Beyond the watery grave

When a body washes up on a beach it's difficult to say how it got there. Now a macabre experiment could produce some answers. **Cornelia Reichert** reports

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ON 22 MAY, a severed right foot washed up on Kirkland Island near Vancouver in British Columbia. Bizarrely, it was the fourth such grisly discovery along this part of the Canadian coast in recent months. In August 2007 two right feet were found on Gabriola and Jedediah islands, still wearing size 12 men's running shoes. A third washed up on Valdez Island in February. Who the feet belonged to and how they met their fate is still unknown, and DNA tests have failed to come up with any matches in police databases.

For forensic scientists this is an all-too-familiar story. It is not unusual for oceans around the world to disgorge mysterious human remains. Some are suicides, others the victims of swimming, boating or diving accidents. Still others are homicides, their bodies dumped in the ocean. Yet even when it is possible to identify the remains, there is often little that forensic medicine can say about how the victim died. For the bereaved relatives the uncertainty can be unbearable.

"How did my son die? Did my girlfriend suffer? What happened to my loved one? These are the first questions that families and friends ask," says Gail Anderson, a forensic entomologist at Simon Fraser

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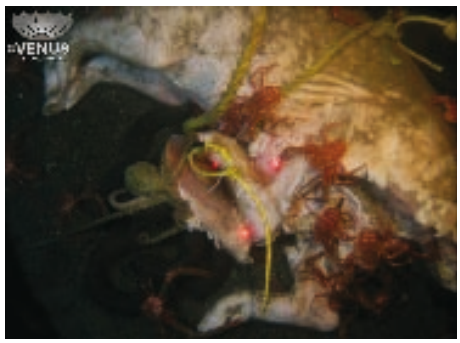
University in Burnaby, British Columbia. "They can't begin grieving until they have the answers." All too often she cannot give them any. Determining the time and cause of death of a body recovered from the sea is all but impossible. And that's not all. Was it an accident or murder? Were the marks on the body caused by a human assailant or by waves, marine predators or rocks? Standard forensic techniques are of little use in answering these questions. "We know next to nothing about what happens to bodies under water," Anderson says.

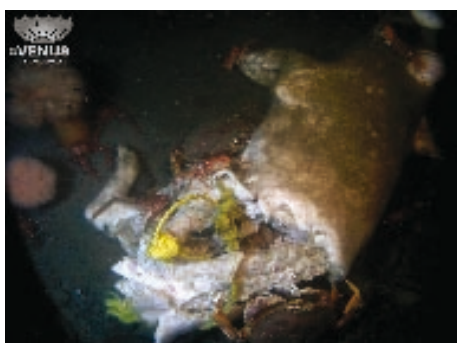
If a corpse is found on land or in fresh water, there are well-established ways of determining time of death. For a recently deceased body, the temperatures of the organs is an important indicator. The rate at which a body cools is influenced by many factors including weight, clothing and the surface on which it was lying. Even so, estimates made within the first few hours or even days of death can be accurate to within an hour.

After longer periods, things become less precise. If weeks have passed temperature is no longer any use. This is where forensic entomology comes in. By examining the type, age and size of maggots and beetles living on the corpse, entomologists can narrow down the time of death to within a day or two. Another, less-established, approach is to analyse inhaled pollen, which can provide evidence about the time and place of death.

Unfortunately, none of these techniques is of much use when a body is recovered from the ocean. Immersed in seawater, the corpse is subjected to changing salinity, temperature and pH, which make normal time-of-death estimates impossible. Forensic entomology is also of little use: insects are only found if the body has spent considerable time floating on the surface, which is rare. And it is almost impossible to distinguish wounds and traumas inflicted by a human from those that result from being submerged in the ocean.

Ocean forensics could soon be put on a more secure footing, though, thanks to a pioneering experiment taking place between Vancouver Island and the British Columbia mainland. Called VENUS (Victoria Experimental Network Under the Sea), it is the world's most advanced underwater observatory. For the past two years, a network of instruments has been providing oceanographers, marine biologists and geologists from the nearby University of Victoria with real-time data from Saanich Inlet (see Map, right). More than 30 sensors at a depth of 96 metres measure the temperature, salinity and pressure of the water 24 hours a day, seven days a week.





By studying pig carcasses, Gail Anderson hopes to find out what happens to human bodies in seawater

VENUS also has an underwater camera, and this is where the forensic action takes place. In August 2006 Anderson bought a freshly killed 25-kilogram pig from a local slaughterhouse, loaded it into her car and headed for the wharf. From there a boat took her and her cargo to the VENUS site, where the carcass was weighed down with 23 kilograms of ballast and sent to the bottom. A robot then positioned the pig squarely in front of the camera and in the weeks that followed, Anderson spent around 2 hours a day in front of her laptop watching what was happening to the submerged carcass.

Funeral feast

On Anderson's footage, prawns can be seen rocking back and forth on the pig's legs. Giant starfish turn their stomachs inside out to feed off the carcass. Meanwhile, countless crabs, squat lobsters and the odd fish gnaw on its flesh. At first, Anderson says, the underwater show was so captivating she could have watched it 24 hours a day. But switching on the camera illuminates the pitch-black seabed, possibly interfering with the results.

Anderson says the idea to study these "funeral feasts" came from her late friend Bob Teather, an investigator for the Royal Canadian Mounted Police. "He was always deeply upset when he couldn't tell the victim's family anything," she remembers. In one such case, the body of a young woman known to be suicidal was recovered from the ocean weeks after her disappearance. The body was covered in deep wounds of unknown origin. Were they caused by rolling over rocks or were they stab wounds? "We simply didn't know," she says.

Anderson began observing submerged pig carcasses in the waters north-west of Vancouver in 2000. She chose pigs because, in forensics terms, they are the next best thing to a human body. Their skin, organs and flesh resemble our own, and even the bacteria living in their intestines are similar to those found in ours. In her first experiment she sank six pigs in water 7 to 15 metres deep. Divers took photographs once or twice a week, but that wasn't frequent enough to get a full picture of how the decomposition progressed (*International Journal of Legal Medicine*, vol 118, p 206). "Divers and boats are expensive and we just couldn't afford more than that," says Anderson. During this period she gave public lectures, hoping to gain support for her research. At one of these talks marine biologist Verena Tunnicliffe, the project director of VENUS, happened to be in the audience. Afterwards she told Anderson: "In a few years we'll have a camera down there running around the clock. If you want, you can put your pigs in front of it."

As a result of Tunnicliffe's offer, Anderson

now has a much clearer idea of what happens to a dead body in the ocean. She doesn't discuss real cases where her research has been used, but is convinced it has been immensely useful for generating basic knowledge.

Like maggots that colonise bodies on land, marine fauna crawl beneath the skin, perhaps to avoid being seen by predators. Yet contrary to what happens on land, they leave the head and face until last. With human corpses on land the head is almost always the first to go. The fatal gunshot wound on the forehead of the pig – Anderson has her pigs stunned and shot, and says they suffer less than pigs slaughtered for meat – remained untouched until the very last.

Thanks to these observations, she can now be confident that when a body with wounds to the face but otherwise unharmed is washed up, foul play is likely. In the past this assumption would have been impossible. Anderson can also classify certain patterns of damage to corpses as being consistent with scavenging and believes that this can help rule out some causes of death.

She has also formed a better understanding of how fast bodies decompose on the ocean floor, which can help improve time-of-death estimates. "If it is sandy, the prawns arrive quickly because that's where they live. The pig disappears in about three weeks. On a rocky ocean floor it takes much longer," Anderson says. So now if you know the nature of the ocean floor on which a body has probably been lying, you can make a pretty good guess at how long it had been immersed.

But how much can a pig weighed down on the seabed really reveal about real human corpses floating in the open ocean, which is presumably the most likely scenario? "If we are talking about a homicide victim, it is quite realistic to have it weighted down," says Anderson. "Most killers would not want it surfacing immediately." In the end, though, most weighted bodies do surface, as there are few methods of weighting that ocean tides and currents can't eventually overcome. Once a body refloats, it only takes the right current or tide to wash it ashore.

Even without ballast, corpses usually spend some time on the seabed before being refloated by the gases that bloat a decomposing body. That takes time, during which the body is scavenged by marine life.

Curiously, Anderson has found that during ocean decomposition, the head, hands and feet detach from the body but do not usually resurface – which makes the severed feet that have washed ashore in the Vancouver area all the more perplexing.

Anderson's research is pioneering and extremely valuable, says Jens Amendt of the Center of Forensic Medicine at the University of Frankfurt in Germany. "Each type of bite mark that we can now attribute to a certain type of crab could release a suspected murderer," he says. By the same token, other patterns of damage could help build a case against a suspect who would previously have been released for want of evidence.

In February 2008 a second VENUS array went live in waters nearly 300 metres deep in the Strait of Georgia, between Vancouver Island and the mainland. Here, Anderson hopes to continue her research under the very different temperatures, currents and marine life found in deeper water.

Eventually, her ambition is to set up an underwater equivalent of the world-renowned "body farm" at the University of Tennessee, Knoxville. There, on secluded parts of the campus, bodies of human donors are left to decompose at a natural pace. Some are in the sun, some in the shade; others are buried or wrapped in coverings.

The aim is to learn what happens to dead bodies under various conditions, the obvious application being to help the police and pathologists solve what might or might not be homicide cases. Ideally Anderson's underwater version would use human bodies too. There is nothing in Canadian law to prevent her from using donor bodies, though up to now she has stopped short of this, citing ethical concerns.

So what became of the pig? Its soft tissues disappeared 21 days after it was sunk, completely devoured by marine life. Only its bones remain, still poking out of the sand. These too will gradually decompose as they are demineralised by the saltwater. Anderson has now positioned a new test animal in front of the camera. It's a macabre project, but one of potentially immense value to the families of those lost at sea. "The ocean shapes our life and often our death," says Anderson. "That's why this research is so vital." ●

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