Critters kindle military curiosity

By Bob Felton

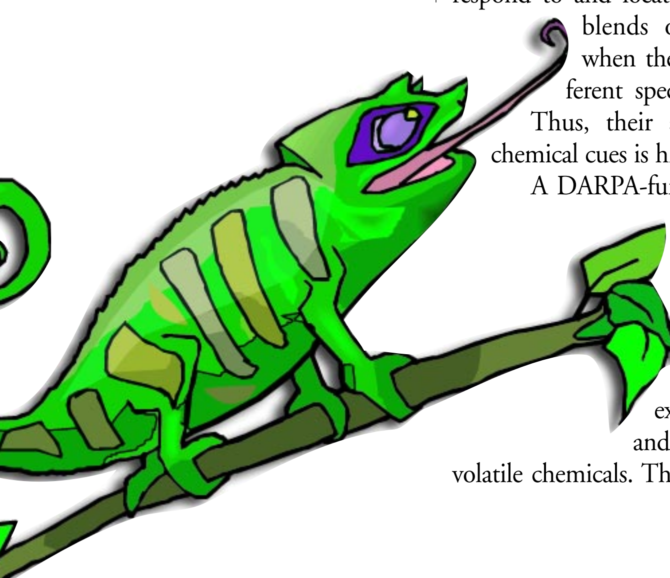
Coming to a plant floor near you: wasp-emulating sniffers, sea cucumber–based smart materials, and brain-controlled robots.

If military research now under way is successful, plant engineers may soon detect airborne chemicals using sensors that emulate wasps, surveil hazardous areas using trained moths, and perform delicate or dangerous work using brain-controlled robots.

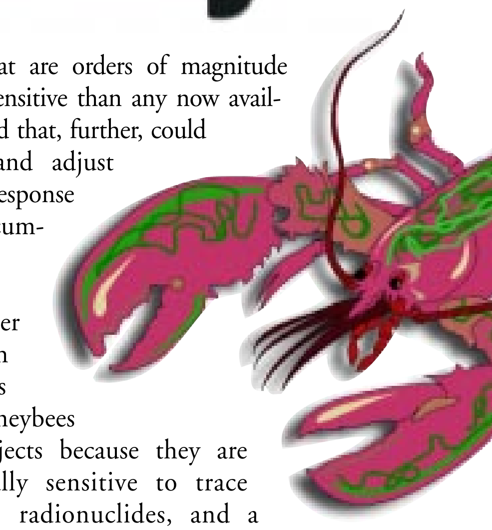
The Defense Advanced Research Projects Agency (DARPA) was established in 1958 in response to the Soviet launching of Sputnik; its missions are to assure that the U.S. maintains a worldwide lead in military technology and to prevent technological surprise from America's enemies—a portfolio of extraordinary breadth. The agency led development of the Internet to give the nation distributed, survivable communications in the event of nuclear attack; is developing technology that will make the Bionic Man seem Lilliputian compared with the next generation of infantry; and is now engaged in biological research that may place the strengths of a broad range of fauna at engineers' disposal.

Insect-emulating chemical sensors

Parasitic wasps (Micropletis croceipes) can detect a wide variety of volatile chemical compounds and use them to locate food and hosts. They can even, according to DARPA, "learn to respond to and locate different compounds or blends of compounds produced when the hosts are feeding on different species or varieties of plants. Thus, their ability to learn different chemical cues is highly developed."



A DARPA-funded research project now under way aims to identify the mechanism that governs wasps' detection and response to olfactory information and apply it to sensors used to detect explosives, toxic chemicals, and other materials that emit volatile chemicals. The end result could be sensors that are orders of magnitude more sensitive than any now available and that, further, could learn and adjust their response as circumstances change.



Other research projects use honeybees as subjects because they are especially sensitive to trace metals, radionuclides, and a broad spectrum of organic chemicals used in agriculture and industry. DARPA contemplates training bees to locate targets using associative learning techniques, tracking individual bees to toxin sources, and mounting sensors on bees to improve their environmental data collection. An entomologist and a hive could soon replace the small army of consultants that modern plants now use to stay on the right side of environmental management agencies.

DARPA has something for plant security, too: a research program that's looking into "mate finding, host finding, alarm, and aggregation behaviors . . . with a particular emphasis on blood-feeding arthropod vectors of disease and insects of nuisance or bioirritant value."

Think and do

Researchers have established that for every unique activity, there is unique electrical activity in the brain. Further, they have successfully recorded that electrical activity and translated it into digital signals used to control a robot. DARPA proposes to develop this technology for battlefield use, allowing intelligent robots to replace soldiers for some missions, utilizing "electrode-based interfaces between brain and computer to directly control locomoting robotic devices using brain activity."

It shouldn't take long for technology such as this to catch on. After all, robots don't get sick, don't come in late, don't get bored, and can be sent into environments where humans won't or shouldn't go. Further, they'll work under intelligent direction, accepting and processing commands in real time. Engineers could use the robots to weld in confined spaces, for example, and then check the welds afterward.

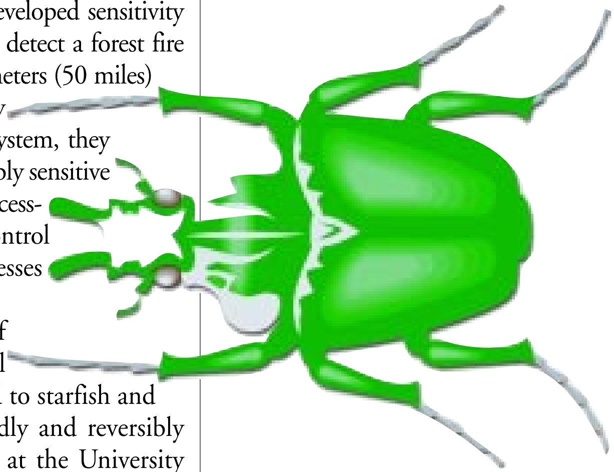
The technology might be used to create biological scouts or workers, too. A project at MIT is developing technology for controlling live rodents using computers. Released on a battlefield, they'll send home information about troop deployments and weaponry; on the shop floor, RoboRat will retrieve tools from hard to reach places and inspect pipe galleries for leaks.

Similarly, a DARPA-funded project at the University of Illinois at Urbana-Champaign looks forward to "the ability to plug into neurological pathways to gain efficient control of insects." Imagine the fun you could have with a joystick and a Madagascar cockroach.

Wild Kingdom

The gecko has admirers, too. A team of researchers at IS Robotics and the University of California at Berkeley is developing a system for robots that emulates the gecko's ability to scoot up vertical walls at speeds up to 1 meter per second. "Prototypes," according to the research synopsis, "will be constructed that employ as much of the biological principles as necessary in order to create a platform that can walk or run vertically and hold at a position for an appropriate length of time." Engineers might use them in the plant for difficult maintenance operations or delivering materials to workstations.

The lamprey and the lobster are the inspiration for another group of researchers. A team at Northeastern University in Boston is developing robots based on the lamprey's snakelike undulating motion and the lobster's eight-legged perambulations. DARPA wants them "developed with the operational concept of using them for mine location and detection." But the robots could, of course, be fitted with sensors that would allow them to enter vats or wastewater lagoons and return with comprehensive, three-dimensional reports of chemical composition.

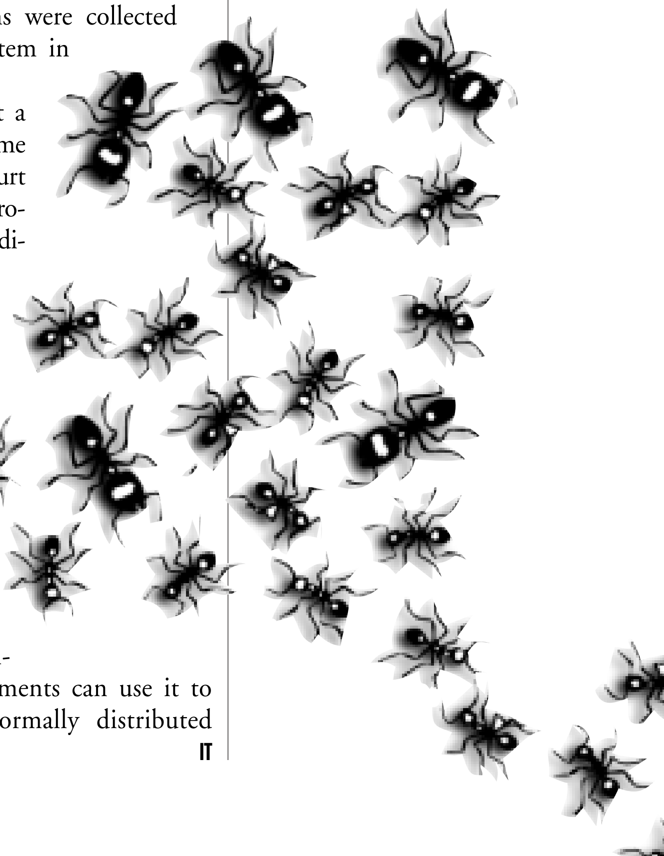


Certain species of beetle lay their eggs in burnt tree bark and have a highly developed sensitivity to infrared radiation; they can detect a forest fire at a distance of up to 80 kilometers (50 miles) away. Researchers hope that, by studying the beetle's sensory system, they can build and deploy comparably sensitive infrared sensors. If they're successful, plant engineers will control temperature-sensitive processes with near-perfect accuracy.

The connective tissues of sea cucumbers, an animal (not vegetable) closely related to starfish and sea urchins, are able to rapidly and reversibly change stiffness. Researchers at the University of New Mexico plan to harness that capability to "develop novel synthetic materials with dynamically controlled stiffness." The end result will be "artificial skins" that may show up on plant floors as anything from protective clothing to packaging materials.

Modeling contaminant spread

Worried that Washington might become the scene of a biological warfare release during the inauguration of George W. Bush, DARPA used its Encompass software program to model epidemiological indicators of illness during the swearing in. Working with local hospital emergency rooms, health departments, and parade-route aid stations during several days preceding and following the ceremonies, non-accident-related medical symptoms were collected and logged in to the system in near real time.



"Encompass picked out a sudden spike in fevers at some military clinics," said Dr. Kurt Henry, the Encompass program manager. "We immediately issued a public health alert to participating civilian medical centers to see whether there was a larger pattern."

Analysis determined that the fevers were consistent with seasonal flu patterns. The software is commercially available now, and engineers and hygienists in industrial environments can use it to identify areas with abnormally distributed symptoms of illness. IT