A189 The Microscopic Study of the Statistical Significance of Household Dust Specimens

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After attending this presentation, attendees will understand some of the tenets behind principal component analysis, support vector machines, and partial least squares discriminant analysis in order to build statistical models of the composition profiles in the study of household dust specimens.

This presentation will impact the forensic science community by establishing the statistical significance of household dust specimens in trace evidence casework; its high confidence level of 99% and error rate of less than 1% reported will go a long way in re-establishing trace evidential materials as a powerful form of scientific evidence.

This paper continues the discussion and study of the statistical significance of household dust specimens presented at the 2011 AAFS Annual Scientific Meeting in Chicago. Additional results of the original household dust specimens, as well as new results for household dust specimens obtained from homes, businesses, and apartments encompassing the New York City Tri-State region, and from other areas in the United States are presented.

The original procedure which began with a preliminary visual and stereomicroscopic examination of each dust specimen has been expanded in order to include a more diverse array of particulate materials. The contents of each new dust specimen are sorted with the aid of a stereoscopic microscope into groups of similar-looking: hairs, fibers, and particulate materials depending on the composition of each dust specimen's composition. In addition, aggregate groupings of fibrous and particulate materials are teased out of each dust specimen and examined. Each aggregate group is further subdivided into smaller subsets based on their macroscopic physical appearance, primarily color and morphology. Each fibrous and/or particulate subset is mounted on a 7.5cm x 5cm microscope slide in Cargille® 1.540 High Dispersion (HD) refractive index oil. Finally, each fibrous and/or particulate subset aliquot is characterized and identified utilizing stereo and polarized light microscopy. Three aliquots were examined from each household dust specimen. Particulates too large to be mounted for PLM examination were studied with other forms of analytical instrumentation, i.e., Fourier Transform Infrared Spectroscopy, X-ray Fluorescence, and X-ray Diffraction.

The resulting information for each new specimen and its mounted subset was collected on a revised dust tabulation data sheet specifically designed for this study. The newly acquired data and the data collected in the prior study were combined and resubjected to principal component analysis, support vector machines, and partial least squares discriminant analysis in order to build statistical models of the composition profiles. These statistical models were then subjected to a test set of randomly selected unlabeled dust samples in order to compute estimates of misidentification rates (error rates). The methods used to compute these error rates were hold-one-out cross validation and bootstrapping.

A number of interesting trends, such as the ubiquitous occurrence of certain types of natural fibers, the recent occurrence of a wider range of species of natural fibers, the appearance of microfibers, the appearance of faux fibers, the proliferation of green fibers, and the expansion of more diverse mixtures of synthetic fiber types as well as the frequent occurrence of several classes of biological and particulate materials, are extensively discussed. Recommendations regarding the use and value of these ubiquitous materials in establishing whether a contact transfer occurred based on their presence are statistically evaluated and discussed at length.

In particular, the building of sound scientifically acceptable statistical models that meet the challenges of the NAS Report on Forensic Sciences, and establish high confidences, levels and accurate error rates for the microscopic examination of forensic dust specimens were primary goals in this study.

Statistical Significance, Household Dust, Trace Evidence

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