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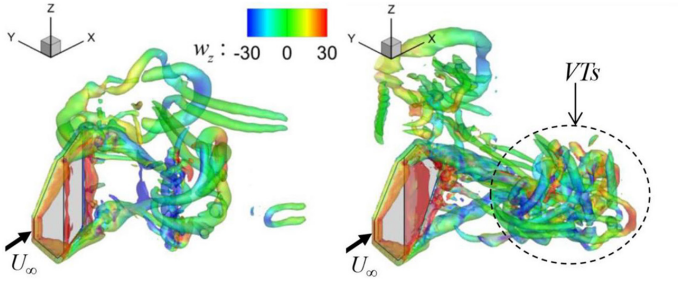
An analysis discerns the effects of shape and torsional spring on hydrodynamic properties of caudal fins with low-order flexibility.



The parameters of a fish's tailfin can have a dramatic impact on the animal's hydrodynamics and speed. As more applications look to nature for alternate means of propulsion, work has been done to elucidate the effects of rigid fins versus fully flexible fins, shedding light on the properties and potential uses of little-studied semi-rigid fins.

Lin et al. simulated the hydrodynamic effects of prototypical low-order flexible fins. The models were composed of two rigid panels, a torsional spring, and different fin shapes, including square, concave and convex.

The group analyzed the effects of the spring and shape on the bioinspired simulated fins, using the Navier-Stokes equation for flow field and an immersed boundary method for characterizing the fluid-structure interactions.

Low-order flexible fins have garnered attention in recent years for being relatively straightforward to engineer compared to their fully rigid and fully flexible counterparts.

The researchers found the torsional spring can significantly enhance the thrust and efficiency of bioinspired fin through changing the phase lag between the fore and hind parts of fins. This effect was pronounced compared to rigid fins.

They found the square shape to be optimal for propulsive efficiency, while a convex shape better for thrust.

"It is surprising that the optimal shape for thrust generation is different from that for propulsive efficiency," said author Jie Wu.

The investigators next look to study the effect of a fish's whole body on the performance of each caudal fin. They hope their findings will help inform the design of future underwater robots.

Source: "Effect of torsional spring and shape on the performance of bioinspired caudal fin," by Xingjian Lin, Tongwei Zhang, and Jie Wu, *Physics of Fluids* (2021). The article can be accessed at https://doi.org/10.1063/5.0057138.