

Cyborg cockroaches dive and scout using on-board oxygen generator

Mini O₂ generator lets remote-controlled roaches swim for hours and probe disaster zones or Mars-like sites

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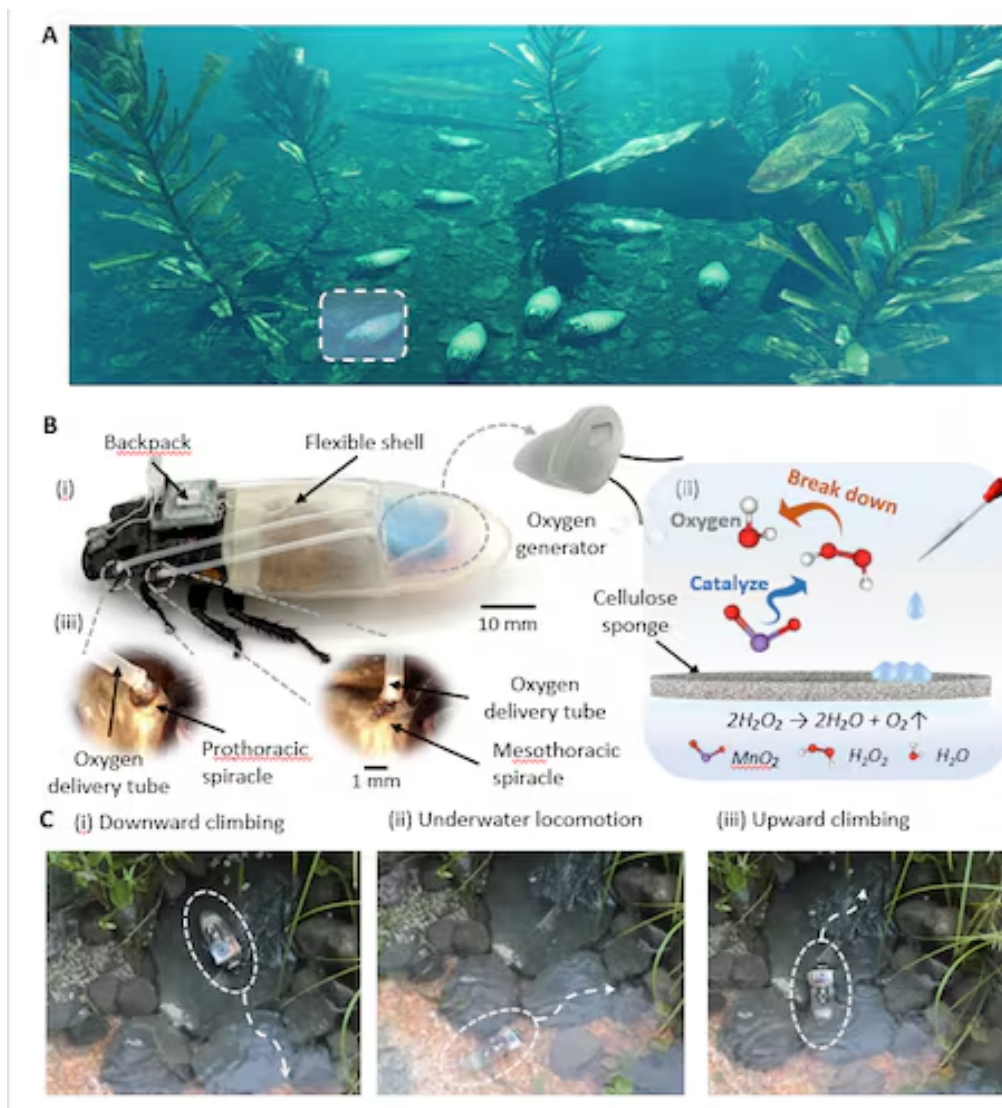
A cyborg cockroach carries a motion-control electronics module on its back. Over it, it wears a soft diving suit. Oxygen produced by decomposing hydrogen peroxide in the tail section (green) is delivered through a tube to the spiracles, its respiratory organs./Courtesy of NTU

A cockroach strapped an electronic device to its back and jumped into the water. A diving suit supplied oxygen so it could move freely even underwater. A versatile cyborg scout capable of traversing land, sea and sky—from the ground to underwater and even space—has been born.

Sato Hirotaka, a professor in the School of Mechanical and Aerospace Engineering at Nanyang Technological University in Singapore, said in the international journal *Nature Communications* on the 29th (local time) that a remotely controlled Madagascar cockroach (*Gromphadorhina portentosa*) can now operate underwater or in space thanks to an ultra-compact diving suit that supplies oxygen.

◇ Oxygen supply by decomposing hydrogen peroxide

Professor Sato thought cockroaches, which can squeeze through gaps the size of a needle's eye, were ideal for finding traces of survivors in buildings collapsed by earthquakes. In 2021, the research team first proved that cockroaches could be remotely controlled by implanting electrodes in their sensory organs and attaching an ultra-small computer on their backs. A cyborg cockroach combining animals and machinery and equipment was born. In 2024, the team also succeeded in controlling a group of 20 cyborgs to move collectively by following a leader.



A. Concept image of a cyborg insect operating underwater. B. Structure of the diving suit for a cyborg cockroach. i) The suit consists of a flexible water proof outer layer, an integrated oxygen generator, and an oxygen supply tube. ii) Manganese dioxide (MnO_2) in a cellulose sponge breaks hydrogen peroxide (H_2O_2) down into water (H_2O) and oxygen (O_2). iii) Oxygen is delivered to the spiracles, the respiratory organs, through a supply tube. C. Real-world mobility demonstration. The cyborg cockroach wearing the diving suit

t performs i) downward climbing, ii) underwater locomotion, and iii) upward climbing./Courtesy of Nature Communications

This cyborg cockroach expanded its stage of activity from land to water. Disaster sites hit by heavy rain or flooding are difficult for existing cyborg cockroaches to access. The researchers added a diving suit tailored to oxygen-poor underwater environments. Thanks to the diving suit, the cockroach was able to operate underwater for up to 3 hours, the team said.

That does not mean the cockroach carried a compressed oxygen tank. A compressed oxygen tank is too heavy and bulky for a cockroach to carry. Instead, the researchers installed an ultra-small oxygen generator made with a 3D printer. Rather than storing oxygen in advance and supplying it directly, they made the generator produce oxygen as needed.

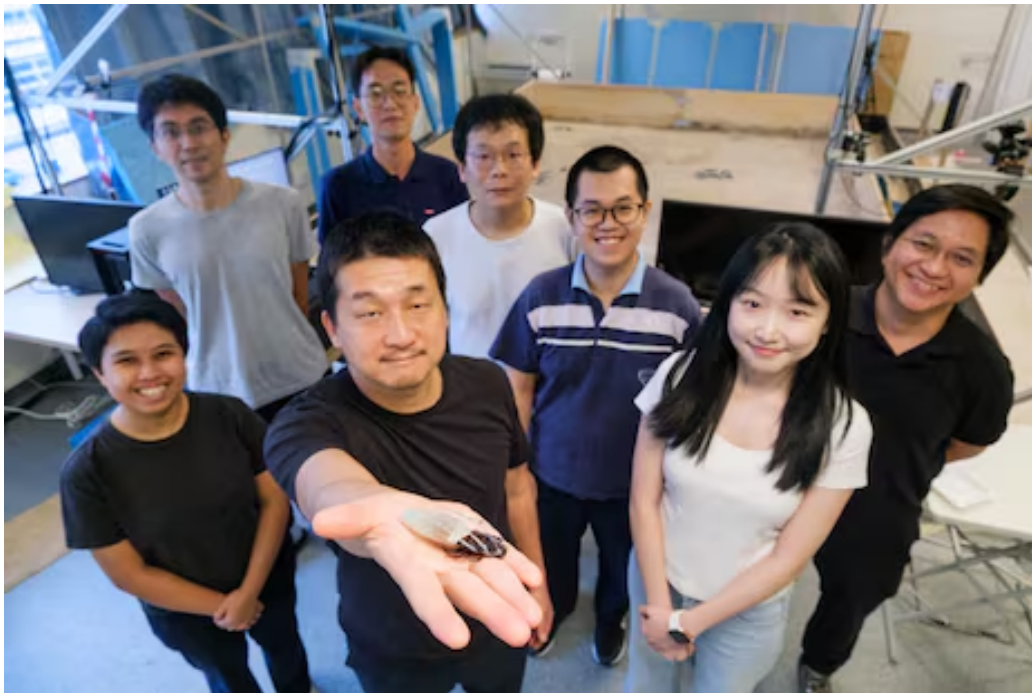
The inside of the oxygen generator is coated with a manganese dioxide (MnO_2) catalyst. When hydrogen peroxide (H_2O_2) is injected, manganese dioxide decomposes it into water (H_2O) and oxygen (O_2). If hydrogen peroxide and manganese dioxide are simply mixed, the reaction proceeds too quickly and oxygen bubbles and droplets can hinder the cockroach's movement. The researchers let hydrogen peroxide soak into a cellulose sponge coated with manganese dioxide. As a result, oxygen was generated slowly and in small amounts at multiple points.

Oxygen is delivered through a silicone tube to the cockroach's spiracles, its respiratory organs. The cyborg cockroach wearing the diving suit operated without problems in an experimental setup simulating a flooded tunnel. The cyborg cockroach moved at 87.5 mm per second on land and 78.4 mm per second underwater. Sato said, "By extending the operating range of cyborg insects to underwater environments, we can strengthen search and rescue operations at disaster sites."

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Sato Hirotaka of Nanyang Technological University in Singapore holds in his hand a cyborg cockroach wearing a diving suit with an oxygen generator. /Courtesy of NTU

◇ Remote control via wireless, feasible for space exploration

The researchers expected that cyborg cockroaches could also explore Mars using the same method. Like underwater, Mars' atmosphere has almost no oxygen. Until now, space exploration has used robots equipped with batteries. No matter how small a robot is, it must have a battery to drive its motors. In contrast, cyborg cockroaches move with their own muscles as long as oxygen is supplied, freeing them from that constraint.

Of course, a battery is still needed for motion control. The cyborg cockroach carries on its back a backpack consisting of an ultra-small computer for position control, a battery and an antenna. Wires run from there to the antennae and tail. When a wireless signal is sent from outside to the antenna, the backpack computer sends current through the wires accordingly.

The control principle of the cyborg cockroach is simple. When current flows to the right antenna, the cockroach turns left; when the left antenna is stimulated, it turns right. Stimulating both antennae makes it back up. To accelerate, current is applied to the hair-like sensory organ (cercus) on the tail.

Alan Winfield, a professor at the University of the West of England, said of the study, "The notion of a cockroach going scuba diving may look strange, but there are clear applications such as environmental monitoring," adding, "Cockroaches are not only far more efficient than robots but can also operate longer without refueling." On Earth, if not in space, they can find food on their own to replenish muscle strength.

The researchers are exploring the commercial potential of cyborg cockroaches. On Mar. 28, when a magnitude 7.7 earthquake struck Myanmar, cyborg cockroaches were test-deployed at search-and-rescue sites. Sato said, "The results of this study suggest cyborg cockroaches could be used not only for search-and-rescue missions but also to inspect hard-to-access infrastructure such as flooded pipes, drains and tunnels."

References

Nature Communications (2026), DOI: <https://doi.org/10.1038/s41467-026-74235-1>

arXiv (2024), DOI: <https://doi.org/10.48550/arXiv.2403.17392>

arXiv (2021), DOI: <https://doi.org/10.48550/arXiv.2105.10869>

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