

August 12, 2008

Come Up for Air? Not These Insects, Which Carry a Bubble as a Lung

By [KENNETH CHANG](#)

To swim underwater, hundreds of species of insects like the water boatman bring along their own air bubbles.

What is even more remarkable is that the air bubbles automatically refill with oxygen, allowing the bugs to swim indefinitely without coming to the surface. Some insects even hibernate underwater all winter.

“It turns out this bubble functions as an external lung,” said John W. M. Bush, an associate professor of applied mathematics at the [Massachusetts Institute of Technology](#) and an author of a paper describing the mechanics of the air bubbles in the Aug. 10 issue of *The Journal of Fluid Mechanics*.

Similar to lotus leaves and Gore-Tex fabric, the abdomen of an underwater-swimming insect is rough and waxy, which repels water molecules. With the water repelled, a thin layer of air is trapped along the abdomen. The roughness comes from tiny hairs, about 100 microns long and 1 micron wide and spaced 10 microns apart.

As insects breathe in and out through tiny holes in the abdomen, oxygen decreases in the bubble and carbon dioxide increases — but the changes in pressure draw oxygen from the surrounding water into the bubble and push out carbon dioxide.

Biologists had noticed this ability in insects long ago. In the new paper, Dr. Bush and Morris Flynn, a former instructor at M.I.T., calculated details of the insects’ diving ability based on the structure of the hairs, including how deep they can go before water pressure overcomes the water repellence and collapses the bubble.

“That’s the math problem we solved, when these lungs can function,” Dr. Bush said.

In principle, it would be possible to build a structure with an expansive hairy, waxy surface to provide an inexhaustible oxygen tank for a human diver. But scaling this mechanism from millimeter and centimeter-size insects to much larger people would be impractical. A more plausible application might be for powering an underwater vehicle that would draw oxygen from

the water for a fuel-cell-driven motor.

[Copyright 2008 The New York Times Company](#)

[Privacy Policy](#) | [Search](#) | [Corrections](#) | [RSS](#) | [First Look](#) | [Help](#) | [Contact Us](#) | [Work for Us](#) | [Site Map](#)
