Incrimination by Insect

Private eyes find a friend in flies

Univ. of Hawaii

By RICK WEISS

The police were getting desperate when they visited Trevor Crosby, an entomologist with the New Zealand government's Division of Scientific and Industrial Research.

"They were clutching at straws," Crosby says, recalling that day in 1982 when officers handed him samples of pot from a 188-kilogram marijuana bust — then the largest in New Zealand's history. Chemists had just told police that sensitive gas-liquid chromatography techniques had found no compounds in the pot unique to imported varieties of the plant, thus failing to support the authorities' case for charges of importation. "Have a look-see," the police said, on the advice of one of the chemists. "See what you can find."

"Quite honestly, we didn't think we'd get anything out of it," Crosby recalls. "We were surprised at the end of the first day that we actually found some insects." He and his colleague, Charles Watt, found 61 desiccated bodies of beetles and wasps trapped in the marijuana buds. Only one, a rice weevil, had ever been found in New Zealand, and eight species were native only to Asia.

The scientists compared the geographic distributions for each species, drew a map of the area where they all overlapped and concluded the marijuana had come from a region approximately 300 kilometers to the northwest of Bangkok. "There was no way that it could have been New Zealand grown," he told police, thus ensuring conviction of the drug dealers not only on charges of possession, but on much more severe charges of importation.

"We didn't realize until after the trial that the police had no case without us," Crosby adds, as the only other evidence of importation was circumstantial. If the police hadn't come to the entomologists, he says, "the case would have fallen around their ears."

Forensic entomology, the study of insects and insect larvae to solve crimes, may seem an odd profession to old-school criminologists. Indeed, some brute-strength crime busters are bugged by the thought of a net-wielding butterfly collector prancing through their cordoned-off scene of the crime.

But increasingly, detectives are finding this little-known subspecialty a useful adjunct to traditional forensic laboratory analysis. And entomologists are responding to this fledgling respect by providing new research — much of it focusing on insect larvae, or "maggots" — to validate their peculiar brand of criminal investigation.

"Medical examiners and detectives are moving away from the traditional view that maggots are simply loathsome worms," says Bernard Greenberg, an entomologist at the University of Illinois in Chicago. "They're coming to realize that insects can communicate, and that they sometimes have much to say."

What various insects and their larvae reveal — and what entomological investigators now interpret with increasing accuracy — are the circumstances and timing of criminal acts, especially murder. In many cases these bugs provide clues — and in some cases convictions — because of their very predictable patterns of geographic distribution, larval development and behavior. In particular, the variety and maturity of insect larvae found on corpses can prove invaluable in the determination of the postmortem interval, the time elapsed since death.

One has to be "a little off center" to really appreciate forensic entomology, confides Robert Hall, an entomologist at the University of Missouri in Columbia. "We've all had to put up with some snide comments from our colleagues."

But the use of insects to solve crimes has a long and noble history, he adds, and recent advances are making entomological evidence ever more convincing in courts of law.

Perhaps the earliest reference to housefly forensics is in Sung Tz'u's 13th-century work, *The Washing Away of Wrongs*, says Hall. A Chinese primer for death investigators, the text describes a case of murder by slashing. The local investigator in the case, knowing some flies are exquisitely sensitive to the smell of even microscopic traces of decomposing tissue, had all the villagers bring their sickles outside. After a few minutes, flies began to land on one of the blades. The sickle's owner, confronted with such overwhelming evidence, confessed to his crime.

The first reported case of Western investigators using insects in the service of criminal justice goes back to 1855. A French couple was cleared of responsibility for the death of a child found behind a mantle in their house when a naturalist determined that the particular insects living in the body tended to be found only on corpses dead longer than the couple's brief occupancy there.

Since then, references to medico-legal entomology have appeared sporadically, but with increasing frequency, in modern criminal literature. In one recent case, described last month at an international entomology meeting, a murder suspect's alibi fell apart when investigators found several mayflies in the radiator grille of his car. The insects spend less than one week of the year in flight, and specific varieties are often restricted to a small geographic area.

More often, living insect larvae — rather than deceased adults — play the major role in forensic entomology. Their value is in their well-defined pattern of growth: Typically, an insect develops from an egg into a worm-like larva before pupating, metamorphosing and eventually emerging from its pupal case as an adult. Researchers say the precise stage of larval development on a corpse, and to a lesser extent the order of arrival of different insects, reveal a lot about the timing and circumstances of death.

"These insects are highly predictable as larvae," says Hall, noting that certain insects, especially blowflies of the family Calliphoridae, typically discover and lay

eggs on fresh corpses very soon after death, and these eggs develop into adults on predictable schedules. Thus for the bug-savvy gumshoe, a maggot's biological clock can provide a highly accurate measure of a body's postmortem interval, or PMI — a variable that very much interests murder investigators.

Like any biological system, insect development is not perfectly predictable. Most important, temperature must be considered in PMI calculations for its effects on rates of larval growth. Moreover, Hall notes, criminologists must consider not only ambient temperature, but also temperature changes induced by the larvae themselves when they are present in high enough densities. "The mass of larvae, as they are working furiously in a dead body, can in and of themselves make the temperature higher and constantly accelerate their own development," he says.

Other factors — such as drugs consumed by a person soon before death — may also affect rates of larval development. For example, says Hall, "From the very preliminary research that has been done, cocaine residues in the tissues appear to speed the development of some fly larvae that are decomposers." However, he adds, as researchers quantify the precise effects of such variables, bugs become increasingly valuable to forensic examiners.

The gathering of such data is a slow and smelly process. For weeks at a stretch, Australian entomologist Beryl Morris kept track of the comings and goings of necrophagous, or carcass-eating, insects on killed pigs and sheep left outdoors in a fenced enclosure. (Dead pigs, with their hairless skin, are good models of human decomposition and insect infestation; sheep mimic corpses with clothing on.)

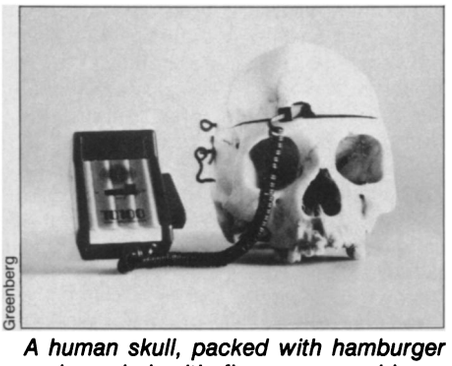
"Flies are generally the first insects to arrive on a carcass," Morris says. She found blowfly eggs on the animals' lips and eyes within 30 minutes after she shot the animals — confirming that the necrophagous clock starts ticking soon after death, and providing a reliable starting point from which investigators can calculate the PMI. "Accurate estimates of the time of death — even pinpointing the time of day — could be obtained," she says, by simply noting the stage of development of fly larvae on a carcass.

Morris has been called upon to examine human remains, too, and to testify at the trials of suspected murderers when convictions hinge upon the time of death.

"Each time I've been in a court, I've had to take the judge and the jury through the life cycle of a fly," she says. "Even I have been surprised at the incredible accuracy of my predictions, based on later confessions."

Morris' studies, along with other work by entomologists such as Lee Goff and his colleagues from the University of Hawaii at Manoa, document hour-by-hour changes in the entomological environment of corpses. By pooling their data, researchers are compiling computer databases with temperature and climatological information included, so investigators can use the type and maturity of insects found under particular conditions to predict the PMI with increasing accuracy.

Goff has a special interest in late-stage decomposition, by which time most of the flies — "which everyone seems to concentrate on, and which are excellent indicators for as long as they're there" — are gone, he says. After the flies disappear, other bugs arrive, and investigators can garner clues about the time of death from the succession of soil-living organisms found underneath the corpse. Most important, he says, "We do have some [beetles] coming in at various times, and other taxa showing up," including non-insect arthropods such as mites.



Greenberg

A human skull, packed with hamburger and seeded with fly eggs, provides a realistic model for measuring temperature increases due to larval activity and temperature's effect on larval growth.

"As decomposition continues, we find a more varied assemblage of arthropods becoming involved in the decomposition process," Goff says. "These arthropods can be related to the remains either as decomposers feeding directly on remains, as predatory forms feeding on the decomposers, as herbivores feeding on the fungi associated with decomposition or as parasitoids of other arthropods associated with the remains."

Thus, with an understanding of insect ecology — the ways various bugs interact with each other — forensic entomologists are learning to use insect data to determine not only the time of death, but also whether, for example, a body has been moved. However, Goff warns, insect interactions are complex. If not taken into account, some insects such as ants can throw off PMI calculations by, for example, stealing large numbers of other insects' eggs that might otherwise have become telltale larvae.

For this and other reasons, Goff doubts late-stage PMIs will ever be as accurate as those within the first few days of death, when insect interactions are much simpler. Nevertheless, he is optimistic that latecoming bugs will someday play an important forensic role.

"Looking at the soil arthropods, and particularly the mites, we do find that there are some significant changes in the soil fauna that will be of considerable use in estimating postmortem intervals, once we get things worked out a little better," he says.

Some insects, such as mosquitoes, midges and caddisflies, have aquatic larval stages and don't walk on land or take to the air until they become adults. One such larva — a bright red, multisegmented midge larva in the family Chironomidae — lives mostly on the bottom of freshwater lakes and rivers and is frequently found on corpses that have been submerged for long periods of time. According to Neal Haskell, a former deputy sheriff and now a forensic entomologist at Purdue University in West Lafayette, Ind., chironomids may provide important information about the PMI since they rarely appear on a floating body unless the corpse has already spent some time on the bottom.

Haskell emphasizes that little is known about the timing and development of aquatic, meat-eating insects, and much more research is needed before these larvae provide the detailed kind of information scientists are already culling from terrestrial bugs. Still, he notes, medical investigators are beginning to take note of aquatic larvae on corpses, and are less frequently making the mistake one pathologist made in a recent Indiana murder case where a chironomid larva was misidentified as a red carpet fiber.

A *lack* of insects, too, can provide medical investigators with important clues. In one case last year, entomologists were baffled by the lack of flies or maggots on a body apparently dead for at least a day in a house with open windows during a hot summer month. The victim's boyfriend alerted police when he discovered her body, apparently believing she'd been murdered by a burglar. But the lack of entomological evidence helped detectives correctly conclude the boyfriend himself had murdered her the previous day. After killing her, he left the windows closed with the air conditioner on, and only the next day returned to the scene of the crime, when he opened the windows and called the police.

"In this unusual case, the flies were not the first on the scene, but their absence was important," says Greenberg, the University of Illinois entomologist.

Despite such examples, entomologists still are not common expert witnesses in court, Greenberg concedes. "Better timetables of [insect] development are necessary if we are going to transform maggots into sleuths," he says. But the future of this specialty is bright, he adds with a smile: "Clearly, forensic entomology is not a dead subject." □