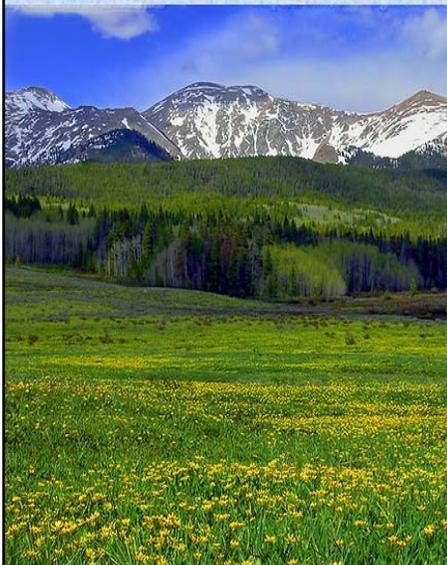


FORENSIC PALYNOLOGY: WHY IT WORKS

VAUGHN M. BRYANT
Palynology Laboratory
Texas A&M University (TAMU 4352)
College Station, Texas 77843
979-845-5242
vbryant@neo.tamu.edu

1

Why is pollen a good forensic tool?



- There are about $\frac{1}{2}$ million plants that produce pollen or spores, each species is unique
- Some plants are wind-pollinated and *disperse millions of pollen grains or spores*, most fall close to the source, some can travel great distances
- Some plants are **insect-pollinated** and **produce only thousands of pollen grains** that don't get dispersed easily
- Each geographical region produces a unique "*pollen print*" that can be very useful in linking "things" *to the exact location*

2

Situations in which pollen studies could assist in an investigation

A few examples of how pollen can be used in forensics:

- **Suspect** → primary or secondary crime scene, object, victim
- **Secondary crime scene** → linked to primary crime scene, to the victim, to the suspect, to an object
- **Item from a crime scene** → suspect, victim, secondary crime scene, to other objects (vehicle, clothing, etc.)
- **Item in suspect/victim's possession** → linked to victim, to primary and/or secondary crime scenes, to vehicle used
- **Item, suspect or victim** → linked to geographical location of crime scene (primary or secondary)

3

Other applications of forensic Pollen data include

- **Corroborate a victim's account:** (location of crime scene)
- **Build a profile of the suspect:** from pollen found at crime scene
- **Narrow the list of potential suspects**
- **Point the investigation in the correct direction**
- **Determine the origin or travel history of items:** antiques, drugs, weapons, money, explosive devices, vehicles, etc.
- **Determine the geographic contents & origin of food products**
- **Determine the season in which a crime was committed**

4

Beginning of Forensic Palynology



- Pollen analysis begins in 1916 in Sweden with the concept that was first outlined by *Lennart von Post*
- Earliest use of pollen as a forensics technique may be unrecorded prior to 1950s
- Earliest known use was in 1959

5

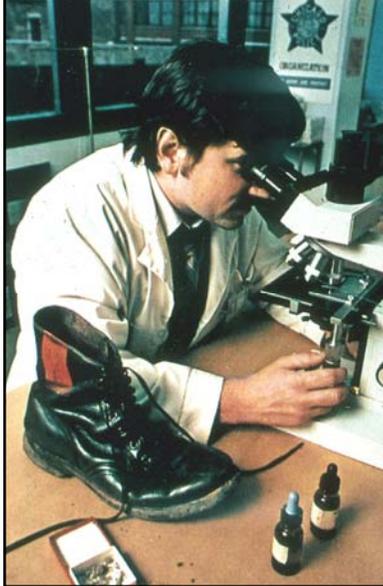


Murder Case: Sweden in 1959

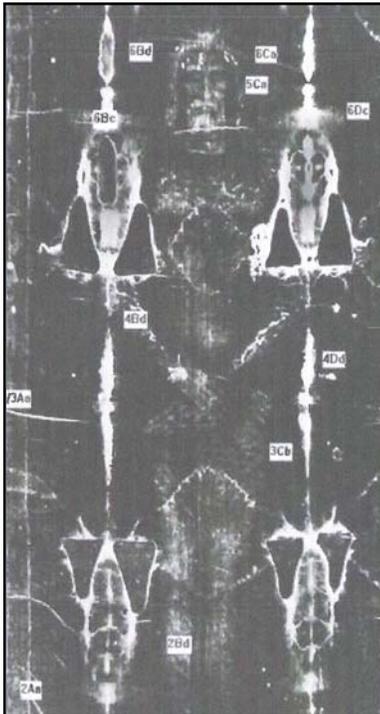
- Soil **washed from the clothing** on a murdered woman, liquid sent to a palynologist at the University of Sweden to examine
- Surface dirt (**control samples**) was collected at the crime scene from areas near the body, pollen from the *control samples did not match pollen from the soil on the clothing* of the victim
- That told the police the victim was killed somewhere else

6

Murder Case: Austria in 1959

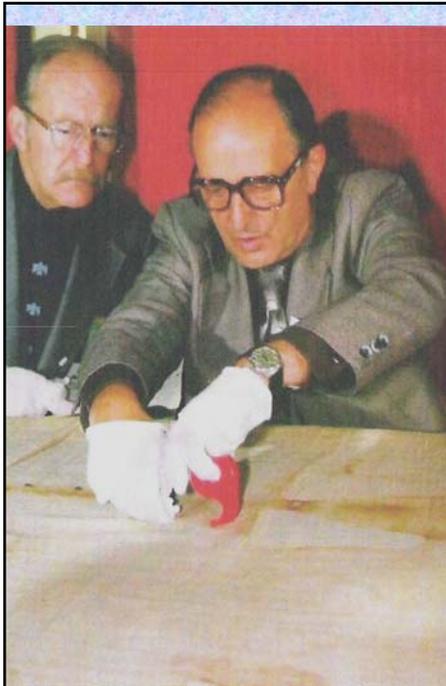


- A *passenger was missing* when a sightseeing boat on the Danube River arrived in Vienna, Austria
- His friend and business partner was on board but he claimed he did not know what happened to his friend
- He becomes a suspect so the police search his cabin on board the boat
- Find a pair of hiking boots with mud on them, send boots to the crime lab
- Mud on one boot contain a **Miocene-age pollen grain of *Carya***
- **Control samples** taken along boat's route confirm only one spot where a Miocene outcrop is exposed with the same type of *Carya* pollen grains
- Suspect is taken to the **crime scene location**, he is so shocked he admits to the murder, shows where the body is buried in a shallow grave 7



Forensic Palynology: 1960-1980

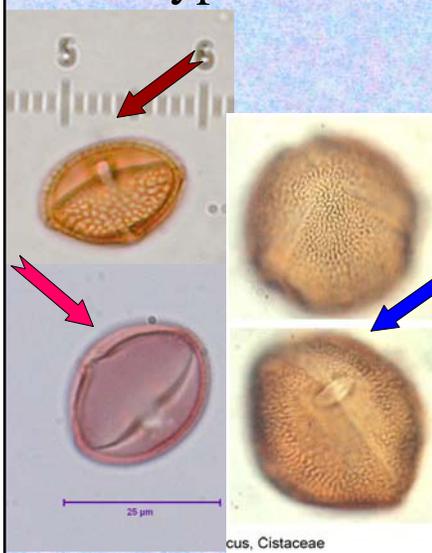
- No published reports of any attempts to use pollen in crime scene investigations
- It is possible some attempts were made and were never reported in the press
- During this time period the most highly publicized use of pollen is during the 1970s by a forensic crime investigator named **Max Frei**
- He is invited to examine the *Shroud of Turin* along with a number of other scientists and clergy
- He claims the *Shroud is authentic* based on its attached pollen 8



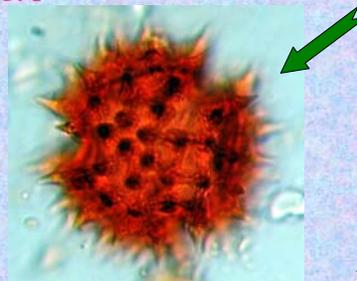
- **Frei** recovered the surface pollen trapped in the weave of the Shroud using tape pulls directly from the Shroud (photo at left)
- He collects 39 tape pulls and finds **54 different pollen types**
- Identified most pollen to species (*most are very skeptical that this can be done using only LM from pollen on the tape pulls*)
- **Frei** says the pollen comes from plants that all live in Jerusalem
- He says the **pollen print** is unique only to that area, he **DID NOT** examine any control samples from surface soil samples in the region of Jerusalem
- He claims the pollen reflects a **spring time exposure time**

9

Key Pollen Types



- The key pollen evidence from the Shroud focuses on **four main types**, all four are insect-pollinated
- *Zygophyllum dunosum*, *Gundelia tournefortii*, *Cistus creticus* and *Capparis aegyptia*



10

US Forensic Palynology: the beginning



- Beginning in the mid 1970s, the USDA begins its search for illegal, non-domestic honey purchased under the *US Farm Subsidy Purchase Program*
- Under the Federal Subsidy Program, the USDA agrees to *purchase USA-produced honey at the subsidy price*
- Recession and falling honey prices make the USDA subsidy price higher than the price of honey selling on the world market

11



- During the 1970s and 1980s *several hundred honey samples* were collected from vats of purchased, subsidy honey and sent from Beltsville, MD to Texas A&M for testing (*to determine honey origins*)
- Government samples consisted of a *very small amount of the total honey* purchased under the subsidy program
- Pollen studies confirmed the *nectar source and the geographical location* (by pollen prints) of the honey samples
- Results revealed *~6% of samples were from non-*¹²*domestic honey*

Murder in Illinois During the 1980s



- Farmhouse is broken into, *rural farmer is kidnapped, forced to get money from a bank*
- Farmer is killed
- Farmer's truck is found *stuck in mud*, and burned near a major highway, location is a few miles north of the farm
- Less than 50 miles north of farm *a thief is caught and jailed* while trying to rob a liquor store

13



- Thief's clothing is replaced with prison uniform
- Thief tells cell mate he wouldn't be in jail if his truck *didn't get stuck in the mud*
- Cell mate tells jailor, hoping his information will earn early release for his help
- Thief questioned about stolen truck found stuck in the mud 50 miles south, convict *denies he was ever in that region of the state*

14



- Police return thief to crime scene, but he continues *to deny any knowledge of the crime*
- A crime scene investigator collects control samples, notices that between the burned truck and the highway there is *a field of maize (Zea mays) plants in full bloom*
- Investigator takes sample of maize pollen

15



- Clothing from jailed suspect is examined by a botanist
- Botanist finds *tiny fragments of maize leaves* on clothing, vacuums clothes, sends the *sample to a palynologist*
- Vacuumed sample contains lots of maize pollen in sample vacuumed from *shoulder area* of thief's shirt (matches height of the pollinating maize tassels), fewer maize pollen grains come from *vacuumed sample of shirt, pants, & shoes*
- *Pollen spectrum from clothing matches control samples* collected from the farm and also suggests suspect walked through a pollinating field of maize plants

16



Maize pollen



- Thief charged with murder and tried in court
- Search of farmhouse leads to the recovery of latent fingerprints that match those of the thief
- Several local residents remember seeing the thief hitchhiking along major highway near the maize field
- Thief convicted of murder, sentenced to life in prison
- Pollen evidence played a key role in *placing the suspect at the farm and at the scene of the abandoned truck* (stolen truck)

17



Texas Murder in 1995

- Murdered victim' *body is dumped on a dirt road near a major highway* in West Texas near Abilene
- Victim had been stabbed 21 times, hands had been cut off (no fingerprints), most clothing is missing
- Victim was *killed someplace else*, and the victim was Hispanic

18

Who was he?

Where was he killed?



➤ Efforts to solve the case focus on *missing persons to the south between the crime scene and the Texas-Mexico border*, a region of about 200 miles from crime scene to border

➤ Months pass, the case is closed & considered a **“cold case”** investigators give up their search

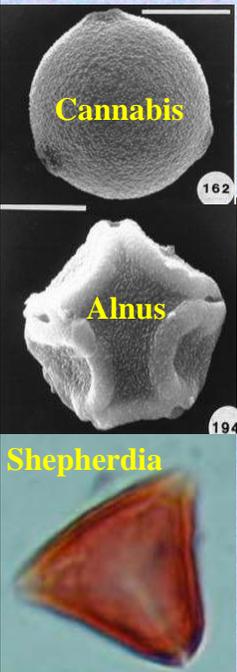
19



Forensic team collecting important control samples of surface soils from the crime scene location

- All efforts to identify the victim fail to discover who he was, & why he was killed
- In 1996, the crime scene investigator from this case attends a *forensic lecture and learns about forensic palynology*, he believed it is worth trying
- Victim’s clothing (shirt, socks, shoes) had been removed from the body & placed in *sealed paper bags* after the autopsy, bags had remained closed and stored in evidence room since the murder
- *Team returns to the crime scene to collect control samples* to test pollen print against the pollen found on the victim’s clothing

20



- Forensic pollen studies are conducted at Texas A&M on each item of the victim's clothing
- Marijuana pollen (*Cannabis*) is found in large amounts on victim's shirt and socks, the amount of marijuana pollen was much higher than the amounts found in the "pollen print samples" from the region of West Texas where the body was found
- Socks and dirt on shoes contain alder (*Alnus*) and buffalo berry pollen grains (*Shepherdia argentea*)
- Neither plant grows in West Texas, neither of those pollen types were found in the control samples from the crime scene
- Conclusion is that the victim came from *some region north of the crime scene*

21



- Alder pollen is airborne, but the plants do not grow in West Texas, none of these types found in the control samples at the crime scene near Sweetwater, TX (see red arrow)
- Buffalo berry is insect-pollinated & does not grow in West Texas
- *Nearest sources of alder & buffalo berry plants is 250 miles north, in southwest region of Kansas*
- Search for the ID of the victim now changes from looking south toward US border area to north in the Midwest region (see green arrow)
- *Six months later a large Mexican-US drug cartel is uncovered in Kansas City*
- Victim was never identified, police suspect the victim was probably connected to that drug operation in Kansas City
- *Victim probably killed in Kansas and later dumped in Texas*

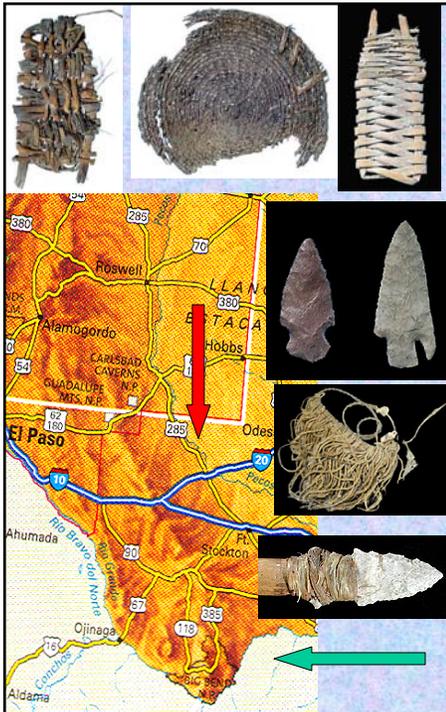
22

- A man was arrested at the Texas-Mexico border in Laredo with a truck full of boxes containing a large *variety of ancient Native American artifacts*
- He claimed he *found the artifacts* in caves on his ranch in West Texas and had taken them to Mexico to get opinions from other collectors about how they might be similar or different from materials found in Mexico
- If those facts are true, his artifacts *would be legal*
- Border agents believed the artifacts were being *illegally removed* from sites in Mexico to be sold in the U.S.



U.S. Customs and Illegal Artifacts

23



- Artifacts include ancient sandals, baskets, spears, nets, & pottery, are *sent to Texas A&M*
- Artifacts from Southwest Texas and Northern areas of Mexico were made by peoples who lived in both areas, *difficult to use the shape or style of artifacts to determine exact origin*
- *Dirt is collected* and woven artifacts are vacuumed for pollen
- Pollen data from artifacts closely matched control samples from Mexico (*green arrow*), not the pollen in the *control samples* collected from the man's ranch near Pecos (*red arrow*)
- *Conclusion:* artifacts were of Mexican in origin, *person was importing illegal artifacts*

24

Magdeburg, Germany

(reported by R. Szibor)



- In 1994 a mass grave found with 32 male skeletons, many of them shot in back of head
- Region was under German control until Soviet troops took over in summer of 1945
- Were they Russian prisoners killed by the German Gestapo
- Were they Russians killed by the KGB in 1953 after a revolt in that area of East Germany
- Pollen collected from the **nasal passages** of 21 skulls
- Dominant pollen types were ***Plantago, Tilia, Secale***, and traces of late summer flower pollinators
- Pollen tests proved the ***Russians killed them in 1953***

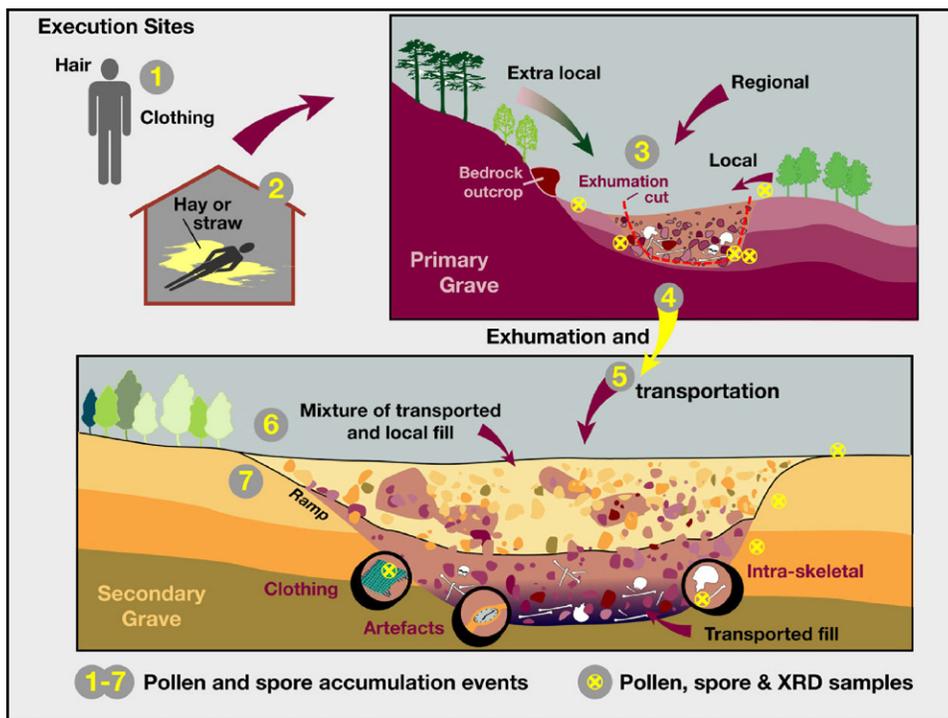
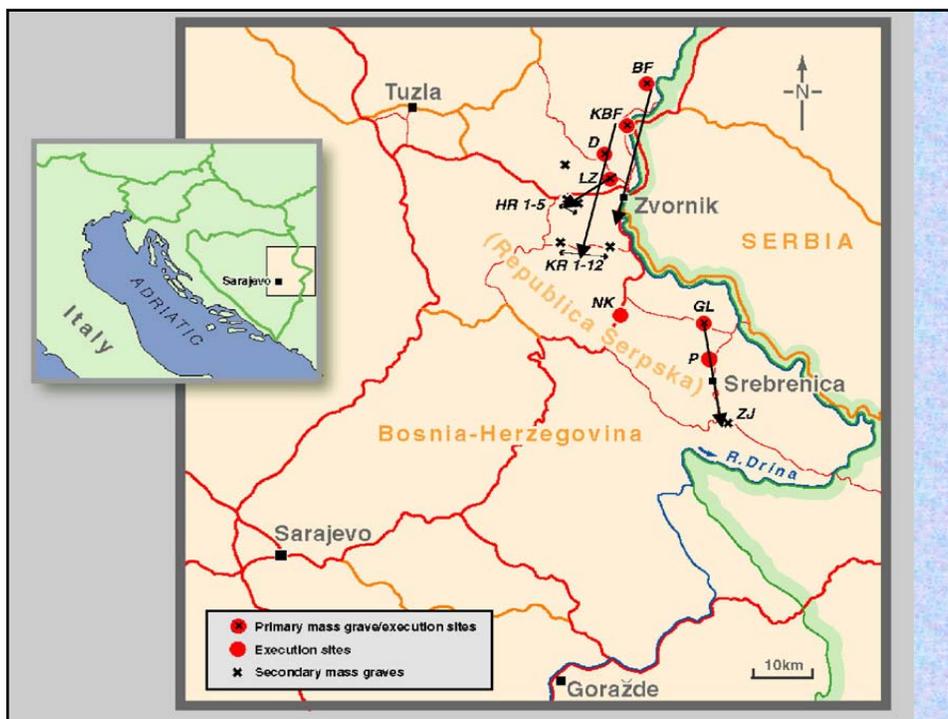
25

Bosnia

(reported by A. Brown)



- 1997-2002 a team of forensic personnel worked with the ***UN International Criminal Tribunal*** to exhume war graves in NE Bosnia
- Reports stated that in 1995 hundreds of Serbians were ***massacred and buried in 7 large graves***
- Other reports stated that 3 months later, ***most bodies were exhumed and reburied*** in many secondary graves to appear to be local burials
- 240 pollen samples were collected from ***primary and secondary sites*** to determine if the bodies in secondary graves were original or if they had ***been exhumed and reburied*** from the 7 mass graves
- Pollen evidence confirmed that the bodies had been killed and buried in one location and ***then exhumed and moved to a new location***



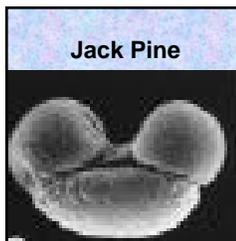


A Major Cocaine Bust in New York City

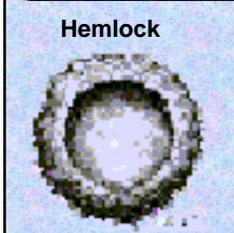
- Cocaine hydrochloride was collected during a drug bust in New York City
- Cocaine is sent to their forensic lab for analysis to determine source area
 - Narcotics division wanted to know *where the drugs came from and how did they get smuggled into the New York city region*
 - A few grams of cocaine were sent to palynologist Ed Stanley who worked for the *NY Police Department* (now retired)



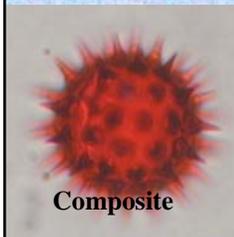
29



Jack Pine



Hemlock



Composite

- The cocaine pollen study revealed *three separate histories* related to the journey of the seized cocaine shipment
- (1) Some of the pollen was identified as coming from several *tropical plants that grow in the northern coca-growing regions of South America* (i.e., Bolivia or Colombia)
- (2) Some of the pollen was from *sub alpine, cold-adapted plants* including **Jack pine** (*Pinus banksiana*) and **Canadian hemlock** (*Tsuga canadensis*)
- (3) Some pollen types are from *weedy urban types of plants* that would be growing in NY city parks, people's yards, and in vacant lots

30

Conclusions: The Cocaine Case



Coca plants in Bolivia



Making cocaine paste

- The pollen data recovered imply three different events:
- **First:** some of the pollen came from *tropical plants*, some of which were insect-pollinated
- Pollen may fall on the leaves that were picked, some was from airborne sources
- Some pollen came from areas where *coca was processed outdoors* in some cocaine lab in a tropical region of South America, most probably Bolivia or Colombia

31



- **Second:** the pollen from *Jack pine* & *Canadian hemlock* probably came from the same general area in Canada
- **Control Samples** collected from NE surface soils suggested a pollen print from a region along US-Canada border or along the St. Lawrence River
- **Montreal** is considered a potential location where both pollen types could occur & it has an international airport
- **Conclusion:** cocaine may have been smuggled into North America by plane
- Pure cocaine was *probably "cut"* in Canada before going to the US

32

New York City: Cocaine Case



- **Third:** The various types of *pollen from weeds and some trees found in the cocaine sample* (grasses, Cheno-Ams, plantain, composites, elm, oaks, ash, etc.) probably entered the cocaine sample after it *arrived in NYC*
- Sample was probably “*cut*” *again in NYC* and was going to be put into “dime bags” for final distribution on the streets of NYC
- The drug bust prevented the final packaging of the sample for street sale

33

Jane Doe Murdered in Upstate NY

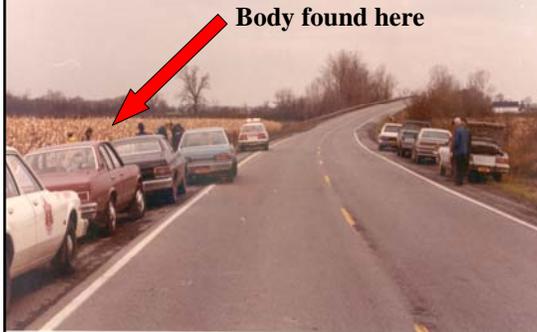


- Teenage girl age about ~15 is was killed and left in a corn field south of Rochester, New York
- Murder takes place in November, 1979
- Case remains unsolved and it becomes a cold case in the summer of 1980
- There are no clues about who the victim was, where she came from, or who killed her and left her in the corn field

34

Farm near Rochester, New York

1979 photo of crime scene area, south of Rochester, NY



- In 2006, the ME hires a new assistant who was trained in the UK
- New assistant looks through their files of cold cases and finds the 1979 unsolved case
- New Assistant knows that the girl's parents must still be grieving & would want to know what happened to their daughter who disappeared in 1979
- Asks the ME to reopen the case

35

Jane Doe's Pollen Samples



- Assistant asks *why pollen studies were never attempted on victim's clothing*
- Gets permission to send victim's clothes to Texas A&M for pollen studies (21 years after the murder)
- Samples are collected from the clothing at the Texas A&M Pollen Lab



Searching for Answers



➤ Vacuumed & soil samples from a crime scene, are **processed to recover the trapped pollen**

➤ Extraction process includes: using various acids to destroy all debris other than pollen:

➤ All work is done in a sterile lab

37



Samples might be full of debris such as polyester fibers that are difficult to remove

Samples in a heating block

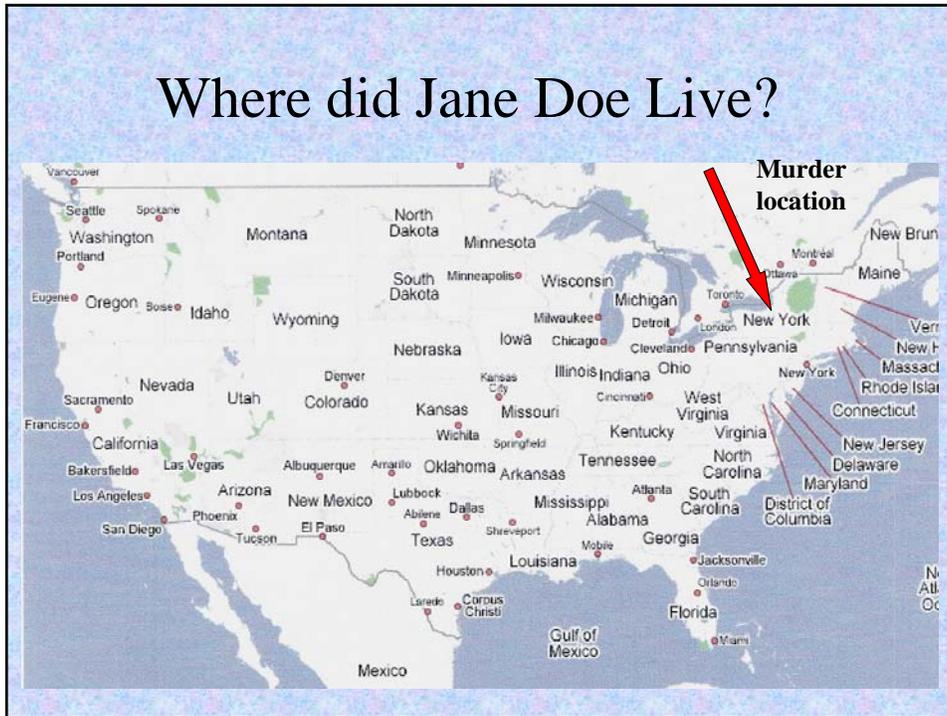


➤ Samples are typically very small, often a sample might contain less than 0.5 grams of material, must be very careful

➤ Samples must remain sealed at all times except to remove or add chemicals, this prevents airborne potentials of contamination

38

Where did Jane Doe Live?



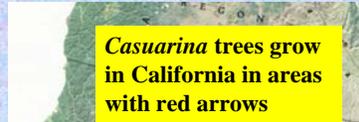
Marker Pollen Clues in the Clothing



Marker pollen grains came mainly from the lint in her pants pockets & in the inside lining of her coat

- **Casuarina** (she oak, also called Australian pine) first arrived in the U.S. during the late 1800s in Florida, 1850s in California, mid 1900s in TX
- Data about U.S. flora claims that this tree is only found **growing in a few areas of South Florida and Southern California**
- **Quercus** (oak) is common in many regions of the U.S. but it is not in the pollen print of the control samples from NY crime scene
- **Picea** (spruce) and **Betula** (birch) grow in NY, but they don't grow near the crime scene and were not found in the control sample

Where is the best Pollen Print match?



- Florida is **not a good match**
- Southern Texas is **not a good match**
- Campus of the U. of AZ & AZ State U are **not good matches**
- **Best match** for pollen recovered from the clothing appears to be in areas of Southern California (based on data from the Control Samples)

41



The Hibiscus & Bottlebrush



- A wealthy man in **Upper Midwest** is murdered in the kitchen of his home
- Loose dirt is found on the kitchen floor near body
- Bag of spilled groceries found by the back door of the home where garage leads into the kitchen
- Desk drawers broken open, a small strongbox is missing from one of the desk drawers
- Man's wife says her husband kept \$10,000 in \$100 bills in the box, purpose was for an emergency need

43

Greenhouse has pollen clues



- The couple had a **greenhouse** next to main house where they raised orchids and other tropical plants
- Greenhouse shovel was found in the kitchen, it had dirt on it and a hair sample from the victim, it was used as the **murder weapon**
- **Dirt on kitchen floor matches dirt on the shovel** and matches control samples of dirt from the floor of the greenhouse
- Police believe the thief probably hid in the greenhouse and waited for the man to come home and then hit him in the back of the head as he opened the kitchen door

44



Bottlebrush



Hibiscus

- **Hibiscus** bushes are blooming in the greenhouse, they do not grow naturally in the Midwest region, *therefore their pollen grains would only be found in some greenhouses*
- There is also a bottlebrush bush (*Callistemon citrinus*) in a pot growing inside the greenhouse by door; it is also blooming
- Both plants are **insect-pollinated**, neither one grows naturally in Upper Midwest, both can only be grown in greenhouses, both plants cannot tolerate hard freezes

45



Suspect is arrested

- A month later a drug bust nets a couple of cocaine and crack addicts
- One addict has **five, \$100 bills** in his pocket, said he got them when a friend repaid a loan
- **Addicts questioned about murder, both deny any involvement**
- Search permit is obtained, their cars & apartments are searched, no more money is found
- **In one apt. they find a pair of muddy shoes and a blue sweater on the floor in a closet**
- Both items, and other clothing are sent to the crime lab to search for DNA and blood stains related to victim

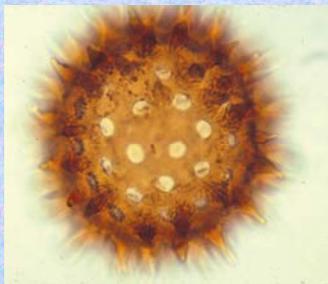
46



- Sweater, shoes and other clothes are tested for evidence, DNA tests prove negative, it can't link suspect to victim
- Among the debris collected from the sweater are a few fragments of leaves, DNA tests reveal the leaf fragments are from holly and elm trees, both grow in the victim's yard, but those trees also grow in many other yards and areas
- Dirt from shoes is collected by a geologist who finds it is very similar to the dirt in the victim's greenhouse, suggests dirt might also contain some pollen grains

47

Hibiscus pollen



Bottlebrush pollen
(*Callistemon*)



- Some of the shoe dirt and a sample of vacuumed lint from the sweater is sent to a forensic botanist for study
- Botanist extracts pollen from samples, finds an assortment of common pollen types on the sweater, but also finds one *Hibiscus* pollen grain and two pollen grains from *Callistemon* flowers
- Pollen spectrum from the dirt on the shoes contains a variety of pollen types that matches the pollen from the *Control Samples* collected from the soil on the floor of the greenhouse
- Suspect is booked for murder; he later confesses & is convicted

48

Current Status of Forensic Pollen Use

- The **United Kingdom** is currently the world leader in using forensic pollen routinely in a wide variety of criminal and terrorist investigations, training not offered at any university
 - *It is now routine in most areas of the UK for a forensic palynologist (FP) to be the **FIRST** person to visit a crime scene & collect essential samples for study*
 - *Last year the leading Forensic Palynologist team in the UK worked on **over 60 criminal cases of all types***
- New Zealand is a co-leader in Forensic pollen studies, it has been used routinely in criminal since the mid 1980s
- **Australia, Canada, Europe, and even a few Asian countries are now using forensic palynology in criminal cases**
- However, the **skills and competency of forensic pollen ID & use** in some regions of the world are questionable

49

A Rarely used Technique in the U.S.

- **Forensic pollen studies** are very **rarely attempted** in the US, most attempts come from cold cases where the potential pollen evidence has often been compromised by time and contamination
- **Current problem in the US** is that there are very few people who are trained to do forensic pollen studies
- **Currently there is little demand** for this service, this is why very few forensic labs currently use it
 - There are **currently no jobs** for those who might want to train as forensic palynologists
 - Because of no jobs, there are **very few training programs** currently available for students interested in becoming forensic palynologists

50