



Case review

Extraneous fibre traces brought by river water – A case study



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ABSTRACT

The fibre traces on a young victim found underwater were mostly single fibre traces besides small amounts of fibre collectives indistinguishable from his parents clothes (mainly wool). Most of those single fibre traces were blue-grey polyester fibres showing tiny differences among each other. They were unexpected according to known population fibre studies. One year after the victim's discovery experiments were conducted to evaluate the possible contamination with fibres from river water. A small amount of extraneous fibres were collected among which blue and grey-black cotton and man-made (mainly polyester) fibres. All man-made fibres were single fibre traces and small fibre collectives were only observed for cotton. These results confirmed the frequent occurrence of blue and grey-black cotton fibres as background, but also highlighted the possible contamination with single blue and grey-black man-made fibres from river water. No wool was found, strengthening the significance of the wool fibre collectives present on the victim.

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1. Introduction

One of the least favourable case scenarios in terms of trace evidence is a victim found after a long stay underwater. In such a case, DNA examinations often lead to inconclusive results due to the degradation of biological traces [1]. Investigations to incriminate a potential suspect may become difficult without DNA evidence. Therefore, microtraces and especially fibre traces could remain the only way to link a potential suspect to the victim's body.

In 2009, the dead body of a young boy was found drifting under the water surface of the Lys river. The victim had disappeared 15 days earlier from the family home. He was dressed in nightwear and barefooted. The autopsy indicated that death occurred before the water immersion and that no sexual abuse was committed.

A quarrel had taken place between the victim's father and mother during the night of his disappearance. An accidental death of the young boy during that altercation was the most probable case scenario for the prosecutor. However, both parents maintained their son ran away during their argument. The police investigation produces no other suspects.

A fibre examination was conducted on the tape lifts of the outside of the victim's nightwear as these were considered to hold traces due to contacts with the offender. The inside of the clothing was supposed to be more related to the family background. Fibre collectives were found which corresponded to the family clothing. These consisted of 65 fibres, mainly wool. Other fibres corresponded to bedding from the

family home. Additional unassigned fibre traces (91 fibres) were found besides these fibre collectives. Most of these were single fibre traces easily differentiated using microscopy and microspectrophotometry in the visible range (MSP Vis), among which 18 wool fibres (mostly black), 15 reddish and greenish acrylic fibres and 17 very similar blue-grey polyester fibres. Those blue-grey polyester fibres were ultimately discriminated by tiny differences in their morphology and in their MSP Vis spectra.

However, the significance of that discrimination was suspicious without being able to evaluate the possible intra-variation of a known source textile material. The presence of such polyester traces was indeed surprising regarding population studies of coloured fibres on outdoor surfaces [2] and on car seats [3] or even background studies [4–5], which mainly highlight the occurrence of blue and grey-black cotton fibres. A lot of polyester textile sources from the family house and from the family car were seized and compared without any correspondence. A possible explanation could be a contamination with fibre traces from river water. Indeed, an important source of microplastic on shorelines appears to be through sewage contaminated by fibres from washing clothes. Forensic evaluation of microplastic from sediments showed that the proportions of polyester and acrylic fibres used in clothing resembled those found in habitats that receive sewage-discharges and sewage-effluent itself [6].

The victim's body was suspected to have been immersed in the Douve river, a tributary of the Lys river. Along the course of the Douve river were observed many sewage-discharges from houses nearby and from the nearest village. Due to large amounts of sludge and vegetal remains in water the opportunity of using filters to collect fibre traces was rejected. Experiments were consequently conducted using two

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homemade dummies immersed for a 15-day period in both the Douve river and the Lys river simultaneously. The experiments took place exactly one year after the recovery of the victim and helped to study the possible contamination with fibres during immersion into these two rivers.

2. Material and methods

2.1. Homemade dummies

Two white cotton T-shirts (brand Nur Die, EU size 116/122, 100% cotton) were chosen as recipient textiles because the victim was dressed in knitted cotton nightwear. Two weighted plastic jugs (5 l jug filled with equal volumes of sand and water) were used to mimic the upper part of a body immersed midwater. A metal cable was secured around the jugs to serve as an attachment point. Prior to the experiment, the plastic jugs were thoroughly washed with deionized water and dried. The T-shirts were purchased new, hand washed with detergent, rinsed with fresh water and air dried. Both the plastic jugs and the T-shirts (outside and inside) were also tape lifted to remove any background of fibres. The T-shirts were then pulled on the weighted plastic jugs to set-up a homemade dummy. T-shirts were secured with an external belt of metal wire in both horizontal and vertical directions in order to prevent undressing.

The preparation took place in a clean sampling room with operators wearing single-use Tyvek overall and gloves. The homemade dummies were stored in sealed paper bags for transportation to the immersion site.

2.2. Immersion

The immersion site on the Douve river (50°45'37.8"N 2°59'27.9"E) was located in grassland downstream to the sewage-discharges. On the Lys river (50°45'16.3"N 2°57'15.9"E) it was located at the dam-slucice where the victim was found drifting nearby.

A metal cable was positioned over the river (on a tree branch for the Douve river and on a platform of the dam for the Lys river). The homemade dummy was unpacked and two control tape lifts were applied on each of both sides of the T-shirt. It was then directly hung to the metal cable and dropped into water. The metal cable was adjusted to fix the position of the dummy midwater (20 cm under the water surface in the Douve river and 1.5 m in the Lys river) and was then securely attached (to the tree for the Douve river and to the platform for the Lys river).

Operators wore single-use Tyvek overall and gloves during each of both immersion steps to prevent contaminations and cross-contaminations between immersion sites.

Both dummies were left underwater during 15 days (between September 30th 2010 and October 15th 2010).

2.3. Emersion and recovery

Both dummies were cautiously recovered from water and packed in sealed paper bags for transportation to the lab. Sealed bags were opened in separate clean rooms and T-shirts were taken off the dummies. They were put vertically on a hanger for drying. T-shirts were then tape lifted outside and inside to recover extraneous fibres on both sides.

Operators wore single-use Tyvek overall and gloves during each step to prevent contaminations and cross-contaminations between sampling rooms.

2.4. Fibre examination

The tape lifts were searched for fibres with low-power microscopy (Leica MZ12, magnification 8× to 100×). All fibres were removed from the tape lifts and mounted separately on glass slides using a

synthetic resin (Histomount, National Diagnostics). Each fibre was observed and described using high-power microscopy (Leica DM5XP, magnification 400×) in bright field and the generic class of man-made fibres was determined using polarised light. Fibres were compared and discriminated in types according to their generic class, their colour and morphological details. Fibres from non-discriminated groups were analysed using microspectrophotometry in the visible range (J&M Tidas 800 coupled to a Zeiss microscope, magnification 400×, spectral range 380–800 nm, integration time 350 ms, 5 accumulations).

3. Results

3.1. Recovery and tape lifting

Both T-shirts were extensively covered with sludge deposits (Fig. 1) which had penetrated deep inside the textile structure. That latter was damaged and disintegrated when undressing the dummies. The T-shirts lost their shape and structure and turned to shreds of clothing as illustrated in Fig. 1.

After drying, the knitted structure had become totally rigid (Fig. 1) due to textile impregnation with dried sludge. The tape lifting technique was hard to implement on such a rigid and uneven surface. Tension was applied on the edges of the textile remains in order to flatten the surface and to bring back some elasticity to the textile structure before tape lifting.

3.2. Fibre examination

The search of the tape lifts resulted in finding 16 extraneous textile fibres for each of both T-shirts immersed in the Douve river and in the Lys river respectively. Besides those textile fibres, some vegetable fragments and one fine brown hair as well as colourless cotton fibres were also present. These were not further considered in fibre examination.

The population of 16 extraneous fibres from the Douve river is schematically presented in Fig. 2. It includes 11 cotton fibres and 5 man-made fibres. All man-made fibres were differentiated according to their generic type, their colour and some morphological details. Cotton fibres were classified in four groups of blue and grey-black fibres after MSP Vis measurements: two groups called "blue 1" (2 fibres) and "blue 2" (3 fibres), another one grouping 5 indigo dyed fibres and a last one called "grey-black 1" (1 fibre). The examination of the control tape lifts made on the dummy before immersion in the Douve river revealed the presence of one indigo dyed cotton fibre.

The population of 16 extraneous fibres from the Lys river is schematically presented in Fig. 3. It includes 7 cotton fibres and 9 man-made fibres. All man-made fibres were differentiated according to their generic type, their colour and some morphological details. Cotton fibres were classified in three groups of blue and grey-black fibres after MSP Vis measurements: one group corresponding to the one previously called "blue 1" (2 fibres), another one corresponding to the previously one called "grey-black 1" and one single fibre described as "grey-purple". The examination of the control tape lifts made on the dummy before immersion in the Lys river revealed the presence of one colourless polyester fibre (round section, \varnothing 10–12.5 μ m).

4. Discussion

Two homemade dummies dressed in white cotton T-shirts were immersed in the Douve river (probable immersion site) and in the Lys river (recovery site) during 15 days, in order to study the possible contamination with fibres due to immersion into these two rivers.

The first observation was the presence of a large amount of sludge on both T-shirts and inside the textile structure which was extensively damaged. At the opposite, the victim's nightwear (similar structure) was not altered and the garment was covered by sludge more superficially. Assuming this latter also spent 15 days in river water, these

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