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The prevalence of two 'commonly' encountered synthetic target fibres within a large urban environment

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ABSTRACT

A target fibre study was carried out to assess the random prevalence of two ostensibly commonly encountered synthetic fibre types; black acrylic and blue polyester. The study was performed in an environment which maximised the number of random contacts between textile garments in the population and specific surfaces, namely; seating relating to buses, public houses and cinemas found within a large urban conurbation.
Surface debris tapings were collected from samples of bus seats (30), pub seats (54) and cinema seats (53). Using low power stereomicroscopy, a total of 114 and 68 fibres, superficially similar to the respective black acrylic and blue polyester target fibres, were recovered from these tapings. The full range of comparative microscopical and instrumental analysis used in operational forensic laboratories was performed on the recovered fibres.
No matches were found with either of the target fibres.
These findings are in accordance with similar studies which show that the probability of an 'adventitious' match with a particular fibre type/colour combination is extremely low. In addition, the findings demonstrate that the current techniques and instrumentation employed by operational forensic laboratories are fit for purpose.
Importantly, the findings demonstrate that databases and surveys (e.g. fibre population studies) which do not consider the analytical/comparison processes, must not be used in isolation when evaluating fibre evidence at source level.

1. Introduction

Fibre evidence is often considered as having poor probative value in forensic investigations due to the perception that unlike DNA evidence, there is a lack of robust frequency data which renders source level determinations problematic [1,2].

Seasonal, fashion, and economic factors (to name a few) create a state of flux within the textile industry which means that it is virtually impossible to create a reliable database providing frequency data for every possible fibre type/dye combination. The fundamental difference between DNA evidence and fibre evidence is therefore that; data relating to the prevalence of the former is (by and large) fixed in time, whilst the latter is not.

This difference means that (as far as source level evaluations are concerned) they must be treated with different evaluative methods. The use of a single database may be appropriate for DNA profile frequency data (since it is underpinned by established genetic models), however, attempting to apply a similar approach to other evidence types may not be appropriate [3]. Perceived difficulties and misconceptions regarding the availability and use of relevant data for fibre evidence are discussed by Houck [2] who described these problems as arising from; "[limiting] *a discipline by requiring it to fit into a preordained* [*mathematical*] *model. One size does not fit all.*"

In the absence of 'fixed' data such as allelic frequencies used in the calculation of DNA match probabilities, the following types of studies are extremely useful in forming an evaluative opinion as to the significance of source level fibre evidence;

- Fibre population studies: which provide estimates of the relative frequencies of different fibre type/colour combinations, at the generic level, on particular surfaces/substrates e.g. car seats [4], skin [5].
- Colour block studies: provide information on the ability of a scheme of analysis to discriminate between ostensibly similar fibres of a given generic fibre/colour combination [6–13].
- Target fibre studies: provide estimates of the probability of finding significant numbers of a specific fibre type, morphology and colour combination, on a random surface [13–22].

It is important that the distinction between these studies is understood. Fibre evidence is often dismissed because population studies show a particular fibre type/to be 'common'. To use an analogy; whilst stating that "*blue cars are common*" is ostensibly true, not all blue cars are the same (as anyone who has attempted to repair car panels will know).

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Evaluating source level evidence purely on the relative frequency of a fibre at the *generic level*, without consideration of the ability of instrumentation to discriminate between apparently similar fibres (colour block studies and target fibre studies), is likely to lead to important evidence being woefully understated or wrongly dismissed as irrelevant.

Target fibre studies published over the past 28 years, have consistently demonstrated that the chances of finding significant numbers of a particular fibre type/colour combination on a random surface are very small. It therefore follows that the chances of finding more than one particular target (e.g. in a cross transfer situation) are even smaller. These studies are therefore extremely useful in addressing source level propositions, particularly when a Bayesian framework is employed.

Despite their high value, only 10 such studies have been published over the past 28 years. To put this into perspective, a target fibre study which incorporated a review of the results of previous such studies was published in 2004 [21]. Since this work was published, only 2 target fibre studies [13,22] have been carried out during the intervening decade. The list of published target fibres to date, is shown in Table 1.

2. Aims

The aim of the present study was to investigate the degree of prevalence of synthetic fibre targets which are (*at the generic level*) commonly encountered in forensic casework. To this end, surfaces within a large urban environment which were likely to be subjected to enumerable contacts with textile garments worn by the populace were sampled and examined. Since the number of random contacts between clothing and a particular surface are likely to influence the chances of encountering an adventitious match with a given target fibre, the purpose of this approach was to obtain a 'worse case' estimate.

Table 1
List of published target fibre studies.

Study	Recipient items	Sample size	Target fibres	Number found
Cook and Wilson (1986) [14]	Garments	335	Blue wool (1)	9
			Blue nylon	0
			Blue acrylic	0
			Red acrylic	2
			Blue wool (2)	1
Jackson and Cook (1986) [15]	Car seats	108	Red wool	37
			Brown polyester	8
Cook et al. (1993) [16]	Garments	56	Blue wool	62
			Pink cotton	4
			Blue cotton	1
			Grey polyester	0
Palmer and Chinherende (1996) [17]	Cinema seats	67	Red acrylic	14
			Green cotton	3
	Car seats	66	Red acrylic	0
			Green cotton	6
Bruschweiler and Grieve (1997) [18]	Garments	435	Red acrylic	2
Cook et al. (1997) [19]	Head hair	100	Blue wool	20
			Green acrylic	2
			Grey acrylic (1)	15
			Grey acrylic (2)	0
Kelly and Griffin (1998) [20]	Pub seats	80	Blue wool	9
Wiggins et al. (2004) [21]	Garments	58	Blue wool	11
			Black polyester	0
			Grey polyester	1
			Blue acrylic	4
Jones and Coyle (2010) [13]	Garments	100	Black polyester flock	6
			Blue-grey nylon flock	0
			Grey-brown nylon flock	12
			Orange nylon flock	
			Green nylon flock	0
			Black nylon flock	0
			Grey nylon flock	0
Coyle et al. (2013) [22]	Garments	100	Fluorescent yellow polyester (52 samples)	0

3. Experimental

3.1. Target fibre data

Constituent and shed control samples were taken from each target garment to establish the degree of intra sample variability under reflected light, for use in initial tape searching using a *Leica M60*™ low power stereomicroscope, as well as for subsequent high power comparison microscopy using a *Leica DMR*™ comparison microscope equipped with fluorescence and polarising filters.

3.2. Black acrylic

The target garment chosen for the black acrylic fibres was a pair of black 'HANDY magic' gloves. Manufactured by the 'Handy Glove Co', this product is widely available in high street shops and markets as well as numerous internet mail order sites. Whilst the product label cited the composition as 85% acrylic, 10% nylon and 5% spandex, shedding tests demonstrated that virtually all of the transferred fibres were from the acrylic component.

Although appearing black to the naked eye, the acrylic target fibres were found to have a dark green appearance when viewed using high power transmission microscopy. The cross section of the fibres was found to be 'bean' shaped, approximately 20 μm in diameter and was delustred (dull). There was minimal intra-sample variation in dye uptake.

3.3. Blue polyester

The target garment chosen for the blue polyester fibres was a dark blue fleece style top donated by a member of staff. Other than a label stating 'Originals', details of its manufacture were unknown. The target fibres were blue in colour (in reflectance and transmission) with a round cross section, approximately 12 μm in diameter, and delustred (dull), typical in appearance of the type commonly (in the generic sense) encountered in casework. There was minimal intra-sample variation in dye uptake.

3.4. Tape lift sources

Surface debris was collected from seats relating to cinemas, public buses and public houses within the Newcastle upon Tyne conurbation. The surface debris from the seats were collected using surface debris tapings. The back and squab surfaces of random seats were sampled using the 'press and rub' method using 2 in. wide strips of '*J-Lar*™'. The tapes were then secured for subsequent searching by pressing the adhesive side down onto a clear acetate sheet.

Table 2 shows the source and the number of seats sampled and tape lifted.

Table 2
Details of sampled seat sources.

Source	Source no.	Seats sampled	Total
Bus	1	10	30
	2	10	
	3	10	
Pubs	1	5	40
	2	5	
	3	6	
	4	7	
	5	5	
	6	6	
	7	6	
	8	5	
	9	5	
Cinemas	2	14	53
	3	39	