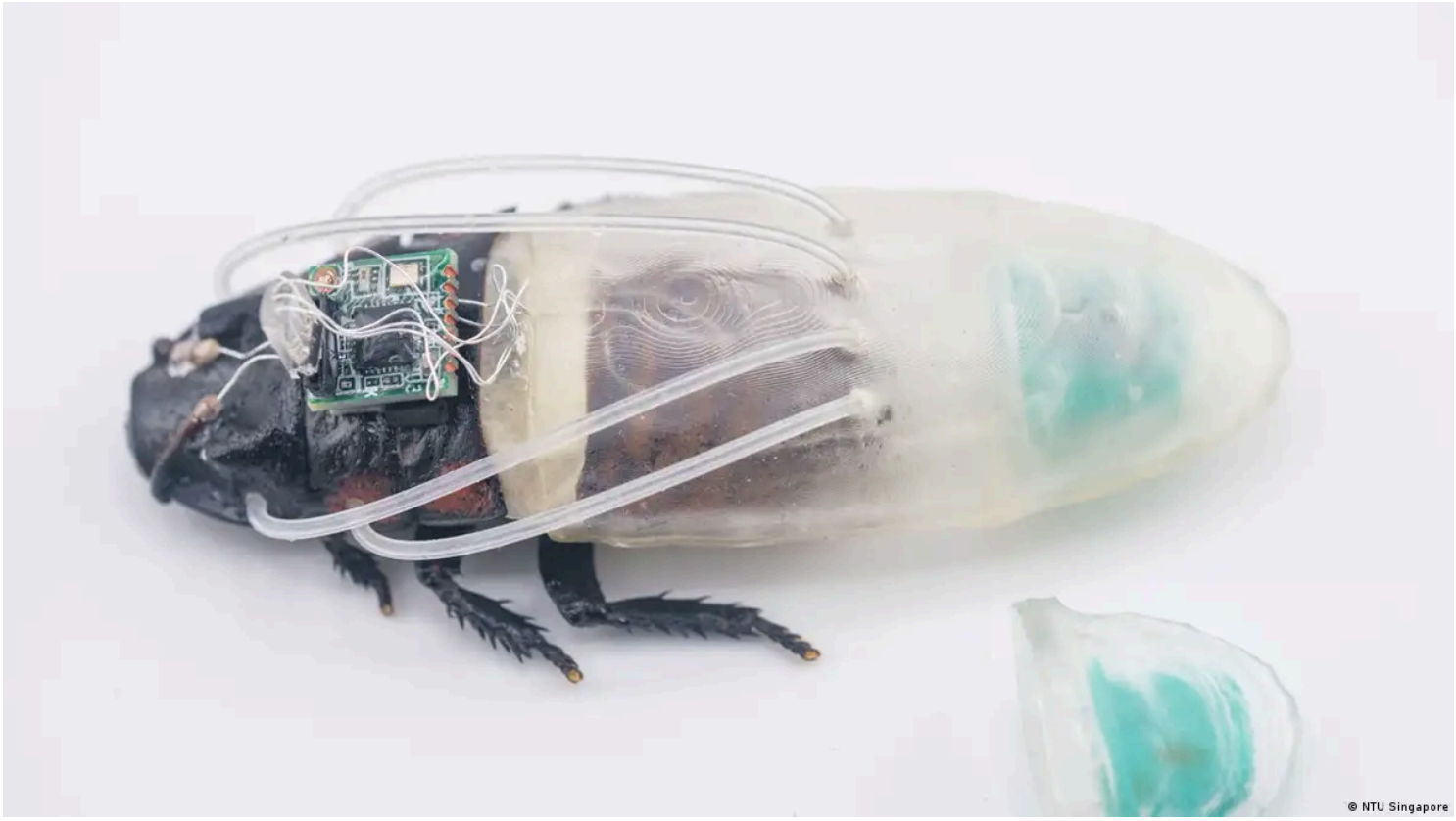
| GLOBAL SCIENCE |

Cyborg cockroaches receive suits that give them new superpowers

Felipe Espinosa Wang with information from NTU, P. Science and N. Scientist
07/07/2026

Can remotely controlled cockroaches become underwater rescue allies? A scientific team believes so, and they already have the suit to make it happen.



A team from Singapore and Tokyo equipped cockroaches with a 3D-printed suit that allows them to breathe and swim underwater, like a miniature oxygen tank. *Image: NTU Singapore*

It may sound like a bad joke, but the truth is that one day, in an emergency, we could count on an ally as unexpected as it is unlikely: the cockroach.

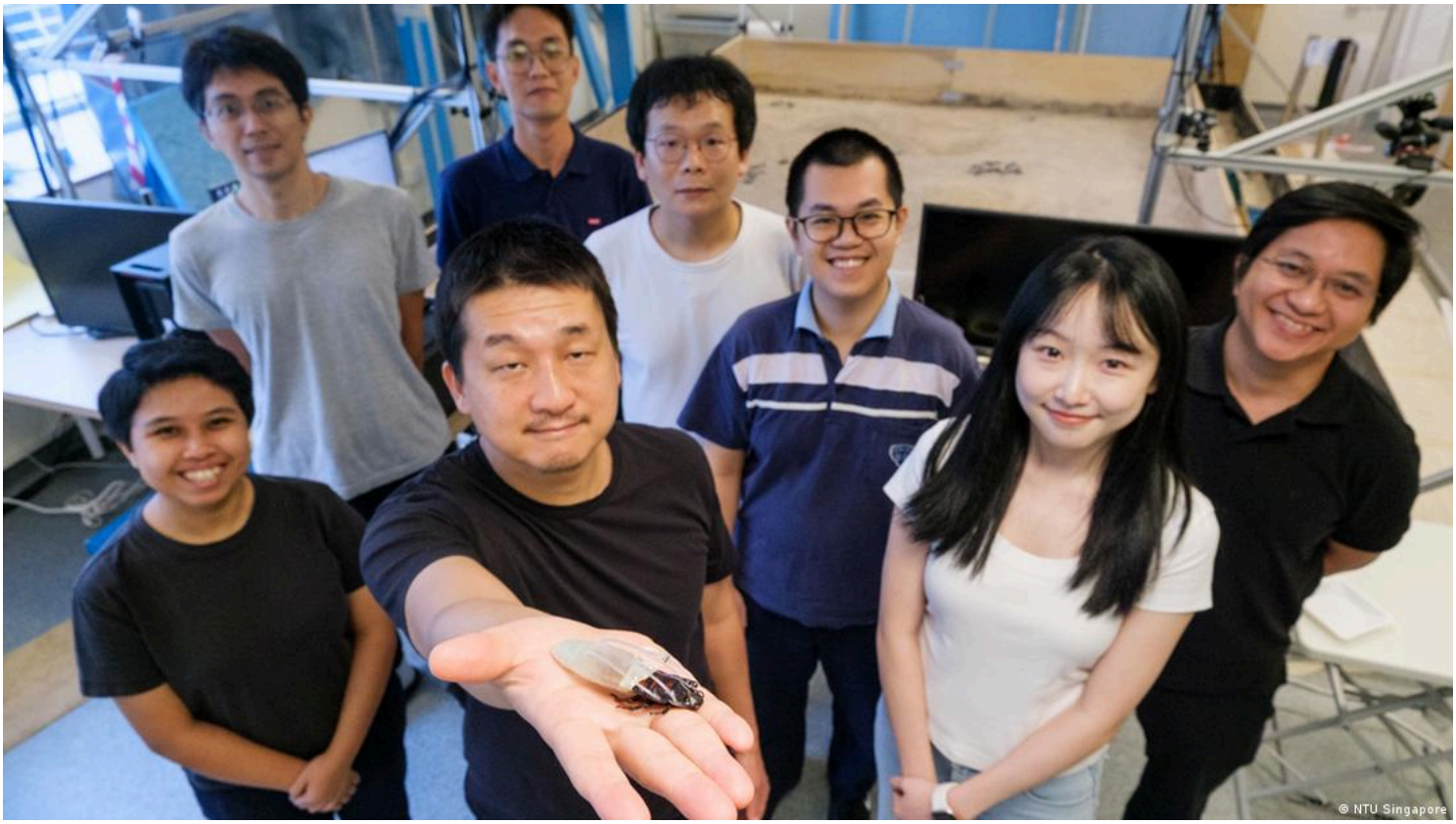
It's hard to imagine this insect equipped with a kind of diving suit, making its way through the rubble. However, that's exactly what a team from **Nanyang Technological University (NTU) in Singapore,** together with Waseda University in Tokyo, has devised: a system that allows these insects to be transformed into amphibious cyborgs capable of moving and breathing underwater.

Cyborg cockroaches: a proven technology

As outlandish as it may sound, cyborg insects **are nothing new.** For more than a decade, scientists have been anesthetizing insects, **implanting electrodes in their brains** and sensory organs, and then controlling them remotely with a simple remote.

Unlike conventional robots, their advantage lies in the fact that they utilize the animal's own musculature, **as explained by NTU Singapore.** This means they consume far less energy and don't require motors for movement. Furthermore, they retain a degree of autonomy, as they are only pushed when they stray from their path or stop, allowing them to avoid obstacles naturally.

The major obstacle, until now, has been water. Cockroaches breathe through spiracles, small openings connected to a network of internal tubes that stops receiving oxygen when the insect is submerged. In other words, however compliant they were, they would eventually suffocate.



Professor Hirotaka Sato of NTU held a cyborg cockroach equipped with a diving suit that allowed it to breathe underwater for three hours. *Image: NTU Singapore*

A suit that functions as an oxygen bottle

To overcome this obstacle, the researchers designed a flexible, 3D-printed suit that, according to the authors, works similarly to an oxygen tank for divers. The system incorporates a small reservoir with a sponge coated in manganese dioxide.

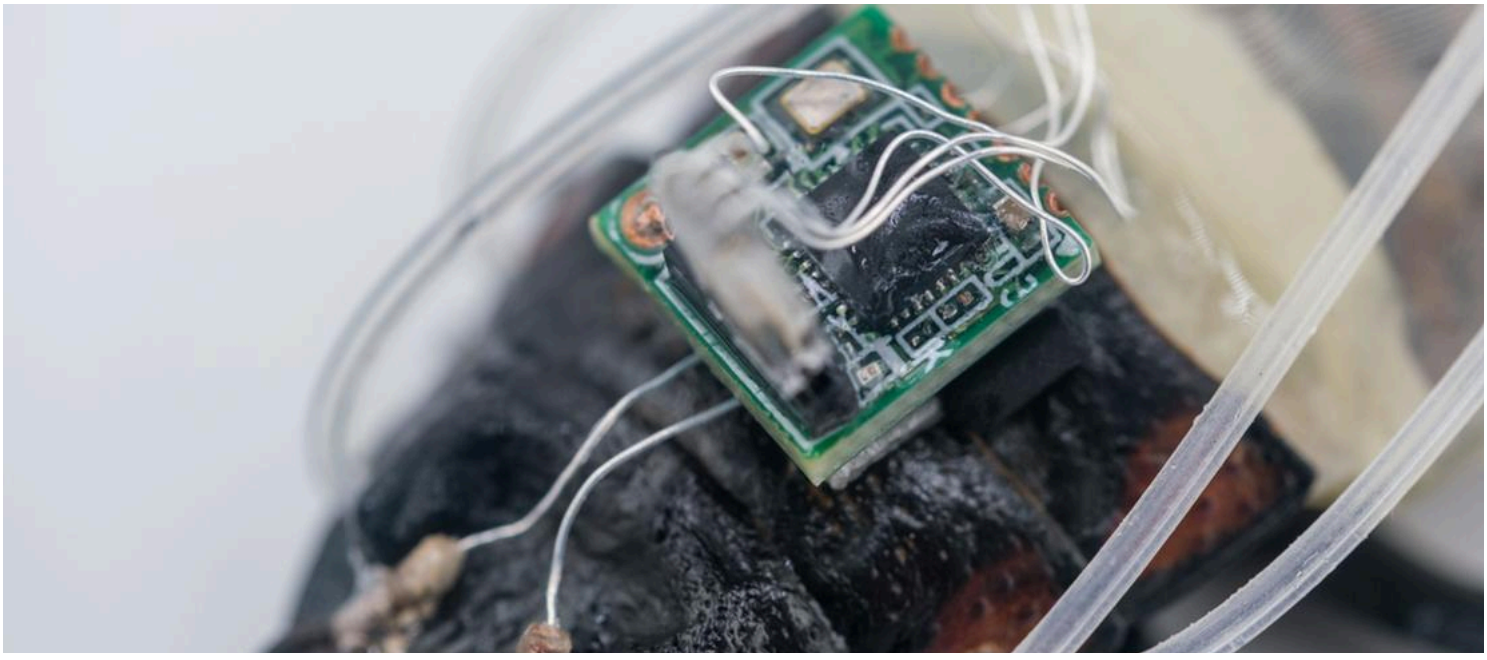
Adding diluted hydrogen peroxide triggers a chemical reaction that gradually releases oxygen. This oxygen travels through four silicone tubes connected to the cockroach's spiracles, allowing it to breathe while underwater, **according to NTU Singapore.**

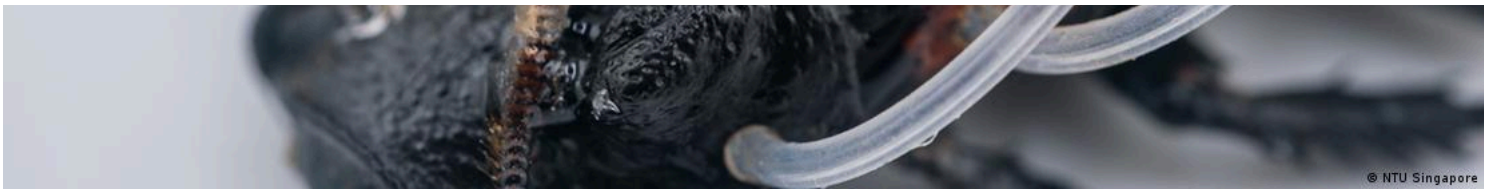
The whole thing is surprisingly compact. *Popular Science* notes that the backpack measures just 10 by 10 millimeters—about the size of a small piece of gum—and is made of a plastic-like material using 3D printing. The design aimed to add as little weight as possible so the insect could maintain its natural mobility.

The tests were conducted using Madagascar hissing cockroaches, a species particularly well-suited due to its large size, resilience, and lack of wings. Equipped with the device, they remained active and were able to move underwater for up to three hours at speeds only slightly lower than those they reach on land.

Search and rescue: the precedent of Myanmar

Beyond the laboratory, this technology already has a concrete track record. For example, cyborg cockroaches equipped with infrared cameras **participated in real** search and rescue operations **after the 7.7 magnitude earthquake that struck Myanmar** in March 2025. According to reports, the information gathered by the insects was processed using **machine learning algorithms** to help detect possible signs of life among the rubble.





The tiny device generated oxygen through a chemical reaction with hydrogen peroxide.

Image: NTU Singapore

That is precisely why Professor Hirotaka Sato of NTU, who led the study, believes that extending their movement capabilities to the aquatic environment could make them an even more useful tool in floods or landslides, where water can block access for conventional robots.

The great challenge, adds his colleague Shinjiro Umezu, from Waseda University, was finding the balance between generating enough oxygen and maintaining a system so light and flexible that it did not limit the insect's mobility.

From Mars to the oceans: the next steps

The team's ambitions, however, extend far beyond the flooded areas. Sato, speaking to *New Scientist,* has even raised the possibility of adapting this technology to develop a kind of "spacesuit" for cyborg insects, with an eye toward future exploration missions on **the surface of Mars.**

The study, **published in *Nature Communications,*** also suggests that the design could be adapted to other insects with similar respiratory systems, such as beetles or lobsters. However, it's best to temper expectations. For now, the experiments haven't gone beyond a few centimeters of water. It will be a long time before we see patrols of cockroaches exploring shipwrecks or reefs.

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