Fatal Vision Revisited

Jeffrey MacDonald in 1995 at Sheridan, Oregon, Federal Correctional Institution. Courtesy AP Wide World Photos

Dr. Jeffrey MacDonald was convicted in 1979 of murdering his wife and two young daughters. The events surrounding the crime and the subsequent trial were recounted in Joe McGinniss's best-selling book Fatal Vision. The focus of MacDonald's defense was that intruders entered his home and committed these violent acts. Eleven years after this conviction, MacDonald's attorneys filed a petition for a new trial, claiming the existence of "critical new" evidence.

The defense asserted that wig fibers found on a hairbrush in the MacDonald residence were evidence that an intruder dressed in a wig entered the MacDonald home on the day of the murder. Subsequent examination of this claim by the FBI Laboratory focused on a blond fall (a type of artificial hair extension) frequently worn by MacDonald's wife. Fibers removed from the fall were shown to clearly match fibers on the hairbrush. The examination included the use of infrared microspectrophotometry to demonstrate that the suspect wig fibers were chemically identical to fibers found in the composition of the MacDonald fall (see Figure 1). Hence, although wig fibers were found at the crime scene, the source of these fibers could be accounted for—they came from Mrs. MacDonald's fall.

Another piece of evidence cited by MacDonald's lawyers was a bluish-black woolen fiber found on the body of Mrs. MacDonald. They claimed that this fiber compared to a bluish-black woolen fiber recovered from the club used to assault her. These wool fibers were central to MacDonald's defense that the "intruders" wore dark-colored clothing. Initial examination showed that the fibers were microscopically indistinguishable. However, the FBI also compared the two wool fibers by visible-light microspectrophotometry. Comparison of their spectra clearly showed that their dye compositions differed, providing no evidence of outside intruders (see Figure 2). Unfortunately, the U.S. Supreme Court denied the modified MacDonald's petition for a new trial.

FIGURE 1
A fiber comparison made with an infrared spectrophotometer. The infrared spectrum of a fiber from Mrs. MacDonald's fall compares to a fiber recovered from a hairbrush in the MacDonald home. These fibers were identified as modacrylics, the most common type of synthetic fiber used in the manufacture of human hair goods. Courtesy SA Michael Malone, FBI Laboratory, Washington, D.C.

FIGURE 2
The visible-light spectrum for the woolen fiber recovered from Mrs. MacDonald's body is different from that of the fiber recovered from the club used to assault her. Courtesy SA Michael Malone, FBI Laboratory, Washington, D.C.

Chapter Review

- The hair shaft is composed of three layers called the cuticle, cortex, and medulla and is most intensely examined by the forensic scientist.
- When comparing strands of hair, the criminalist is particularly interested in matching the color, length, and diameter. Other important features in comparing hair are the presence or absence of a medulla and the distribution of pigment granules in the cortex.
- The probability of detecting DNA in hair roots is more likely for hair being examined in its anagen or early growth phase as opposed to its catagen or telogen phases.
- The follicular tag, a translucent piece of tissue surrounding the hair shaft near the root, is a rich source of DNA associated with hair. Mitochondrial DNA can also be extracted from the hair shaft.
- All positive microscopic hair comparisons must be confirmed by DNA analysis.
- Fibers may be classified into two broad groups: natural and manufactured.
- Most fibers currently manufactured are produced solely from synthetic chemicals and are therefore classified as synthetic fibers. They include nylon, polyesters, and acrylics.
- Microscopic comparisons between questioned and standard/reference fibers are initially undertaken for color and diameter characteristics. Other features that could be important in comparing fibers are striations on the surface of the fiber, the presence of delustered particles, and the cross-sectional shape of the fiber.
- The visible-light microspectrophotometer is a convenient way for analysts to compare the colors of fibers through spectral patterns.
- Infrared spectrophotometry and the polarizing microscope are reliable methods for identifying the chemical composition of fibers.
- Fiber evidence collected at each location should be placed in separate containers to avoid cross-contamination. Care must be taken to prevent articles of clothing from different people or from different locations from coming into contact.

Review Questions

1. The ___________ is important for the individualization of hair.
   a. cuticle  
   b. cortex  
   c. follicular tag  
   d. medulla

2. The final growth phase in which hair naturally falls out of the skin is called the
   a. telogen phase.  
   b. anagen phase.  
   c. catagen phase.  
   d. follicular phase.

3. The most prevalent plant fiber is
   a. hemp.  
   b. cotton.  
   c. wool.  
   d. mohair.

4. Which of the following is not a manufactured fiber grouping?
   a. polyester  
   b. rayon  
   c. mohair  
   d. spandex

5. In the examination of fibers, the first and most important step in the examination will be
   a. a microscopic comparison for color and diameter using a comparison microscope.  
   b. a determination of whether the fiber is natural or manufactured.  
   c. synthesizing long-chained molecules into a polymer.  
   d. analyzing the individual characteristics of the material.

6. True or False: Because of advances in forensic technology and the equipment available, it is now possible to individualize human hair through its morphology.

7. True or False: Two of the features that make hair a good subject for establishing individual identity are its resistance to chemical decomposition and its ability to retain structural features over a long period of time.

8. True or False: Most often, when hair evidence is present in a criminal case, the primary purpose is to establish the identity of the individual when no other means is available.

9. True or False: The ultimate value of fibers as forensic evidence will depend on the criminalist’s ability to narrow their origin to a limited number of sources or even to a single source.

10. True or False: Properties frequently used to identify fibers are refractive index and an IR spectrum.

11. What is hair and what organ produces it?
18. What two features make hair a good subject for establishing individual identity? To which layer of the hair shaft are much of these features attributed?

14. The scale pattern of the cuticle is an important feature for characterizing hair.

15. What is the main forensic importance of the cortex?

16. What is the difference between the medullae of human and animal hairs? Name one exception to this among humans.

17. Name three phases of hair growth. A criminalist is more likely to collect DNA from hairs in which stage of growth? Why?

18. Why must microscopic human hair comparisons be undertaken with extreme caution?

19. In comparing hairs, what aspects of the hair is the criminalist particularly interested in matching? Name at least one other important feature that the criminalist may compare.

20. Which of the following questions cannot be answered with a microscopic examination of hair?
a. whether a hair came from a 25-year-old or an infant
b. whether a hair is from a man or a woman
c. whether a hair is from a scalp or a beard
d. whether the hair is consistent with Caucasian or Negroid hair

21. What types of hairs found at a crime scene are most likely to provide useful DNA evidence? Why?

22. What part of a hair is most likely to yield useful DNA evidence?

23. Why must questioned hairs and standard/reference hairs being compared come from the same area of the body?

24. Hairs from which parts of the body are most often used for hair comparisons?

25. Why should the entire hair be collected when performing a hair comparison?

26. Define polymer and monomer. Why are polymers sometimes known as macro-molecules?

27. Which of the following is not an example of a natural polymer?
a. starch
b. cellulose
c. sugar
d. protein

28. What two morphological characteristics does a criminalist first compare when examining fibers with a microscope? What other features may be important in such a comparison?

29. What analytical technique does a criminalist use to analyze the composition of the dye in a fiber?

30. Describe three analytical techniques for comparing the color of two fibers.

Application and Critical Thinking

Indicate the phase of growth of each of the following hairs:
a. the root is club-shaped
b. the hair has a follicular tag
c. the root bulb is flame-shaped
d. the root is elongated

3. A criminalist studying a dyed sample hair notices that the dyed color ends about 1.5 centimeters from the tip of the hair. Approximately how many weeks before the examination was the hair dyed? Explain your answer.

4. Following are descriptions of several hairs; based on these descriptions, indicate the likely race of the person from whom the hair originated.
a. evenly distributed, fine pigmentation
b. continuous medullation
c. dense, uneven pigmentation
d. wavy with a round cross-section

4. Criminalist Pete Evert is collecting fiber evidence from a murder scene. He notices fibers on the victim's shirt and trousers, so he places both of these items of clothing in a plastic bag. He also sees fibers on a sheet near the victim, so he balls up the sheet and places it in separate plastic bag. Noticing fibers adhering to the window sill from which the attacker gained entrance, Pete carefully removes them with his fingers and places them in a regular envelope. What mistakes, if any, did Pete make while collecting this evidence?

5. For each of the following human hair samples, indicate the medulla pattern present.
The most common scale patterns found on hairs are generally classified as coronal, spinous, and imbricate. Examine the scale casts of animal hairs shown here and indicate the scale pattern of each.

A.  
B.  
C.  
D.  
E.  
F.  
G.  
H.

A young child is kidnapped from her school playground. Shown on the left is a reference sample of the kidnapped child’s hair. The only cars that left the parking lot before the child was discovered to be missing were those of four cafeteria workers. The car of each worker was searched and hairs collected. These recovered hairs are shown on the right. Which recovered hair, if any, is consistent with that of the victim and warrants further investigation?

Hair from car of Worker A
Hair from car of Worker B
Reference Hair from Victim
Hair from car of Worker C
Hair from car of Worker D

Courtesy Richard Safarstein, Ph.D.