SECRET LIFE OF SEA URCHINS ▪ WILDFIRES ▪ ASTRONAUT JANET KAVANDI

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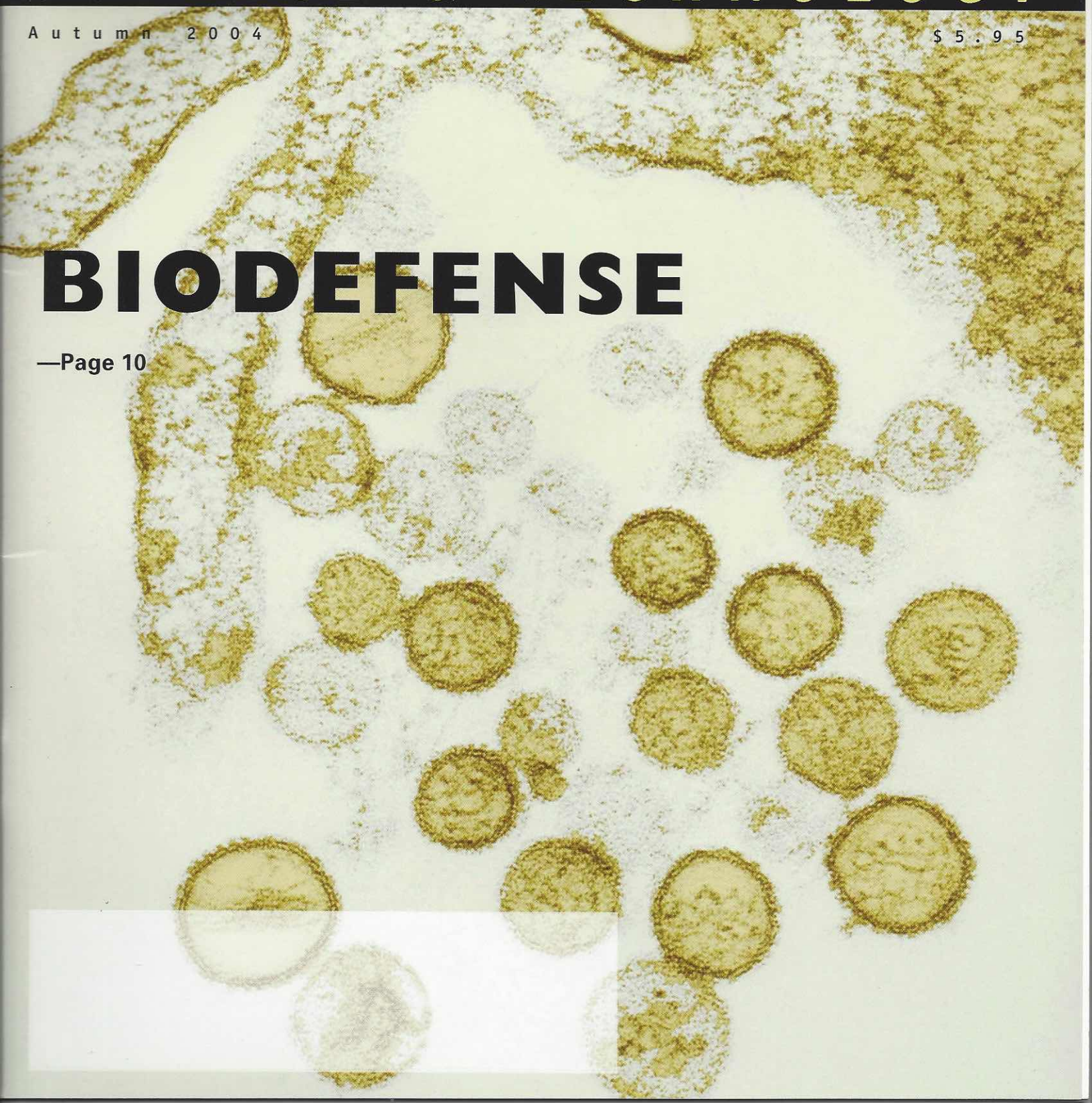

BIODEFENSE

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The Dead Don't Talk, But Plants Might

Rolf Mathewes, Forensic Botanist

The body of a woman lay in a shallow grave in the forest. A small, dead sapling had been pulled up by its roots and just barely covered the grave, partially camouflaging the hasty burial.

Rolf Mathewes remembers the moment like it was yesterday. It was a December day in 1986. His colleague, John Borden, an entomologist, poked his head around the corner into his office.

"Hey, Rolf, have you got time to come along? The police need a botanist to help interpret things."

The bodies of two women had been discovered off a road outside of Vancouver, B.C. A man out looking for a Christmas tree had come upon a woman's nude body in the dense brush. The police came out to investigate and found a second body nearby.

The phone call to Borden that morning was not out of the ordinary; the police often asked for his expertise. But Mathewes says his own involvement was by "accident." Like Borden, he was a biology professor at Simon Fraser University (SFU) in Burnaby, B.C. His specialty: paleoecology. He studied plant evidence to reconstruct past environments, as in the climate of British Columbia thousands of years ago.

That morning back in 1986, Mathewes wasn't planning a second career. He had merely thought, What the heck? The students' exams were finished.

When Mathewes arrived at the crime scene, the yellow, do-not-cross police tape cordoned off a section of the forest. Hesitantly, he walked over to the body covered by the sapling. The other one had been removed by the police. He was a bit apprehensive; he dealt with dead plants in his research, not human remains. Even though Mathewes didn't get "grossed out" easily, the sight and smell were difficult to ignore.

In the lab with dead plants, detachment was easier. Out here, well, a woman was dead, and her body badly decomposed. So, he tried to focus on the plants around him: he'd been doing that for years.

That day, he hadn't thought to pack his own camera. Plus, the officers on the scene insisted on taking their own photos. Mathewes advised the photographer on a couple of shots, being careful not disturb the foliage around the grave.

Dense vegetation, fallen leaves and needles, and mosses often leave the scene on clothing, shoes, or vehicles, and can later be identified. Middle photo: Rolf Mathewes

Bottom: Rolf Mathewes at the microscope. Photo: SFU Media/PR

by Elizabeth Sharpe

Coastal vegetation in the Pacific Northwest is typically lush and dense. Someone entering and leaving a vegetated area will almost certainly carry plant fragments and pollen on their clothes, shoes, or hair—possibly linking them to a particular area. Photo: Rolf Mathewes

Mathewes was used to that kind of care, and used to taking photos himself. An amateur photographer, by default: his research required it.

In fact, Mathewes had an enormous slide collection, recalls Ian Walker, who was once a teaching assistant in the evolution course Mathewes taught to biology undergraduates. Walker remembers the slides Mathewes used and the lectures that always ran over. There was never enough time for all the material Mathewes had to share. Images. Historical information. Anecdotal evidence. Now, Walker is an associate professor in the departments of biology and earth and environmental sciences at Okanagan University College in Kelowna, B.C. He describes Mathewes as one of the best lecturers he's ever had.

Out in the forest, the officer was still shooting photos of the plant growth. Mathewes bent closer, examining the uprooted tree partially covering the body. That's when he noticed a green bracken fern entangled in the stump of the tree.

Bracken ferns grew everywhere around him in the forest. Only they were brown and wilted. The fern on the grave was dried out and stiff, but still noticeably green. Evidently, it had been there quite a while. How curious, he thought. The murderer must have pulled it out with the sapling. Mathewes gathered the bit of evidence and meticulously labeled what it was and where he found it. He would have a photo to back it up, if he needed the evidence in court.

It would be much, much later that the prosecutor would subpoena him for his report in court, to act as an expert witness for the Crown. But he was not out to prove someone guilty or innocent. In fact, his agenda was only to deal with the science, not the legal issues. "I'm there to be as scientifically dispassionate as possible and look at the evidence and interpret it the best I can and give them a report," Mathewes says.

Plants, Mathewes knew from his own research, are highly individualistic. Put a plant "bit" like a needle from a coniferous tree under the small dissecting microscope and Mathewes could name its species, like whether it was a Douglas fir or a Western hemlock. Even a single seed can be highly diagnostic.

Plant cells have rigid external walls made up of cellulose, hemicellulose, and lignin. These chain-like molecules are not easily digestible. They are left intact even when eaten. Lignin is more structurally complex and nearly impossible for all but a few fungi to break down. Wood has a high percentage of lignin, making it a reliable building material to last hundreds of years—and good for forensic evidence, too.

Mathewes uses a binocular compound microscope for miniscule pollen and spores. Under the scope is an entirely new world, at 10 to 200 microns in size. Not visible to the naked eye, but readily apparent to those who suffer from springtime allergies. Pollen grains have particular sizes and shapes that can be specific to plant species.

Douglas Hallett's advisor in graduate school at SFU was Mathewes. Hallett remembers the German microscopes in the lab, which pointed to his mentor's roots.

Mathewes had emigrated to Canada in 1955 with his family from Germany. He was about nine years old. This was just after World War II, and Germans weren't regarded too highly in Canada. Mathewes had been determined to blend in, so as not to be teased by the other boys. He learned English very quickly and lost any sort of German accent.

Perhaps it was his European heritage that made him so historically minded, says

An unusually torn fern leaflet from a crime scene may link a victim to a particular environment where such ferns grow. Photo: Rolf Mathewes

Hallett, who is now a research scientist at Northern Arizona University in Flagstaff. He says Mathewes looks at the world with a strong sense of history, as a time continuum. The environment, the native cultures, and what is happening around the world blend together into this wholeness of relationship and time.

This perspective gives Mathewes an edge on the plant world. Plants demand particular environmental conditions to survive. Trees like red alder or the lodgepole pine are characteristic of the Pacific Northwest. Urban areas, agricultural areas, and old growth forests are all found in and around Vancouver, yet have characteristically different kinds of plants. Plant fragments found in the hair or on the clothing of a victim can be traced to a site where the plants are found.

Analysis by a skilled interpreter—a botanist, paleoecologist, or palynologist, who studies spores and pollen—can lead investigators to vital clues.

It was this kind of skill and a keen eye for detail that led Mathewes to discover important evidence in the murder case. Why was the fern on the grave still green when the rest of the ferns in the forest had discolored? He didn't ponder the question long. Press a fresh flower between the pages of the book, and the flower dries out but still retains color. The same is true of ferns. They retain the chlorophyll that gives off the fern's characteristic green color, even when dried. Mathewes had found a crucial clue to the murder.

The first frost had killed the other ferns in the forest, turning them a coppery brown. So, the bracken fern on the grave had to have been pulled up before the frost. He called the local weather station to ask for the records of the first frost that year. From that he could determine the approximate date the body had been buried.

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What was it that led Mathewes into the forest that day in 1986 and into a side career as a forensic botanist? Hallett says he and Mathewes are, by training, "paleo-detectives." Their challenge is to reconstruct the dynamics of the environment based on what little evidence they have. Of course, there is a difference, too, says Hallett, who has also worked in forensic botany. "The forensic stuff is exciting because it has this life-and-death element to it."

Crime Center Canada

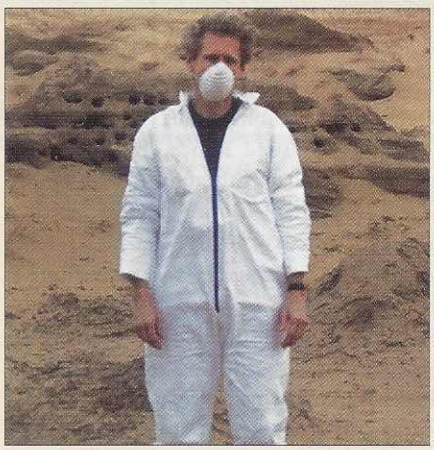
Gail Anderson and her bugs.

Simon Fraser University (SFU) in Burnaby, B.C. is planning the Centre for Forensic Research. With a strong core of talented SFU academics acting as forensic consultants on police investigations, what better idea than to centralize their efforts, notes David Burley, chair of the archaeology department.

A new building will be built in 2005 to expand the departments of criminology and archaeology and to house the center with its specialized forensic labs, offices, and seminar area.

Very few campuses are as close to creating such a world-class center as SFU, says Gail Anderson, entomologist and associate director of the department of criminology.

Ultimately, the center's goal is to push the limits of science and to develop new techniques for forensic science that could be applied to police investigations. "We watch cold-case stuff on TV. We think we can push a button," says Burley. And zap—the answer is found. But it's not that easy. Information about a murder or a death is much harder to discover, and there are a whole range of issues to uncover.



Mark Skinner

With the center and a core of researchers who specialize in certain aspects of forensics—including Mark Skinner, Gail Anderson, Rolf Mathewes, Dongya Yang, and Lynn Bell—those issues can be resolved, given time and the proper equipment.

The equipment isn't cheap. Outfitting the five labs will cost $3.5 million. The labs will focus on bone chemistry, osteology, DNA, entomology, and environmental taphonomy (to study factors critical to determining time of death). ■

When the police contacted Mathewes again for his help, he agreed. The cases grew, from one or two a year to three or four.

Mathewes' schedule is busy, so he works nights and weekends to conduct forensic research, and police reports are finished once teaching duties are done.

Teaching comes first, even though his work in forensics seems to interest a great many students. How can they get into forensics, they ask him. He's a professor who uses science to put murderers behind bars. To students, that's "cool." It reminds them of the popular TV show, *CSI* (Crime Scene Investigation). Mathewes enjoys the attention: "Here's this old silver-haired botany professor who's actually out there doing the *CSI* thing on a regular basis with police departments," he says.

Mathewes does not hedge from the responsibility that the gruesome brings with it. Instead, his fascination has grown. Mathewes is now an avid reader of crime fiction. His favorites: Patricia Cornwell, Kathy Reichs, and Jeffrey Deaver. In fact, he says the dearth of forensic botany in the fiction he reads gives him a new idea. Why not write a novel of his own?

Mathewes keeps a lot of what he does secret. His students aren't usually surprised by what they might hear. But when the Royal Canadian Mounted Police (RCMP) show up at the lab, that's different. It was a shock for former student Markus Heinrichs when an RCMP officer came into the lab carrying a human skull that had plant material on it. Heinrichs is now a Humbolt Fellow, doing research at the Limnological Station of the Technical University of Munich, Germany. Although shocked by the event, he admits that "it was quite evident that an expert in plants would be required to comment on this."

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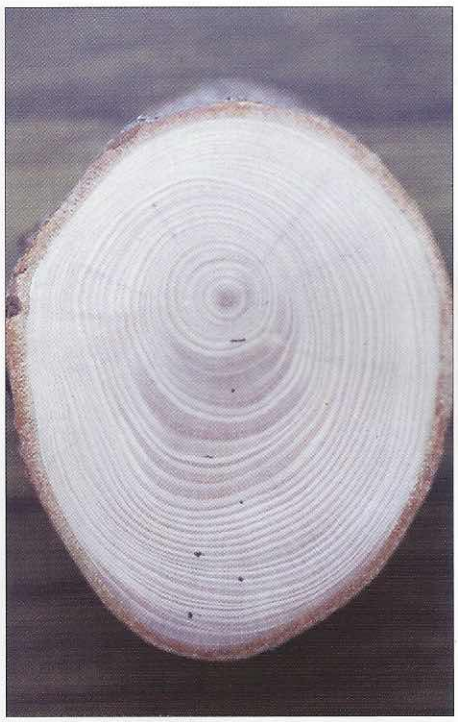
Mathewes describes the cases he worked on vividly, including some high-profile cases. The most difficult? Ones that involved children, he says, because it was hard not to be emotionally involved. His tone grows somber when he talks about a recent case.

October, 2000. A girl's body surfaced in a lake three weeks after she had been reported missing.

Mathewes got a call from the police. Plant remains were in the bag the divers found in the lake, presumably the same bag that the body had been in when submerged. Could Mathewes tell if they were aquatic plants? Or if not, where the plants had come from? The remains could lead to where the murder was committed, a step closer to the person who had done it.



Analysis of changes in growth rings of woody plants associated with burials or other crime scenes can help pinpoint the year in which a crime occurred. Photo: Rolf Mathewes

Mathewes doesn't say what the newspapers did—that the girl had been sexually assaulted before she was strangled to death.

Instead, Mathewes explains that the plant remains he found inside the main compartment of the bag pointed to a place in the forest where the murderer had hidden her body. The man must have come back the next day to stuff the bag with the body and rocks to sink it in the lake. The newspapers reported that some of the plant remains—juniper berries—came from a bush outside the perpetrator's own residence, a house neighboring the little girl's.

Not berries, Mathewes says, juniper *shoots*. He had asked the police to empty out the outside pockets of the bag. Among the materials he saw under the microscope were two very tiny plant bits.

He could tell that they were definitely not coastal plants from around the particular lake, like those from the forest. In fact, the juniper bits under Mathewes' microscope had come from a cultivated plant, like those from a yard around a home.

Mathewes remembers a photograph in the newspapers of the suspect outside of his apartment. There was a row of junipers planted next to the house—right next to where his car was parked, where he might brush past them.

The suspect was given a mandatory life sentence with no parole for at least 25 years. The case is currently up for appeal before the Court of Appeal for British Columbia.

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Compared to the high-profile world of crime on TV, depicted on such shows as *CSI, Law & Order, NYPD Blue*, the real life of forensic investigators is quite different. Not necessarily the beautiful people with coiffured hair, squeezed into skin-tight leather skirts, with lab results done and crime solved within the hour.

"Try seven to ten days, minimum," says Robin Bussoletti, a forensic scientist at the Washington State Patrol Crime Lab in Seattle. She works primarily with DNA and has appeared as an expert witness in court on countless occasions.

"We've got ten lists of why *CSI* makes us mad," says Bussoletti. A single individual cannot be an on-the-scene investigator and conduct trace evidence and DNA sampling as on *CSI*. These skills require a whole team of experts.

Plus, the legal system doesn't work so fast. The first murder case Mathewes worked on, back in 1986, took 17 years before a conviction was made.

The greatest potential for the future, says Mathewes, is applying DNA technology to botanical evidence. Plants are almost always associated with a murder, but often the evidence found is many years old and badly decomposed. Or just trace elements remain. By comparing the DNA of plant material found at a crime scene with DNA from plants at particular locations, the source of plant evidence can be pinpointed. ■

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