



Dim red light illuminates a bioluminescent display by an *Atolla* jellyfish.

HADDOCK/MBARI

identify the animals giving off the light show. “I can’t tell you how many times I’ve seen bioluminescence in the dark and said, ‘hey, that was cool, but I have no idea what it is,’” says Brennan Phillips, an oceanographer at the University of Rhode Island in Narragansett.

A few years ago, Phillips recorded an as-yet unidentified species of *Tomopteris*, a marine worm that looks like a centipede, using cameras fitted with advanced low-light sensors. He was able to capture footage of light glowing in the animal’s central nervous

system and then radiating into each of its legs.

And on a trip off the coast of Mexico in May, Phillips and other researchers used another new, specialized sensor to record an elusive 68-centimetre-long jellyfish called *Deepstaria enigmatica* (D. F. Gruber *et al. Am. Mus. Novit.* No. 3900; 2018). This jellyfish lacks tentacles, and researchers had long wondered how it captured its prey. The detailed footage showed how the invertebrate moved, which enabled scientists to deduce that the animal ‘bags’ its meal using the thin, membrane-like sac of its body.

Roughly three-quarters of marine organisms, excluding microscopic species and those that live on the sea floor, produce light. But researchers are only beginning to learn how the creatures use this ability to communicate, to attract mates or prey, or to defend themselves, says Haddock.

The footage that he and others are collecting shows animals acting in ways scientists have never before recorded, prompting more questions than answers. “We are going deeper than ‘gee-whiz,’” Haddock says. ■

## TECHNOLOGY

# Harpoon-throwing satellite takes aim at space junk

*Tests of experimental craft include flinging a net and shooting a spear at targets in space.*

BY ALEXANDRA WITZE

In a move Spiderman might envy, one satellite flung a net at another craft in low Earth orbit on 16 September. A few months from now, the satellite will ape the spear-wielding Aquaman and fire a harpoon into space.

The manoeuvres will test ideas meant to address the growing problem of space junk. If they work, future missions might use similar nets or harpoons to ensnare dangerous space debris and drag it to a fiery end in Earth’s atmosphere.

“This is proof of concept of a new technology,” says Guglielmo Aglietti, director of the Surrey Space Centre at the University of Surrey in Guildford, UK, and principal investigator for the project, known as RemoveDEBRIS. “The idea is to be really useful and clean up satellite space.”

The US military tracks approximately 20,000 objects in orbit that measure at least 5–10 centimetres across. That’s big enough to cause serious damage if two objects collide, and the threat is growing as more junk builds

up in space. In 2009, a US communications satellite accidentally smashed into a Russian one — creating thousands of shards that now hurtle through low Earth orbit, raising the threat of future collisions.

Now researchers are dreaming up ways to clean up some of this orbital junk. Last year, the Japan Aerospace Exploration Agency tried to unfurl an electrodynamic tether and hook it on to a piece of space debris; the mission failed when the tether did not release as expected. A team spun off from the Swiss Federal Institute of Technology in Lausanne (EPFL) is raising money to build a satellite that would throw a conical net around a defunct craft and steer it to its doom. And the European Space Agency (ESA) is working on ideas for a more complex spacecraft that could dispose of space junk or perhaps even refuel a satellite in

**“There will always be a tension between letting debris stay as it is or going to clean up some of it.”**

orbit, extending its life, says Luisa Innocenti, head of ESA’s Clean Space initiative in Paris.

## TAKING OUT THE TRASH

The €15-million (US\$17-million) RemoveDEBRIS mission is meant to test cheap ways to drag junk out of orbit. “There will always be a tension between letting debris stay as it is or going to clean up some of it,” says Aglietti. But if a space agency could remove particularly big and dangerous pieces of debris — such as ESA’s defunct, bus-sized Envisat Earth-observing satellite — it might be worth the effort.

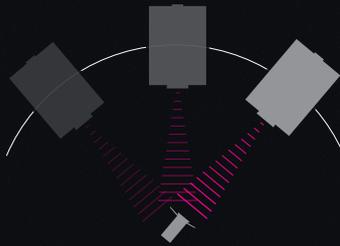
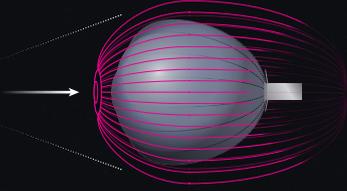
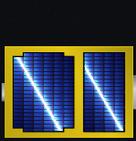
RemoveDEBRIS will test four technologies over a carefully choreographed few months. The spacecraft launched to the International Space Station in April and deployed into space in June. The first test, the net experiment, took place on 16 September (see ‘Ready, aim ... fire’).

The craft ejected a CubeSat, a satellite about the size of a loaf of bread, which inflated a balloon to a diameter of roughly 1 metre — big enough to be worth grappling with. RemoveDEBRIS then hurled its net around the ▶

## READY, AIM... FIRE

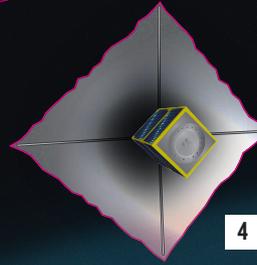
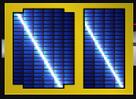
The €15-million (US\$17-million) RemoveDEBRIS mission is testing ways to clean up space junk, beginning this month.

- 1** On 16 September, the satellite threw and cinched a net around a 1-metre-wide balloon target.



- 2** In a few weeks, it will deploy a tiny satellite and use lasers to analyse its movement.

- 3** In early 2019, it will extend an arm and shoot a harpoon at a target 1.5 metres away.



- 4** Finally, it will unfold a sail to drag it into Earth's atmosphere, where it will burn up.

► balloon, using weights to cinch the net closed like a purse.

"It went well," says Aglietti. "We are very happy."

The second experiment is planned for late October. RemoveDEBRIS will eject a second CubeSat, then scan it using lasers to test techniques for studying and

navigating near space junk.

The third test, throwing the harpoon, could come in early February. The RemoveDEBRIS satellite will extend an arm 1.5 metres into space, flip up a target plate and shoot the spear at it.

Finally, in March, the satellite will inflate a 1-metre-long mast and unfurl a sail. The sail is meant to function as a drag, steering the satellite to lower altitudes so it will eventually burn up in the atmosphere.

An industry consortium built the project, with subsidiaries of the aerospace company Airbus providing the net and the harpoon. The team has tested each experiment on the ground, but things could go awry in the notoriously difficult environment of space.

"We are very much prepared for some of the things to go a bit differently than planned," says Aglietti. But if it works, the space net and harpoon could become common weapons for dealing with space junk. ■

### CORRECTION

The News feature 'The information factories' (*Nature* **561**, 163–166; 2018) erroneously affiliated Eric Masanet with Northeastern University. In fact, he is at Northwestern University in Evanston, Illinois.