Authors: Ellen Pak[1], Isabella Claeson[2], Megan Vandenberg[3], Karly E. Cohen[4], Cassandra M. Donatelli[2]

Affiliations

1) University of Washington Tacoma, School of Science and Mathematics
2) University of Washington Tacoma, School of Engineering and Technology
3) University of Washington, Department of Biology
4) University of Washington, Friday Harbor Labs

Tales of Scales: The Relationship Between Hydrodynamics and Antifouling of Pleuronectidae

The diverse surface textures of marine fishes serve many functions such as camouflage, intraspecific signaling, protection, drag reduction, and anti-bioaccumulation (antifouling). Fish scales are known to enhance both antifouling and hydrodynamic performance in different ways via micro- and nano-scale surface structures, making them a good source of inspiration for bioinspired models. However, most studies look at functions independently, so the relationship between hydrodynamics and antifouling features remains unclear. Insight into these two interactions could guide designs of more efficient and sustainable maritime technologies. Fishes, like right-eyed flounders (Pleuronectidae) which swim in the water column and bury in the substrate would benefit from having scales with both drag reducing and anti-fouling features. Our preliminary data, conducted across a range of fish families, showed that Pleurodectidae models produced a wake pattern conducive to both. These scales are primarily flat, with spiked edges that point upwards, with variation within and across species. We used Keyence microscopy and μCT to describe the microscale topographies of 14 Pleuronectidae species to obtain a standard for flexible bioinspired 3D model designs based on shape and arrangement. A hydrodynamic flume was used to quantify drag with particle image velocimetry. Models were submerged in Friday Harbor to evaluate fouling. We believe that models with a straight spike arrangement may excel in drag reduction, but be less capable at antifouling, while models with a staggered spike pattern may have a better balance of drag reduction and antifouling properties.