Biology 2201 CONNECTIONS + SCIENCE AND TECHNOLOGY: Plant Anatomists as detectives?   Name: _____________

Article Written By:
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FBI agents, police, lawyers, medical and veterinary doctors, agricultural extension specialists, and members of the public have all had occasion to contact me over the past several years concerning the identification of plant material. Usually this material was chewed, digested, burned, dried, or otherwise distorted, so that the identity of the plant or plant organ was no longer apparent. Yet every plant species contains cell types with special structures, shapes, sizes, and staining reactions--characteristics that make it possible to identify the plant. Regardless of the kind of case, similar micro technique tools and methods are used, and the application of basic knowledge of plant anatomy is required.

Plant anatomists have been involved in many legal cases, but mostly we are asked for opinions dealing with medical or agricultural problems. For example, agricultural extension specialists need help in identifying root specimens pulled from clogged sewers. Veterinarians who suspect that sick animals have eaten poisonous plants will call plant anatomists. Anatomists have also worked with anthropologists interested in ancient basketry or the identification of wood and charcoal pieces found in ancient fire pits.

Probably the most famous legal case involving a plant anatomist was the Lindbergh kidnapping. In 1932 the infant son of celebrated aviator Charles Lindbergh and his wife, Anne Morrow Lindbergh, a noted writer and poet, was kidnapped out of a second-story nursery. The kidnapper sent a ransom note, but the baby was later found dead. The only evidence left at the crime scene was a crude wooden ladder leaning against the second story window. The police and FBI gave the ladder to the Forest Products Laboratory in Wisconsin for analysis. A plant anatomist there, Arthur Koehler, was able to specifically identify the wood used. After a man named Bruno Hauptmann was arrested for the crime, police found that several boards were missing from the floor of the attic in his house. Pieces of this wood were sent to scientists at the Forest Products USDA Laboratory in Wisconsin, and they positively identified the wood as a match to the ladder. This testimony was used to convict Hauptmann, who was later executed.

Most cases are less poignant. In 1984 I was contacted by the Sheriff's office in Calaveras County, California (the part of California's gold country made famous by Mark Twain's story of the jumping frog contest). In this instance, a man was suspected of growing marijuana (Cannabis sativa) in an elaborate hydroponic setup in his attic. The suspect was warned of an impending raid just before the sheriff arrived. He hid the stems 24 of the plants outside his house and tried to burn the stem stumps and roots in his fireplace. The sheriff arrested him and took the partially burned material as evidence. The suspected grower reportedly told a sheriff's deputy that he would get off because it was not possible to prove that he was burning marijuana in his fireplace. I examined the material taken as evidence and compared it with known specimens of marijuana from herbarium sheets and from identified marijuana stems. The charred evidence and the known specimens showed similar wood anatomy. After I testified in a pretrial hearing that, based on the comparison, the partially burned material was most likely marijuana, the defendant accepted a plea bargain. The case was never brought to trial.

Several of my cases have come from the San Diego Zoo. One of them involved a group of Hanuman langur monkeys, a rare Asian species. For two years the monkeys had been fed mostly Acacia leaves. Suddenly three monkeys died after bouts of weight loss, diarrhea, and vomiting. An autopsy revealed intestinal lesions and plugging with masses of fibrous plant material. I examined some of this material, along with samples of Acacia leaf browse and other plant materials within reach of the monkey enclosure. Microscopic examination of this material revealed partially digested vascular strands with attached thick-walled cells and small epidermal fragments. By making polarized light images and comparing them to known specimens, I was able to identify the material as Acacia leaf vascular bundles. The keepers changed the monkeys' feed.

The point of these stories is that the study of plant anatomy has uses far beyond just knowing what is inside the plant. Basic information and a few simple tools--such as a razor blade, some common dyes, and a microscope--can go a long way toward solving criminal and medical puzzles. So study hard; you never know when your knowledge of plant anatomy might come in handy.

1. What are five jobs that could require you to contact a plant anatomist?

2. Why would an agricultural extensions specialist need help from a plant anatomist?

3. Why would a veterinarian call a plant anatomist?

4. Why would an anthropologist contact a plant anatomist?

5. How did police confirm that Bruno Hauptmann was the kidnapper and murderer?

6. How did the police confirm that it was Marijuana?

7. How did they find out what killed the monkeys?

Article Written By:
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The direct relation between plants and music is obvious if one thinks about it even a little. The earliest musical instruments were probably drums made of grooved or hollowed logs, and to this day drums are usually made of wood cylinders, typically with skins or synthetic materials stretched over them. The bodies of ancient stringed instruments, such as lyres and harps, were made of wood. Tambourines, pan pipes, whistles, recorders, early flutes, shawms, accordions, organs, harpsichords, and pianos were, and still are, made largely of wood. Bodies, bells, mouthpieces, backs, sides, fronts, bridges, or fingerboards of clarinets, English horns, oboes, bassoons, violins, violas, cellos, contrabasses ("stand-up basses"), xylophones, and guitars are made of various kinds of wood carefully chosen for their acoustic and other physical properties.

But wood is not the only plant material that contributes to music making. Many of you have made a sort of whistle using your hands and a blade of grass. Paper, most of which is made of various kinds of plant fibers, can be used to made a kazoo. The oldest types of traditional flutes and whistles were made of various types of cane, a cousin of bamboo. For 2,000 to 3,000 years, the preferred type of cane has traditionally been Arundo donax (giant cane). The hollow stems from this species have always been the best for making reeds for woodwind instruments, such as clarinets (Fig. 1), saxophones, oboes, and bassoons, and for not-so-obvious examples, such as the Chinese sheng (perhaps the oldest reed instrument), Turkish zurna, Egyptian mizmar, Vietnamese ding tac ta (played by inhaling), Scot and Irish bagpipes, hornpipes, krummhorns, concertinas, bandoneons, small organs, some harmonicas, melodicas, and many others.

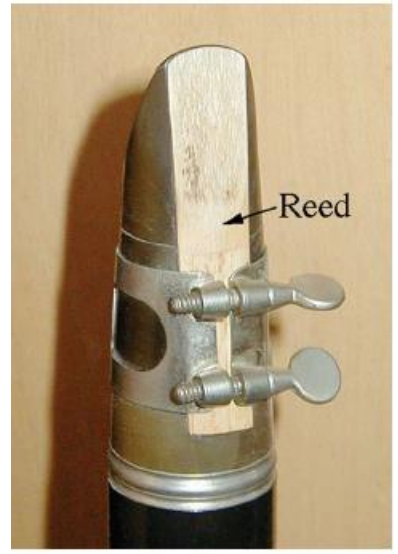

Figure 1. A clarinet reed is a piece of *Arundo donax* stem that has been carved or machine milled to an appropriate shape and clamped to the mouthpiece of the instrument. Air from the player's lungs causes the reed to vibrate.

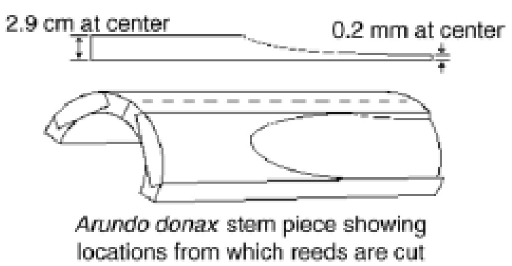

Figure 2. Traditionally, internodes of *A. donax* were quartered and then carved into the characteristic reed shape. This process is now done commercially by milling machines.

Anyone who has played the clarinet or other reed instrument for any length of time knows that getting a reed that produces just the right sound quality is a challenge. Players who cut their own reeds can tell you that the raw material is highly variable in its playing properties. Commercially, clarinet reeds are made from quartered pieces of Arundo donax internodes that are milled into the classic reed shape (Fig. 2). In the past some commercially made reeds often were discarded because they did not sound quite right when used with a particular instrument.

When I started the project described below a considerable traditional lore had developed among players and people who manufactured reeds as to how to select and process them. In 1992, as part of an effort to improve their products, Rico International, an American reed-making company, asked me to research whether there were aspects of the anatomy of A. donax plants that predisposed them to be especially good or bad for clarinet reeds. We asked several skilled symphonic performers to play a number of clarinet reeds and to identify the best and the worst among them. Each reed was randomly given a numeric code identifier, and the reeds were sent to me for analysis. I had no idea which reeds played well.

Thin sections (slices) of each reed were carefully cut. The sections were treated with stains to increase the contrast of the cells and tissues in the reed, and photographs were then taken of each section using a precision photomicroscope. For each reed I recorded twenty-three anatomic characteristics (for example, the ratio of vascular to ground tissue, the size of vascular bundles, the shape of vascular bundles, the proportion of vascular bundles that was bundle sheath tissue, the length and diameter of parenchyma cells, the thickness of parenchyma cell walls, and so on). The combined data were statistically analyzed.

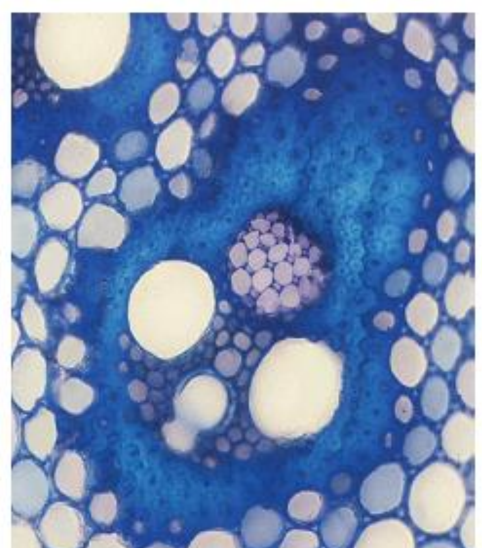

Figure 3. The best sounding reeds have vascular bundles with thick bundle sheaths of fiber cells that completely surround each bundle. The more of the vacular bundles that look like this, the better.

I found that the coded reeds clustered into two groups when several characteristics of the vascular system were considered in combination. The statistical conclusion for any particular clarinet reed matched the professional players' assessments 92% of the time for good reeds and 85% of the time for bad reeds. My analysis showed that reeds made better music when their vascular bundles were more or less lined up, uniformly distributed through the tissue, and had thick, fibrous bundle sheaths that completely surrounded the vascular bundles (Fig 3). Because my study was done for a private company it was never published, but another group of scientists in Australia, which included a clarinet player, did a similar study. Using similar methods, they came to the same conclusions that I did. It was satisfying to know that other scientists had confirmed my results. Clarinet reed manufacturers can now use these data to help them select the best canes for new reeds. It is clear to me that science can be used to help artists get better results.

1.) What are five instruments that are made of wood?

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2.) A) What type of wood has been traditionally used for the last 2000-3000 years to make flutes and whistles?

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B) What are 5 instruments that have reeds?

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3.) How many characteristics did Dr. Daniel K. Gladish look at? ________

4.) What four characteristics made the best reeds?

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5.) Why did he not get credit for the discovery? ____

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