P4-00308

EXAMINATION AND ANALYSIS OF A SAMPLE OF FOREIGN MATERIAL
YOUR REFERENCE: CARPET WASHING SAMPLES A, B AND C

OBJECTIVES

To identify the different material types in the samples in order to characterise and compare the three samples.

SAMPLES

The three samples were received by RSSL on 12 January 2005. They comprised wet carpet washings, each in a different type of container, labelled as below:

Sample Label	RSSL Reference
A	P5-00308-1
B	P5-00308-2
C	P5-00308-3

The bottles also carried a description of the environment from which the samples were obtained:

Sample A Young family with two children (5 and 10 months) plus cat. Sample taken from living room.

Sample B Very old carpet (approx 20 years+) – in old utility room/area with access to garden, where two cats eat! Professional couple.

Sample C Single young professional. Sample taken from living room carpet which was laid in June 2004.

SUMMARY

The samples were examined by low-powered light microscopy, compound light microscopy and electron microscopy, photographed, a subsample from sample B was analysed by X-ray microanalysis and a larva from sample B was submitted to a consultant entomologist for identification and comment.

Sample A was found to consist mainly of man-made synthetic and natural fibres with some feathers and few hairs. There were however, some very distinctive black and white hairs present. There was relatively little fine-grained sediment and few arthropod/insect remains were found. Examination of the very fine-grained suspended sediment revealed a relatively high level of rod-shaped bacteria.

Sample B contained more than twice the mass of solid material (dried) compared to that in samples A and C. It contained a high level of human and animal hair; cat and possibly rodent, mud-like sediment, sand grains and arthropod/insect remains. The red and yellow died hairs found in the sample were considered likely to have originated from the carpet itself. A larva found in the samples was identified as that of a White-shouldered house moth. A relatively low level of bacteria were found in the very fine-grained suspended sediment in this sample.

Sample C contained less solid material (dried) than samples A and B. Most of the sample consisted of man-made, synthetic and natural fibres with some hairs and fragments of plant material and a few feathers. A moderate level of fine-grained sediment and a single insect fragment were found. Examination of the very fine-grained suspended sediment revealed a relatively high level of rod-shaped bacteria and a large number of squamous epithelial-type cells that were considered to be skin cells.

METHODS

The particulate material in the samples was allowed to settle. The liquid and very fine-grained suspended sediment was removed and stored and the settled fibres and particulate material were dried in an oven at 60°C. The dried material was then weighed and examined by low-powered light microscopy, compound light microscopy and scanning electron microscopy (SEM) to determine the nature of any characteristic features. Subsamples and characteristic features were photographed. A subsample from sample B was analysed by X-ray microanalysis in order to determine its elemental composition and a larva from sample B was submitted to a consultant entomologist for identification and comment.

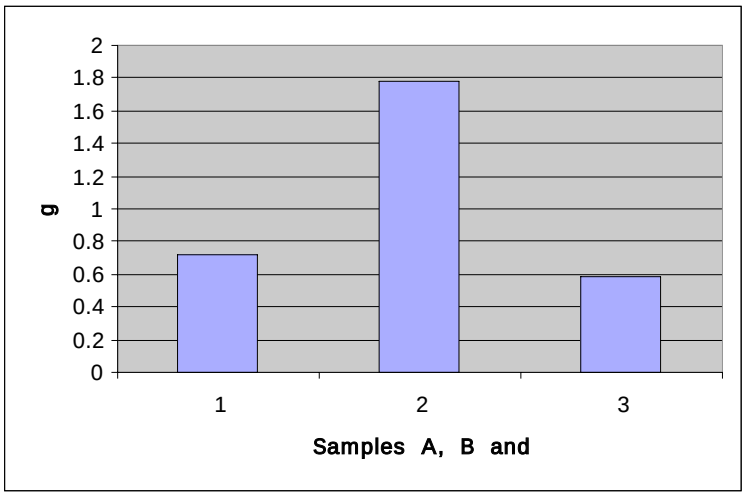
RESULTS AND DISCUSSION

Sample Weights

The dried fibres and particulate matter from the three samples was weighed. The results are shown in Table 1 below below:

Sample	weight of dried matter
A	0.714g
B	1.778g
C	0.584g

Table 1 dried sample weights



The relative amounts of material in the three samples was considered to reflect the source and brief history of the three carpets that was outlined on the printed labels on each of the sample containers. For example, it would be expected that the old carpet (B) from the utility room in which cats were fed and with access to the garden would contain more dirt than the other two samples (A and C) and that the new carpet (C) would contain the least amount of dirt.

Low Powered Light Microscopy Examination

Sample A

Examination of the dried fibres and particulate material that comprised sample A showed it to consist of a mass of man-made synthetic and natural fibres with some feathers, a few hairs and a relatively low level of sediment and particulate material and some fragments of insect-like material (Figures 1 and 2). It was noted however, that there were some very distinctive black and white hairs present in the sample (Figure 3).

The majority of the fibres found in the sample were considered likely to have originated from the carpet and other textiles. The few hairs present in the sample were considered to be mainly human with some cat, although some may have originated from textiles. The feathers in the sample did not appear to be flight feathers and were therefore considered most likely to have originated from stuffing in pillows, cushions, furniture, etc.

The sediment and particulate material found in the sample was not particularly distinctive in either particle size distribution or general appearance. The few fragments of insect-like material found were identified as fragments of arthropod exoskeleton and were considered likely to have originated from a woodlouse. There was not enough of the material to identify the species of woodlouse. However, there are numerous common species that on the whole appear to feed on different types of vegetable matter.

The black and white fibres shown in Figure 3 were mammalian in origin but were not identified further. It was however, considered likely that they had been dyed.

Sample B

Examination of the dried fibres and particulate material that comprised sample B showed it to contain a high level of human and animal hair; cat and possibly rodent, sand grains and finer sediment (Figure 4) and arthropod/insect remains (Figures 5 and 6) and very fine-grained mud-like sediment that dried to form a hard layer (Figure 7). All of the above was considered consistent with the usage of the room described earlier. A larva found in the sample (Figure 8) was submitted to a consultant entomologist for examination, identification and comment. They reported as follows:

> *The sample was identified as a larva of* ***Endrosis sarcitrella*** *Linnaeus, the White-shouldered house-moth (Lepidoptera: family Oecophoridae).*

This species is often associated with slightly soiled carpets (often pet-associated) and favours slightly damp conditions. It is cosmopolitan and is found commonly in houses throughout the British Isles, so we are unable to comment accurately on the country of origin.

In terms of the age of the specimen, it appears most probably to be in the final or maybe the penultimate instar of 4-5 instars. Typically, a larva of this size (based on the life histories of similarly-sized members of the family Tineidae), if reared at 'normal' room temperatures, would be about 10-12 weeks old, but this can vary due to the fluctuating conditions of development in the natural, non-laboratory environment.

Figure 9 shows two images of the White-shouldered house-moth obtained from a literature search.

Further fragments of arthropod exoskeleton (Figure 10) found in the sample indicated that there were more than one species of woodlouse present and the leg shown in Figure 11 was possibly from an insect but it was not possible to identify this further.

A wide range of mineral grains (Figure 12) were found in the sediment that made up a large proportion of the sample. Many of these consisted of well-rounded sand typical of water-eroded sediment, others demonstrated more recent fracturing from their source rock. Most of the grains appeared to consist of silicate minerals, although some carbonate grains also appeared to be present. All of these particles would be expected in soil.

Sample C

The dried material in sample C consisted of man-made, synthetic and natural fibres with some hairs, fragments of plant material, including stem and leaf fragments and a few feathers (Figures 13 and 14). A seed (Figure 15), a moderate level of fine-grained sediment and a single insect fragment (Figure 16) were also found.
Like sample, A the feathers did not appear to be flight feathers and were therefore considered most likely to have originated from stuffing in pillows, cushions, furniture, etc.

Compound Light Microscopy Examination

Sample A

Examination of typical subsamples mounted on glass slides demonstrated sample A to contain a few hairs (Figure 17) that were considered likely to have originated from a small mammal e.g. cat, rodent, etc. Some fragmented pollen grains were also found (Figure 18). Figure 19 shows mixed textile fibres and a cat (probably) hair. Examination of a stained subsample of the very fine-grained suspended sediment in the retained liquid from this sample showed there to be a relatively high level of rod-shaped bacteria present (not shown).

Sample B

Examination of similar slides from sample B demonstrated the presence of red and yellow dyed hairs. These hairs were not human and were, therefore, considered likely to have originated from the carpet or other textile. A relatively low level of bacteria were found in the very fine-grained suspended sediment in this sample, which consisted of birefringent mineral grains, extremely fine-grained sediment, some optically dense particles and a low level of starch (Figure 20).

Sample C

Examination of similar subsamples from sample C demonstrated a mixture of different man-made fibres and fine-grained relatively structureless material (Figure 21). Some suspected plant material was confirmed by the presence of vascular xylem (Figure 22) and a very few human hairs (Figure 23) were also found. Examination of a stained subsample of the very fine-grained suspended sediment in the retained liquid portion of this sample showed it to be very different from the other two samples. It revealed a relatively high level of rod-shaped bacteria and a large number of squamous epithelial-type cells (Figure 24) that were considered to be skin cells. These would naturally slough off from the skin and accumulate as dust.

Scanning Electron Microscopy and X-ray Microanalysis

Examination of subsamples from the three samples by SEM did not reveal any new information but it did provide slightly different images of material already identified.

Sample A Feather barbules (Figure 25) and hair (Figure 26).
Sample B Hair (Figure 27)

X-ray microanalysis demonstrated that the fine-grained sediment in sample A contained high levels of carbon (C) and oxygen (O), moderate levels of sodium (Na), silicon (Si), phosphorous (P), sulphur (S), chlorine (Cl), potassium (K) and calcium (Ca), low levels of magnesium (Mg) and aluminium (Al) and traces of titanium (Ti) and iron (Fe) see Figure 29. It was considered possible that the oxygen, sodium and phosphorous were present as sodium phosphate. The high level of carbon was considered to indicate a relatively high organic content.
Similar analysis demonstrated the mud-like sediment from Sample B to contain a high level of carbon (C), moderate levels of oxygen (O), aluminium (Al), silicon (Si), phosphorous (P) and calcium (Ca), low levels of sodium (Na), magnesium (Mg), sulphur (S), chlorine (Cl) and potassium (K) and traces of titanium (Ti) and iron (Fe) see Figure 30. This result was considered consistent with the earlier observations, i.e. that the sediment contained silicate and carbonate (possibly calcium carbonate) minerals. Also, the high carbon content indicates a relatively high organic content.

Figure 1 Micrograph of a subsample from sample A x 14.5

Figure 2 Micrograph of a subsample from sample A x 14.5

Figure 3 Micrograph of hairs from sample A x 28.5

Figure 4 Micrograph of a subsample from sample B x 21.5

Figure 5 Micrograph of Arthropod fragments from sample B x 21.5
Figure 6 Micrograph of Arthropod fragments from sample B x 11.5

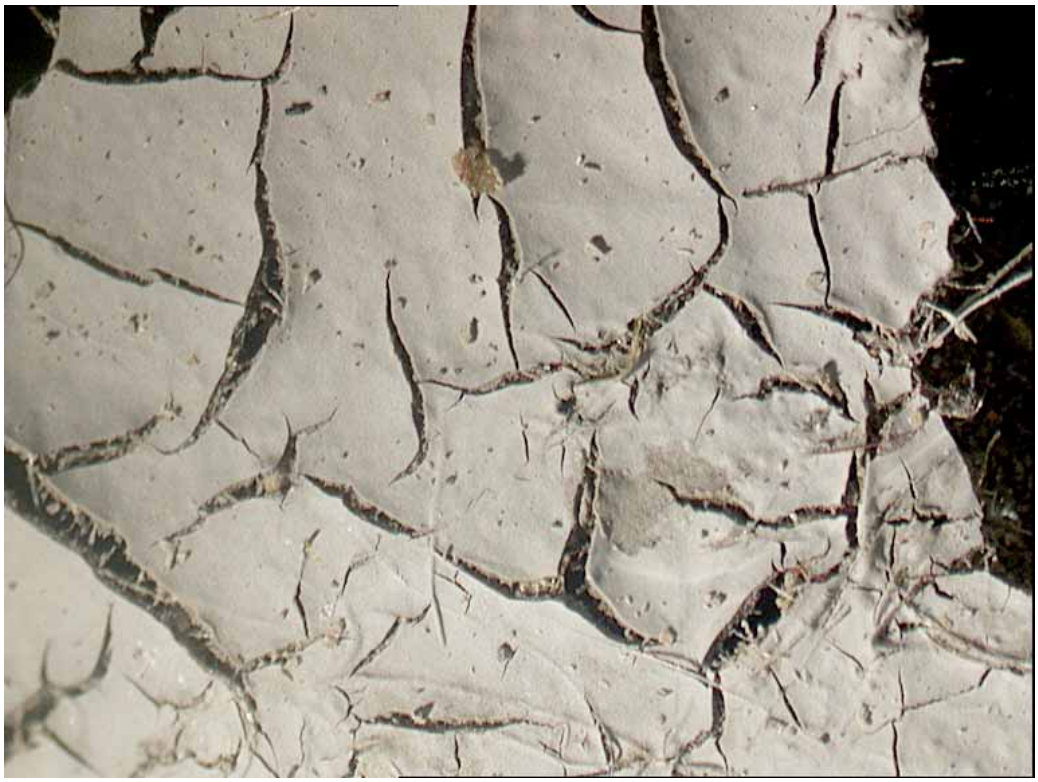


Figure 7 Micrograph of the mud from sample B x 21.5
Figure 8 Micrograph of the larvae from sample B x 21.5

Figure 9 Images of ***Endrosis sarcitrella*** Linnaeus, the White-shouldered house-moth (Lepidoptera: family Oecophoridae).

Figure 10 Micrograph of arthropod fragments from sample B x 11.5
Figure 11 Micrograph of insect/arthropod fragments from sample B x 50

Figure 12 Micrograph of mineral grains from sample B x 44
Figure 13 Micrograph of a subsample from sample C x 9.5

Figure 14 Micrograph of a subsample from sample C x 9.5

Figure 15 Micrograph of a seed from sample C x 44

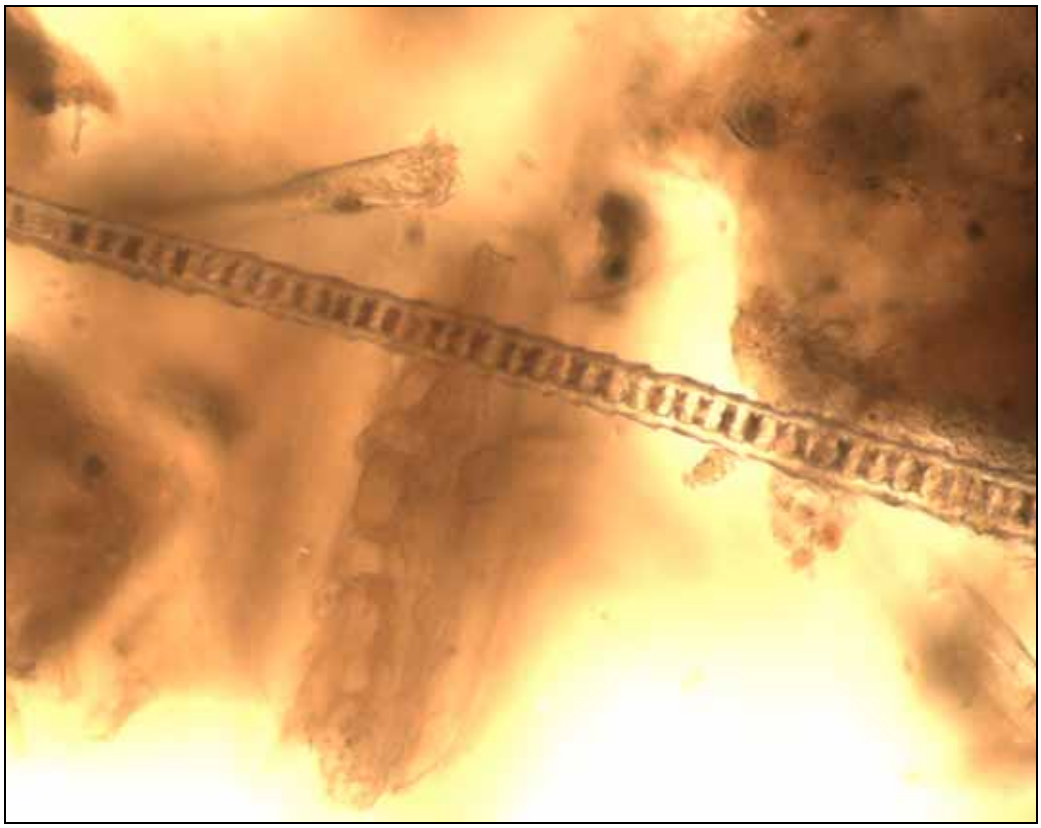


Figure 16 Micrograph of an insect fragment from sample C x 36.5

Figure 17 Micrograph of a hair in sample A x 410

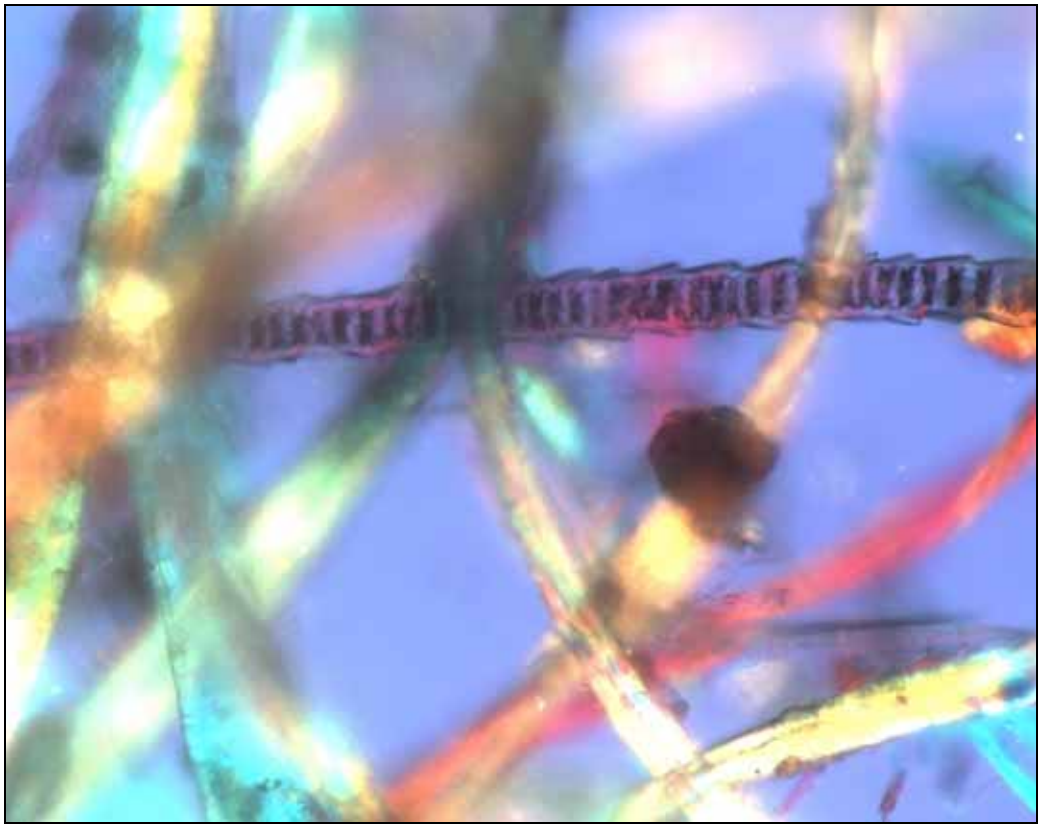
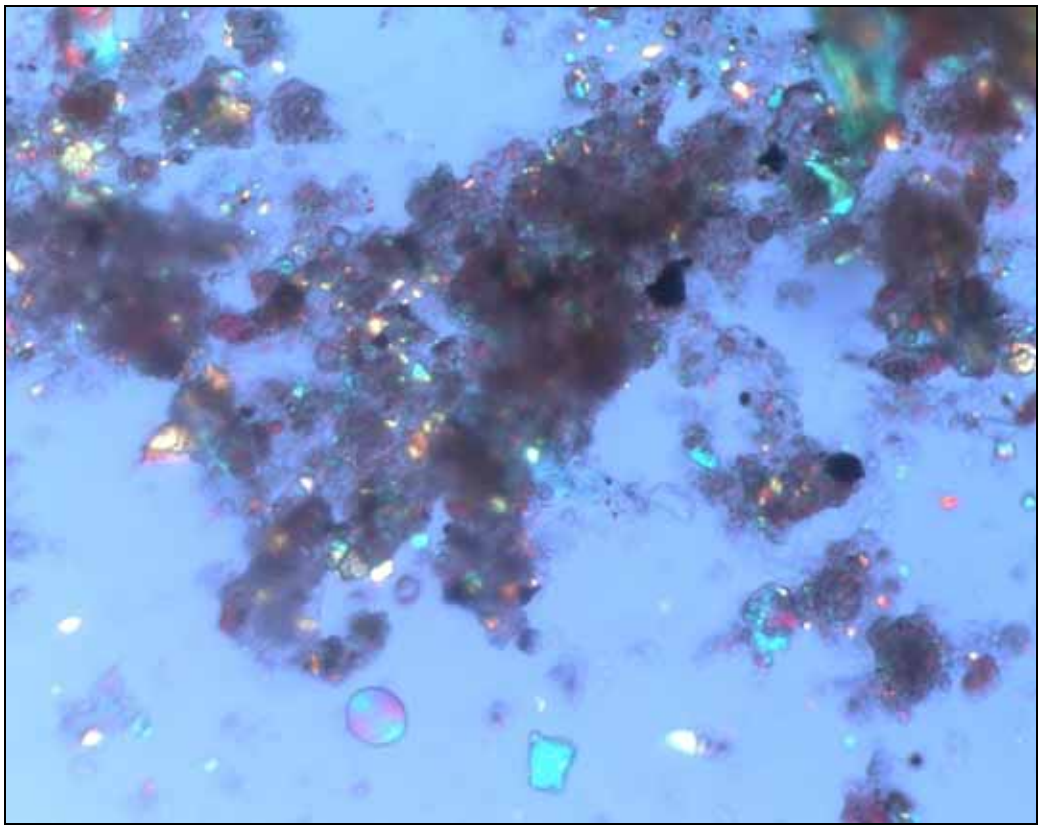


Figure 18 Micrograph of a pollen grain from sample A x 165
Figure 19 Micrograph of an animal hair and textile fibres, sample 1 x 410



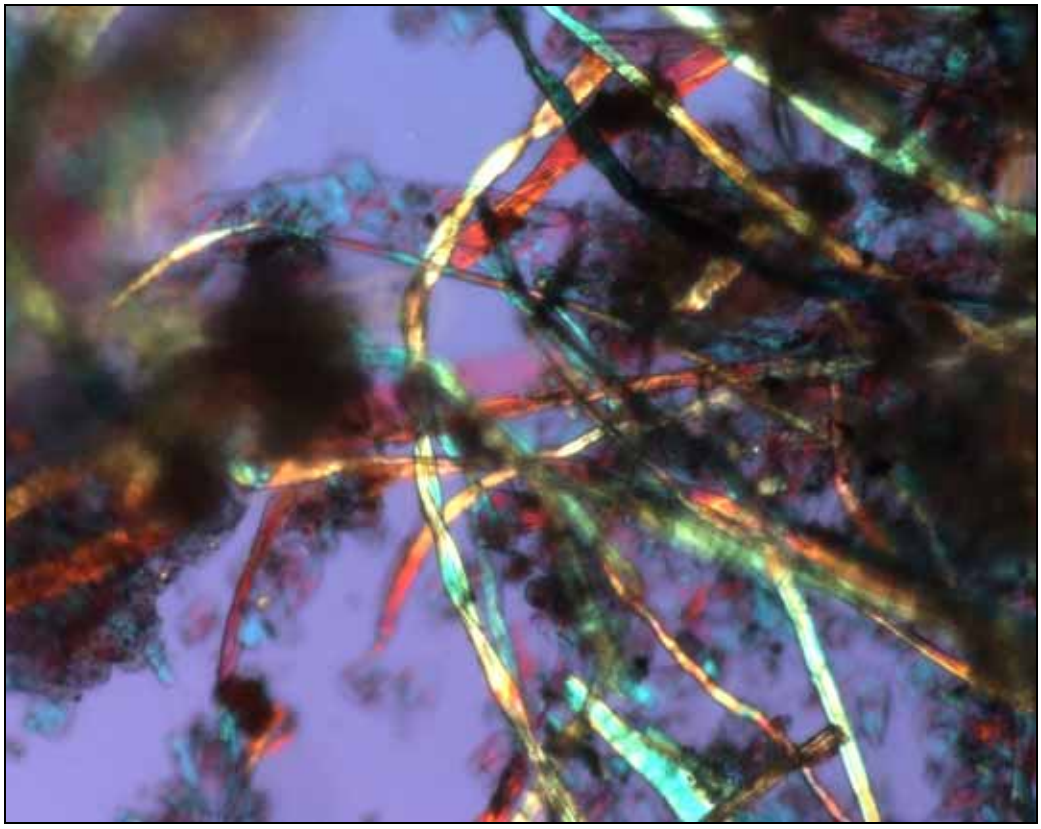
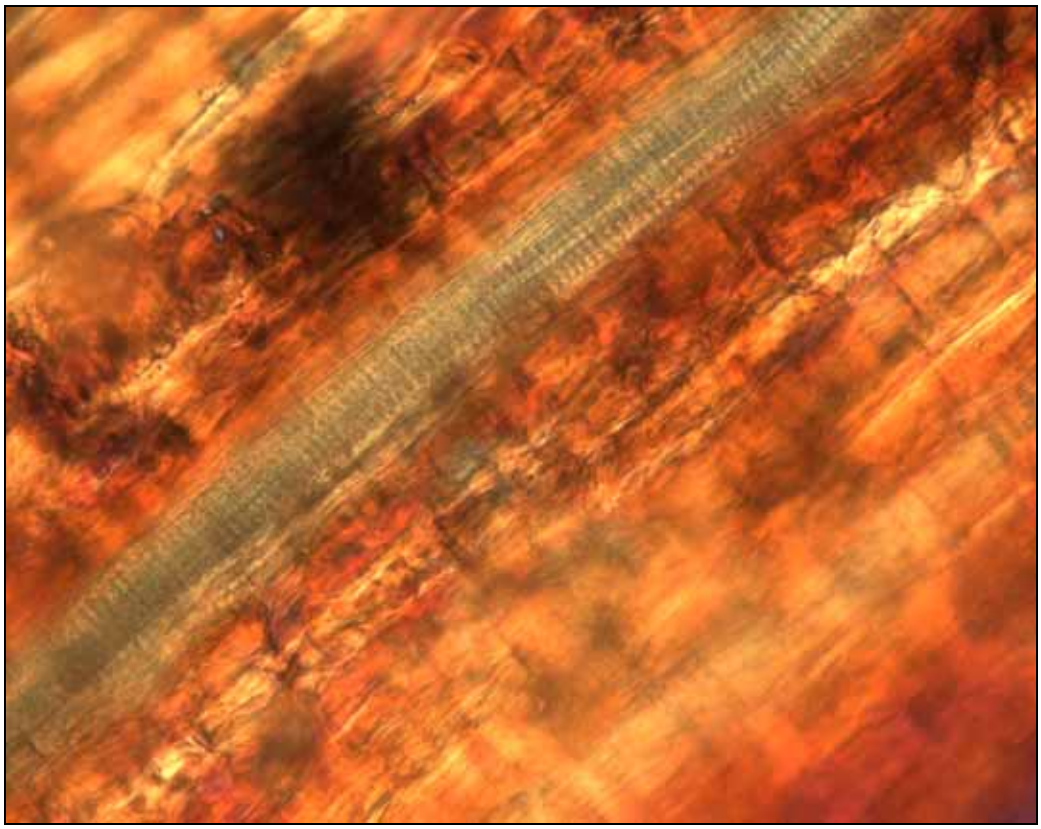


Figure 20 Micrograph of the fine grained sediment in sample B x 410
Figure 21 Micrograph of the fibres and sediment in sample C x 165



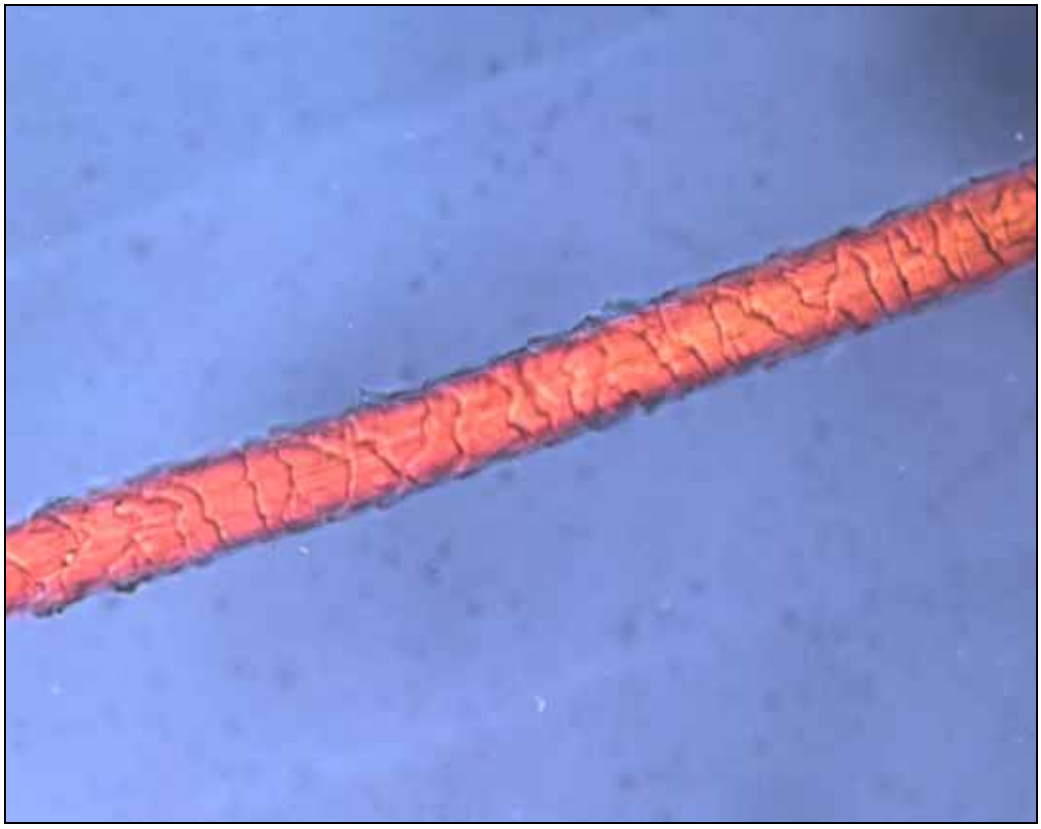


Figure 22 Micrograph of a fragment of plant tissue from sample C x 650

Figure 23 Micrograph of a mammal hair from sample C x 650

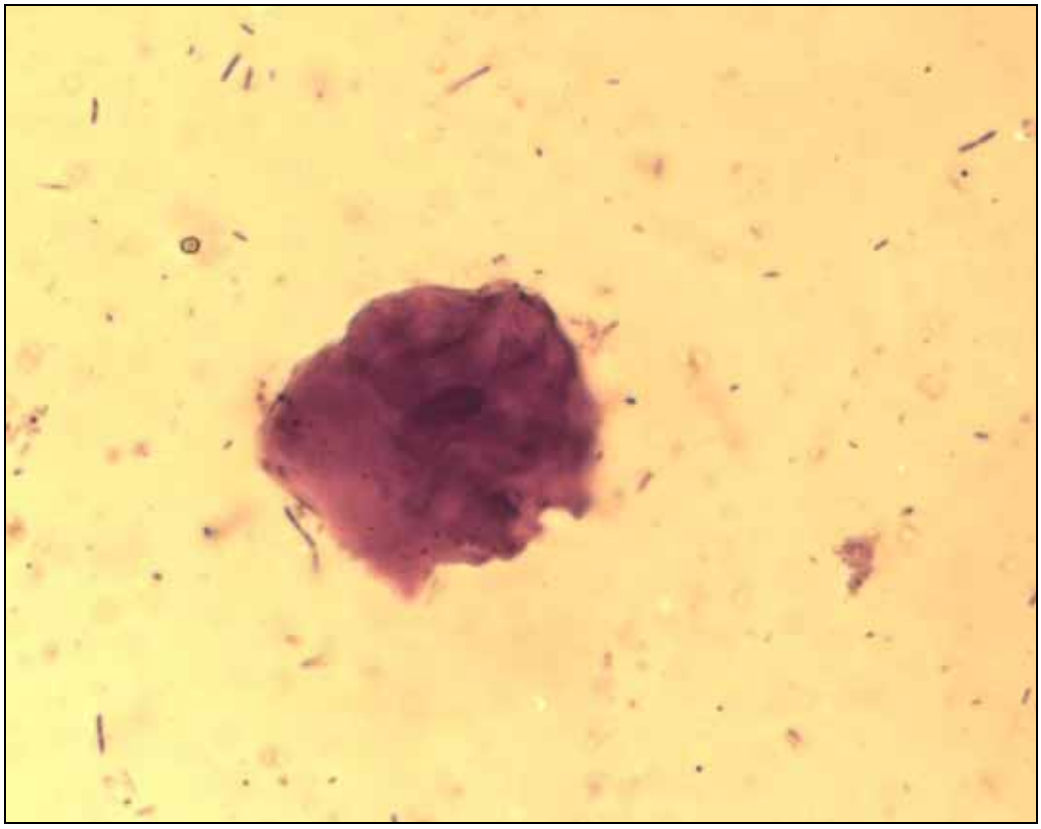
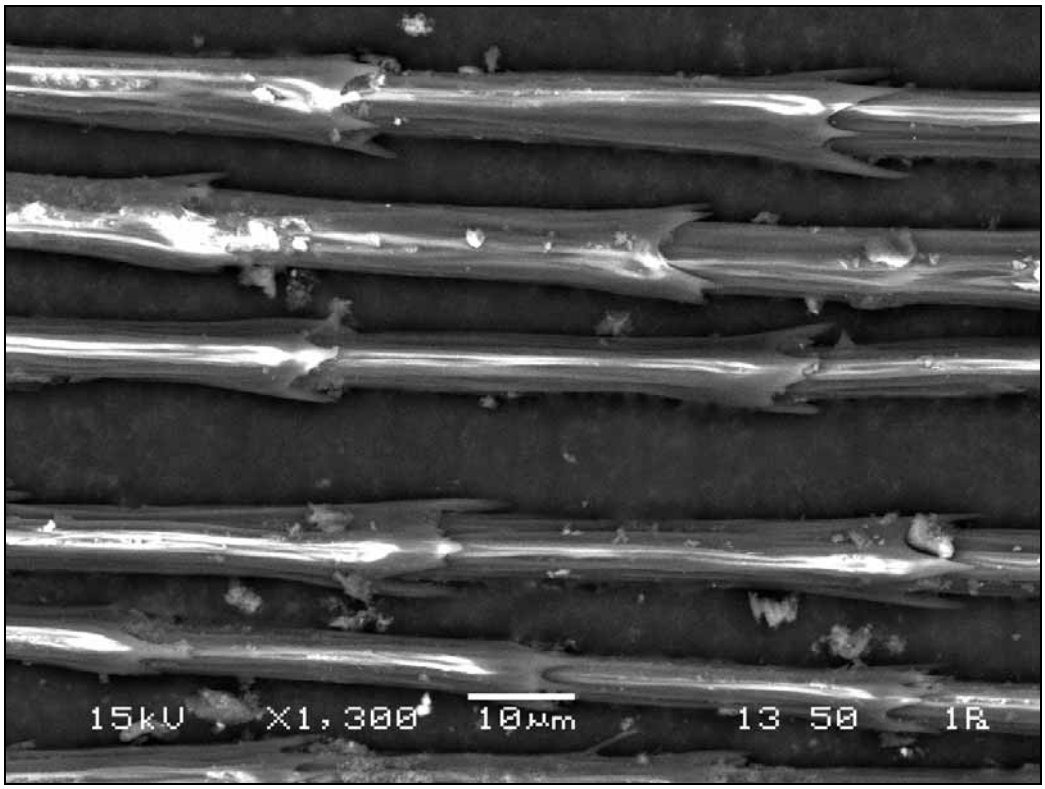


Figure 24 A skin cell and bacteria from sample C x 650



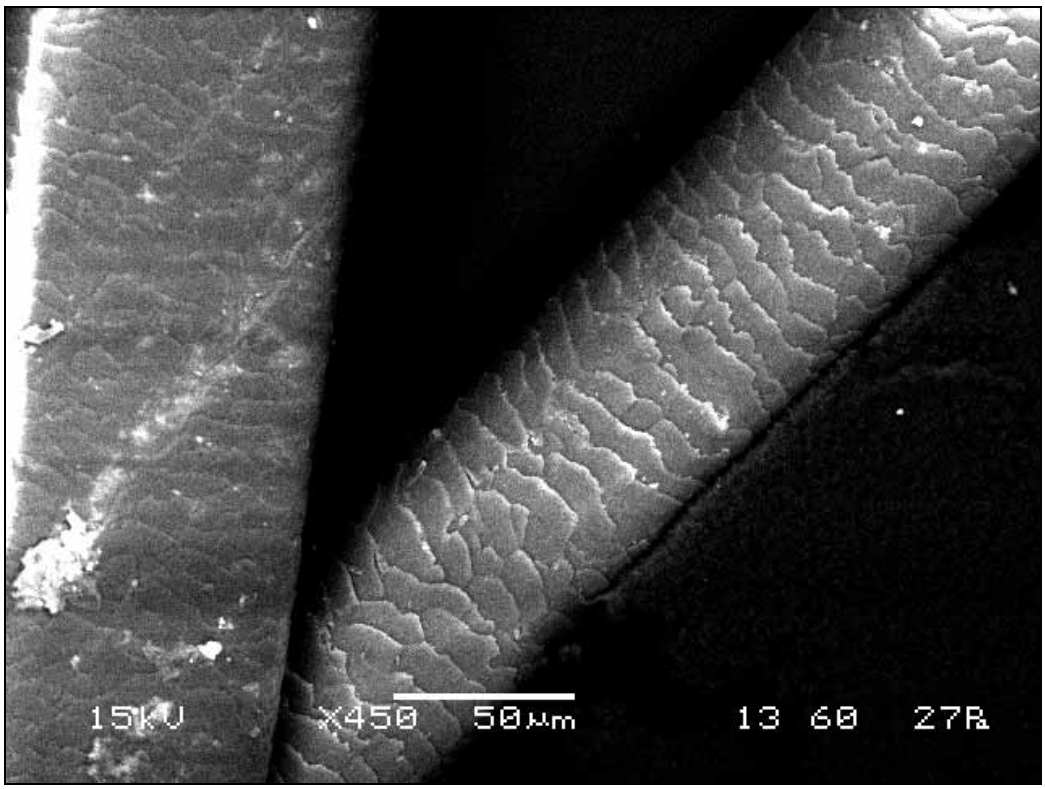


Figure 25 Feather barbules from sample A
Figure 26 Hairs from sample A; typical of those found in all three samples

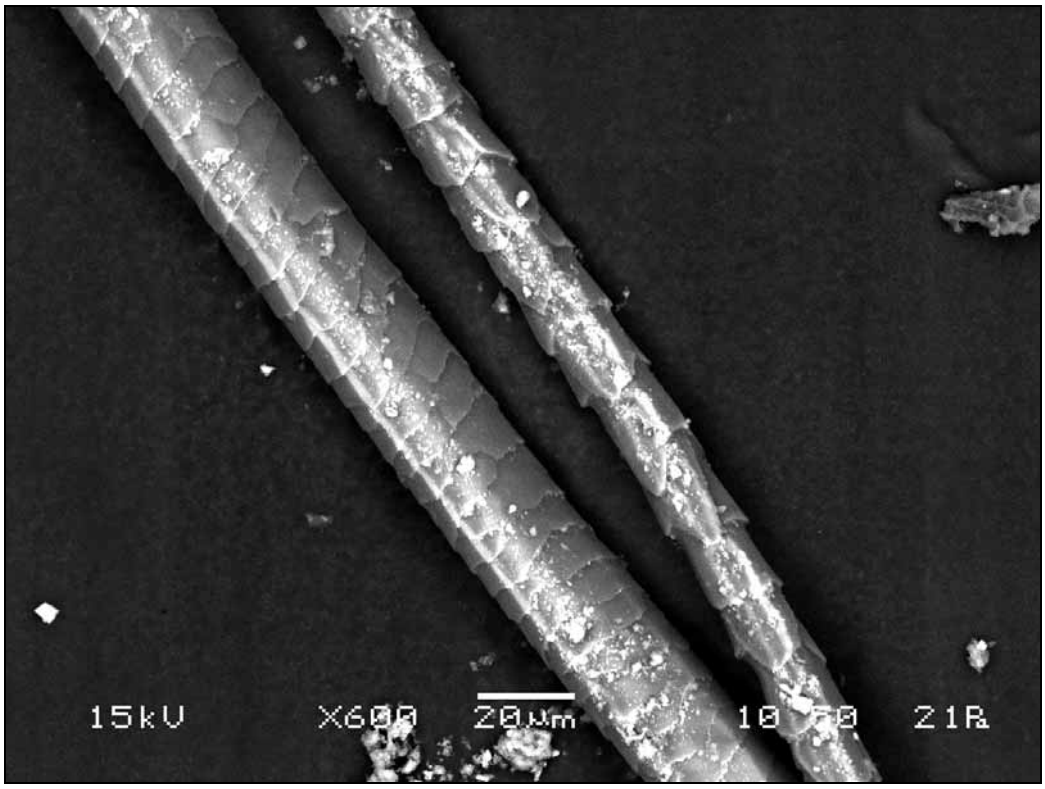


Figure 27 Micrograph showing the change in scale pattern along the length of a non-human hair, sample B

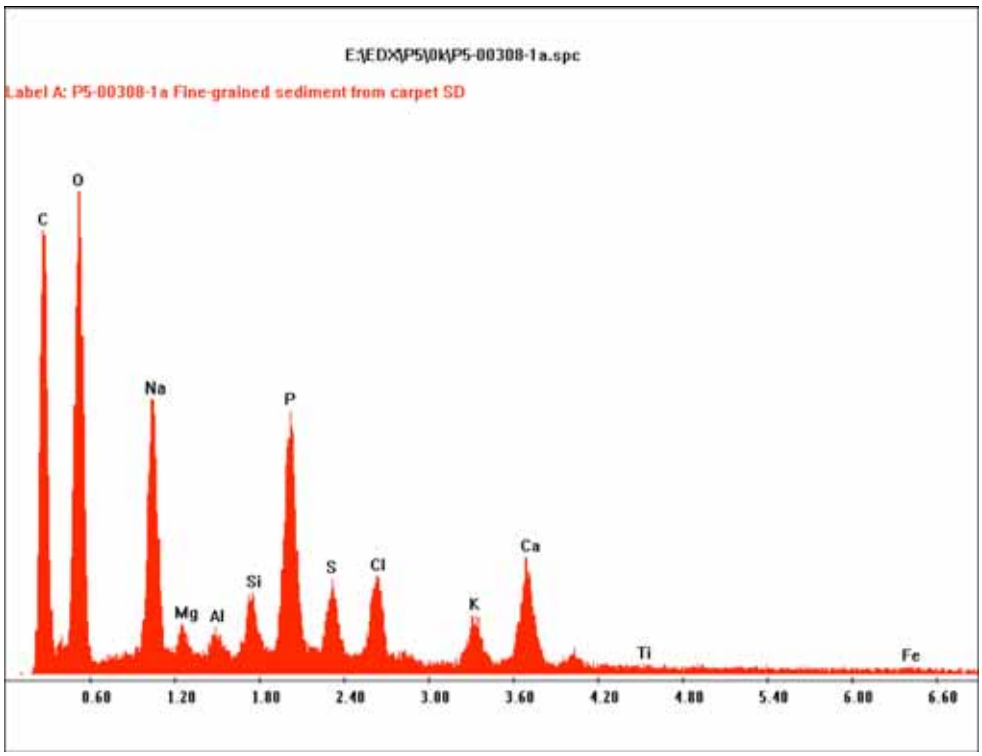


Figure 29 X-ray microanalytical spectrum of the fine-grained sediment in sample A

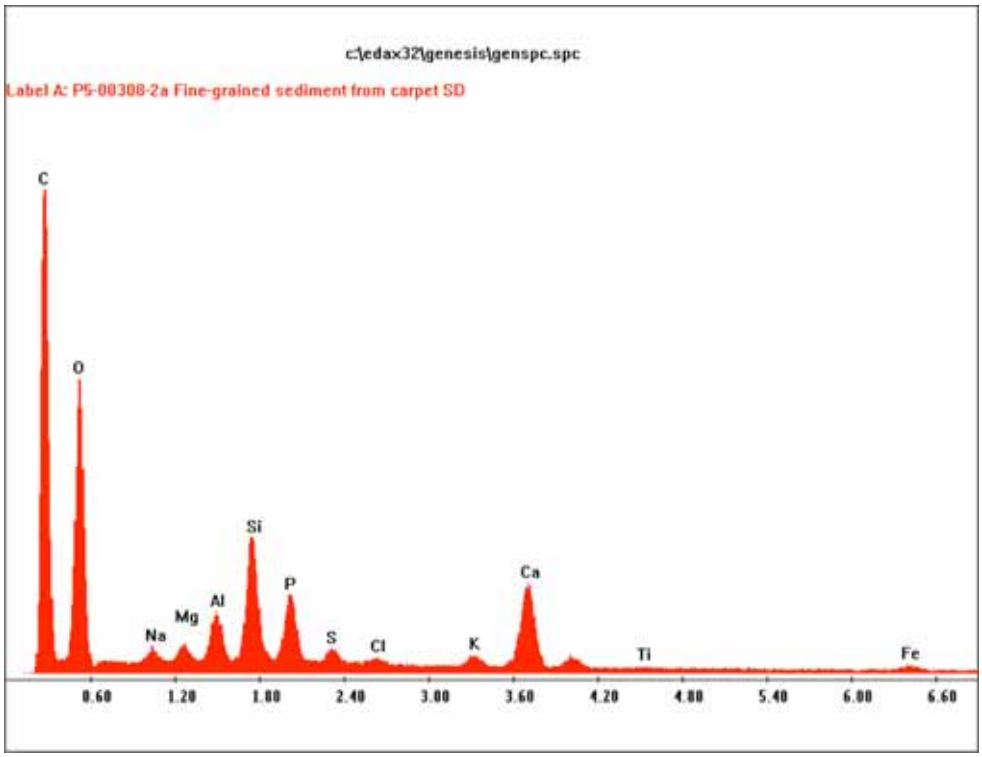


Figure 30 X-ray microanalytical spectrum of the mud-like sediment in sample B

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Struct/SD