuestra que incluso usando un estrecho segmento de la población general de fibres se pueden comparar muchos ejemplos de fibres artificiales de color y tipo específico, de fuentes cogidas al azar y que la prababilidad de dos sean igyuales esmuy baja. Estos estudios ayudarán a mostrar la especificidad y valor de las fibres transferidas en la provision de evidencia forense.

Introduction

Fibres have long been used to demonstrate evidence of contact according to Locard's exchange principle [1]. It is often argued that textiles are mass produced items and the fibre types in question are usually widely distributed and therefore could have originated from a wide variety of sources. This argument has often been put forward in criminal trials as a means of dismissing the evidential significance of a potential link between fibre and suspect.

Before the mid-1980s, there was almost no published information on fibre frequencies. Of course, even in those days, there were a number of factors that would raise the value of fibre evidence. These included finding a cross transfer, especially if a large variety of different fibre types and colours were involved. Recovery of a large number of matching fibres would suggest a recent transfer. The location of the transferred fibres might be of considerable significance especially if they were found in a situation where no other explanation, other than that they had been transferred during the course of the crime, could reasonably explain their presence. Then there is the morphology of the fibres themselves, if they are of an unusual polymer composition, have a peculiar cross sectional form or be of a type considered 'rare' their evidential value will increase. Unfortunately, these situations tended to be the exception, rather than the rule. The stumbling block has always been that no figures could be quoted for the chances of these fibre types being found at random among the general fibre population.

Research during the last 20 years has changed the situation quite dramatically and fibre analysts have tried to arm themselves with valid information to counter these perceived 'disadvantages'. Much useful information has been derived from target fibre studies, population studies and examination of blocks of colour. A target fibre study is a project designed to establish how often an example of a particular fibre from a specific garment will occur as a foreign fibre on a number of randomly selected textiles. At least nine target fibre studies have been published, covering all of the most common generic types of fibre, and they have all shown that the chances of such an occurrence are extremely small. The figures can be found by perusing the appropriate literature [2–10].

A population study is the evaluation of the content of a randomly sampled fibre population usually taken from similar locations (cinema or car seats, outdoor surfaces, T-shirts, etc.) by dividing it into generic type/colour combinations. The results of several such studies have been published at the time of writing [11–20]. These studies provide information on the likelihood of fibres of certain colour/type combinations being found on a particular surface. To minimise the labour involved, colour is only classified into subjective categories. Nevertheless it is quickly apparent that fibres of certain colours e.g., orange, brown, yellow, purple and even green constitute a very small percentage of the general fibre population.

If the colour of fibres falling into these categories was examined objectively by microspectrophotometry, which has been shown to have a discriminating power of around 0.99 [21–24] it could be shown that the percentage of fibres dyed with a particular dye/dye combinations (i.e. representing a particular hue), within these broader categories would drop very dramatically. It is true of course that within a localised population involving a particular textile (e.g. a fashion trend) the percentage might be expected to rise accordingly.

The fibres found within a person's living environment originate from their clothes, furnishings and household textiles. These items are an expression of personal taste and their fibres form a kind of 'textile fingerprint'. For example, if you have purple cotton towels in your bathroom, the bathroom 'dust and fluff' will be full of these purple cotton fibres, but one would probably have to take samples from many other bathrooms before coming up with a similar finding – and even then the chances are high that the fibres would be spectrally different. Of course, such fibres become enormously valuable as an environmental target fibre which may be spread by secondary transfer.

Studies using blocks of colour have demonstrated that fibres of one type with the same broad colour category are likely to be dyed with a wide variety of different dye combinations which are spectrally differentiable. So far, the four studies of this type which have been published have all concerned cotton fibres [19, 20, 22, 23]. This type of study provides particularly valuable information about natural fibres which lack the wide range of morphological characters associated with man-made fibres and therefore rely heavily on colour as the main comparative characteristic. All of these studies have shown that within a particular colour the population can be broken down into a number of spectral sub groups which will occur with different frequencies. These frequencies can be used as an indicator of the relativity of how often one can expect to see fibres dyed with a certain dye. Within a particular colour, e.g. among black cotton, fibres dyed with sulphur black 1 are extremely common and fibres dyed with reactive black 5 also occur frequently.

Another contribution to estimations of fibre frequency has been made by compiling fibre databases. Over 70% of the 27 types of fibre represented in clothing in the German Catalogue Data Base (CDB) [25] occur only as a very small percentage of the total records (usually less than 1.0%) thus elevating their evidential value. By combining data from the CDB with the Forensic Science Service data bank on morphological characters of man-made fibres [Adams J, Coyle T, Middlemist A, Conder A, Christensen P and McHugh C. Personal Communication] and other similar sources of information [26] it can be shown that in commonly occurring generic types, e.g. acrylics, the chances of finding two garments (for example ladies' pullovers) containing identical, yellow, non-delustred, bean shaped vinyl acetate co-polymer acrylic fibres are about 1 in 20,000. For fibres of a less common type and colour, the chances may decrease to around 1 in 250,000 or more. It will also be shown in this paper, that even within the most frequently encountered type of fibre, studying the combination of colour and morphological features permits the creation of sub-groups which have widely variable frequencies of occurrence.

All of this research has shown that man-made fibres display a very high degree of polymorphism, giving specific examples with a high degree of individuality. The chance of finding