Diamonds Are a Fish's Best Friend

Fish swimming in vertical diamond formations gain efficiency through hydrodynamic interactions.

By **Ryan Wilkinson**

Fish travel in schools to defend against predators, improve navigation, and increase opportunities for foraging and mating. It is also thought that each fish can boost its swimming efficiency by leveraging swirling patterns of water, or vortices, produced by its neighbors. Now Haibo Dong at the University of Virginia and his research group have found support for that idea by analyzing the hydrodynamics of fish moving in vertical diamond formations [**1**]. The results could help scientists design efficient fish-inspired robotic swarms for environmental monitoring or underwater exploration.

Previous studies on the hydrodynamics of fish schools have focused on horizontal diamond formations, where four fish are situated at the corners of a horizontally oriented diamond. Those studies suggested that such formations can increase each fish's swimming efficiency through various vortex effects. However, in nature, fish are not restricted to moving in the same horizontal plane. For a more complete picture of schooling hydrodynamics, Dong and his group argued that vertical formations must also be considered.

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The researchers performed detailed numerical simulations of the vortex dynamics in vertical diamond formations. Despite involving just four fish, these simulations were computationally costly because the vortex dynamics were highly complex. The team identified different types of hydrodynamic interactions between the fish's bodies, fins, and wakes—the disturbances left behind by the movement of fish. Such interactions were strengthened when the fish were closely spaced and enhanced each fish's swimming efficiency. The team says that the next step is to explore larger or more elongated diamond formations.

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REFERENCES

1. A. Menzer *et al.*, "Fish schools in a vertical diamond formation: Effect of vertical spacing on hydrodynamic interactions," **Phys. Rev. Fluids 10, 043104 (2025).**