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CONCOURS D'INGENIEURS DE LABORATOIRE DU MINISTERE DE L'ECONOMIE, DES FINANCES ET DE LA RELANCE DU 5 AVRIL 2022

CONCOURS EXTERNE : SPECIALITE CHIMIE ANALYTIQUE

Rédaction d'un résumé en langue anglaise à partir d'un ou plusieurs articles en anglais.
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Nature does not use propellers. So why do people?

No known sea-creature uses propellers. Perhaps that is because they are too difficult to evolve from existing animal body plans. Or perhaps it is because they are not particularly good at doing what they do. When pushing water around for propulsive purposes, bigger is not only more powerful but also more efficient. But the bigger a propeller is, the harder it is to accommodate to a hull and the more it risks adding to a ship's draft and thus snagging the seabed. Even the biggest ships' propellers are therefore only around ten metres in diameter.

Fins and flippers, by contrast, extend sideways, so do not suffer from such geometric restrictions. That means they can get big enough to push a lot more water around. Nor, unlike propellers, need they be rigid. In fact, being flexible is almost part of the definition (a rigid fin might better be described as an oar). They are therefore not easily damaged by contact with the seabed or other objects. Fins have thus become evolution's go-to accoutrement for marine propulsion. From fish, via ichthyosaurs, to dolphins and whales, they turn up again and again. So, from plesiosaurs and turtles to seals and penguins, do their cousins, flippers.

In light of this evolutionary vote of confidence in fins, ships' propellers look like a technology ripe for a bit of biomimetic disruption. And that may now have arrived in the shape of Benjamin Pietro Filardo, an ex-marine biologist and architect who was looking into ways of designing devices to extract power from water currents. His plan was to use flexible materials, so that they could easily shake off any debris which got entangled in them. He then realised that the undulations involved might also usefully be turned into thrust.

Mr Filardo has put his money where his mouth is. His firm, Pliant Energy Systems, based in New York, has developed Velox, a prototype propelled by flexible fins, port and starboard, that are reminiscent of yet another animal's approach to swimming—the undulating mantle of a cuttlefish. Velox can travel on the surface, underwater, and also across mud or ice, with its fins then acting in the manner of a pair of robotic caterpillars.

According to Mr Filardo, Velox produces around three times as much thrust per unit of energy expended as a typical small boat's propeller can manage. And he hopes, soon, to do even better than this. Having demonstrated his device to America's Office of Naval Research, he has piqued their interest. The result is a commission for a follow-up, c-Ray, that should be lighter, faster and yet more efficient.

Unlike Velox, which is controlled by cable, c-Ray will be autonomous—the ultimate aim being to develop co-operative swarms of craft for jobs such as mine detection and removal, reconnaissance and anti-submarine patrols. From a naval perspective, however, undulatory propulsion may have a yet-more-important advantage. Submarines are often detected by the noise they make, much of which comes from the propeller and the shaft driving it. Undulatory propulsion, moving more water at lower speed, should be quieter than any propeller. Nor does it involve a noisy phenomenon called cavitation, caused by transient gas bubbles that form in response to propeller blades' pressure.

This matters, because Velox-like fins may prove to be a technology that can be scaled up to propel full-sized submarines. As Mr Filardo observes, the largest marine animals of all, the great whales, are fin-propelled, even if their fins are arranged differently from Velox's. Indeed, the biggest of the lot, a blue whale, can travel at more than 20 knots, which would not disgrace the average submarine. Previous attempts to scale-up fin-propulsion have failed, he says, because they have not found the necessary compromise between stiffness and flexibility. He reckons he has.

Travelling waves

Even if they do not make the big-time, naval-warfare-wise, swarms of Velox's descendants might be deployed for tasks from harvesting scallops without destructive trawling to mining nodules from the seabed without harming habitats—for undulatory propulsion does not disturb sediment. In a world where the creation of new carbon sinks may become big business, they might even be used to plant beds of seagrass on a vast scale. Craft propelled by undulation would also have less risk of harming swimming mammals, such as manatees and human beings, which sometimes get chewed up by propellers.

Mr Filardo is even looking into the idea of merging his interests, by designing a craft with undulating propulsion that can moor itself and then recharge its batteries from disturbances to its fins caused by passing ocean currents. Just how far he or others will be able to push this new approach to propulsion remains to be seen. But if the engineering works, and can indeed be scaled up, ship's propellers may one day look as old-fashioned as sails.

The Economist – 18 December 2021 edition

https://www.economist.com/science-and-technology/nature-does-not-use-propellers-so-why-do-people/21806832