Bumblebee energy: What's the buzz?

It flaps its wings an astonishing 160 times a second and consumes the caloric equivalent of 180 candy bars an hour. But exactly how the short-winged, big-bodied bumblebee stays aloft remains a mystery. Now, researchers have succeeded in measuring bumblebees' oxygen consumption during forward flight, obtaining the first such data for any free-flying insect. The feat represents a major step toward comprehending the physiology and mechanics of insect flight, they say.

It's no breeze measuring the oxygen consumption of a bee, explains study director Charles P. Ellington of the University of Cambridge in England. Miniature gas masks won't do for an animal that has more than 24 breathing holes. And commercial instruments can't detect changes in atmospheric oxygen concentration down to bee-sized levels of 5 parts per million or less. So Ellington, with co-workers at Cambridge and Rutgers University in New Brunswick, N.J., designed a highly sensitive and rather unorthodox apparatus for measuring the effect of flight speed on oxygen uptake in a mix of queen and worker bumblebees.

They inserted more than 100 bumblebees, one at a time, into a sealed wind tunnel 17 centimeters long. Though most of the captives refused to flap their wings, six bees buzzed along with the tunnel's speed-controlled airstream. Minuscule differences in gas pressure between this chamber and an identical but empty one revealed the insects' rate of oxygen consumption. The scientists eliminated extraneous pressure fluctuations that would have given a false reading by directing incoming air through a deflated condom, which changed its volume slightly to equalize air pressure.

Though Ellington says the results didn't surprise his team, others may find them downright bee-wildering.

Hovering bumblebees consume about the same amount of oxygen – and thus use the same amount of energy – as bees cruising at speeds of up to 4 meters per second, the researchers report in the Oct. 4 NATURE. This matches the oxygen-uptake pattern detected in birds and bats, Ellington notes. In the January JOURNAL OF EXPERIMENTAL BIOLOGY, he and graduate student Robert Dudley presented an aerodynamic analysis suggesting that forward flight at moderate speeds requires about the same mechanical power as hovering. That might help explain the comparable oxygen uptake of hovering and forward-flying bees, Ellington says.

He points out, however, that the oxygen findings fly in the face of standard theories of animal aerodynamics, which maintain that hovering requires more oxygen due to the apparently greater exertion needed to stay aloft without moving forward. Theoretically, only at higher speeds – when atmospheric drag increases significantly – should the oxygen demands of forward flight equal or exceed those of hovering.

"The theories that everybody uses are too simple," Ellington says. "The main message of our paper is to tell people to stop using them."

Study coauthor Timothy M. Casey of Rutgers adds that by measuring oxygen uptake in hovering bees, researchers can reasonably estimate in-flight oxygen consumption, thus avoiding the need for the custom-built apparatus. *– R. Cowen*

Drug curbs river blindness

Ivermectin, an antiparasitic drug used primarily in domestic animals, can significantly reduce the spread of a devastating human disease called onchocerciasis or river blindness, according to a study conducted on a West African rubber plantation.

The disease currently affects about 18 million people in tropical regions, where it spreads through the bite of blackflies that breed in river water. The flies transmit the immature, thread-like forms, or microfilariae, of the parasitic worm *Onchocerca volvulus,* which migrate through the skin and can eventually invade the eyes, causing blindness.

Ivermectin emerged as a promising weapon in the fight against river blindness several years ago (SN: 10/31/87, p.287), but the new study is the first to demonstrate its benefits in an entire community, the researchers say. For three years starting in 1987, a team from the University of Alabama at Birmingham and the Johns Hopkins University in Baltimore administered a yearly ivermectin dose to each of the 14,000 residents of a Liberian rubber plantation except pregnant women, very small children and people with serious illnesses. At the end of the study period, skin samples showed that the average number of microfilariae had dropped by 84 percent, they report in the Oct. 5 SCIENCE.

Ivermectin doesn't affect adult *O. volvulus,* explains Beatriz Muñoz of Hopkins, but it does kill microfilariae, easing symptoms of intense itching and presumably helping to prevent eye damage. Moreover, the drug slows disease spread because blackflies pick up fewer microfilariae when they bite an infected person, says Alabama's Bruce M. Greene.

Because 90 percent of adult residents already carried the parasite when the study began, the researchers focused on 5-year-olds to gauge the rate of new infection. Among these children, the three-year treatment program reduced the incidence of new infection by 21 percent, they report. □

Laser cooling made simpler, cheaper

Scientists cooling atoms to near absolute zero no longer need laser systems costing thousands of dollars. With just two $200 diode lasers, physicists at the University of Colorado in Boulder have now chilled cesium atoms to 1.1 microkelvins, or about a millionth of a degree above absolute zero – the coldest temperature ever achieved.

Laser-cooling studies have boomed in the last few years, repeatedly breaking temperature records (SN: 7/23/88, p.52). But those experiments required elaborate and expensive equipment. The Boulder group's technique "dramatically simplifies" laser cooling, assert Carl Wieman and his colleagues in the Sept. 24 PHYSICAL REVIEW LETTERS.

In the past, researchers heated atoms to create a fast-moving beam, then slowed them with a laser aimed against the flow of atoms. To complete the cooling, they mired the atoms in the "optical molasses" existing at the intersection of six crisscrossing laser beams.

Bypassing the first two steps, Wieman's team started with room-temperature atoms – in this case, cesium vapor. No one has tried to do this before, Wieman told SCIENCE NEWS. The team also used far less expensive diode lasers – similar to those in compact-disk players – first to "catch" cesium atoms for study, and then to generate the cooling "optical molasses." The physicists managed to cage their record cold sample in a magnetic field for about 1 second, establishing another record.

Other experimenters have had difficulty trapping atoms at temperatures below 300 microkelvins because the atoms would leak out of the "optical molasses" in a fraction of a second. "In earlier [experiments], the cold atoms were freely falling in a vacuum. You couldn't hold on to them or do anything with them," Wieman says.

By locking far colder samples in place, "we can do a lot of experiments with cold atoms," he adds. Wieman is building a new apparatus that he thinks may hold the cold atoms for about 1 minute.

"There's a list of applications [for the new technique] as long as your arm," says Harold J. Metcalf of the State University of New York at Stony Brook. These include atomic spectroscopy, studies of low-energy atomic collisions, and verification of some fundamental processes predicted by quantum mechanics.

The new technique might also improve atomic clocks. Wieman says he and Stanford University physicist Steven Chu have a patent for an atomic clock that may achieve up to 100 times the accuracy of the most precise existing clocks.

– R. N. Langreth