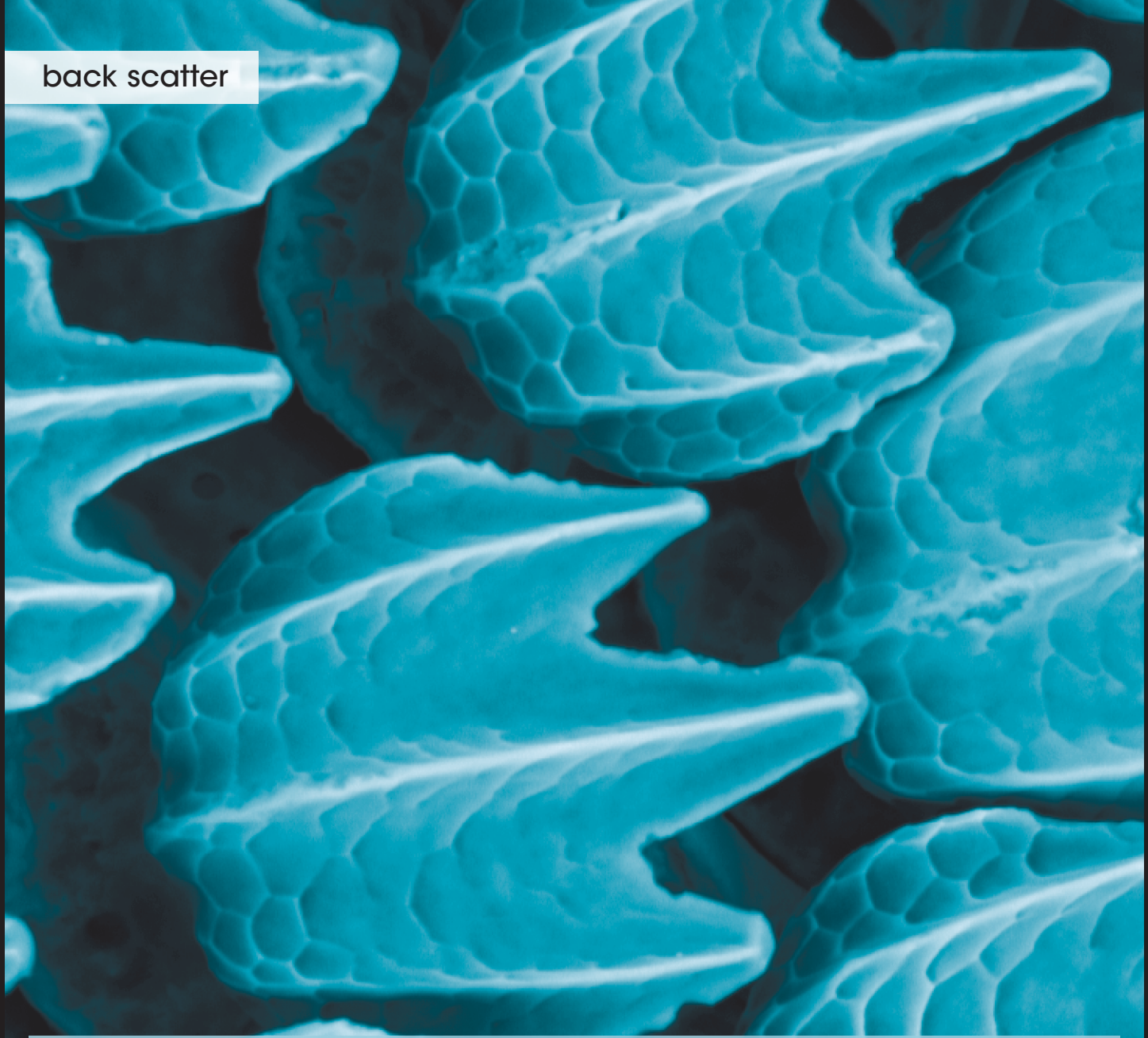

The hydrodynamics of shark skin

The skin of sharks is covered with scales called denticles. This image, 250 μm across, of the skin of a bonnethead shark shows the details of typical denticles, with three surface ridges leading to three prongs oriented toward the tail. Related in structure to teeth, denticles have long been suspected of reducing hydrodynamic drag on sharks as they swim. Indeed, shark skin has inspired a variety of materials engineered to reduce drag on submerged bodies; swimsuits are perhaps the best-known example. (For more on swimsuit technology, see PHYSICS TODAY, August 2008, pages 32 and 84.)

Many of the experimental studies of such materials—and of shark skin itself—have examined the drag on rigid bodies, a scenario that may be relevant for some applications but not for sharks or swimmers. New work by Johannes Oeffner and George Lauder of Harvard University has now looked at the effects of undulation. The pair mechanically flapped sheets of shark skin in a flowing water tank to determine the speed at which each sheet held its position. Comparing the swimming speed for natural shark skin with that for skin with the denticles sanded off, the team found that denticles actually decreased the swimming speed for rigid sheets but produced a 12% increase for flexible sheets that mimicked typical shark undulations. The team attributes the increase not just to decreased drag but also to increased thrust arising from the altered flow environment observed near the undulating surface. Surprisingly, the researchers saw no clear speed increase in similar experiments with "shark-inspired" swimsuit fabric. (J. Oeffner, G. V. Lauder, *J. Exp. Biol.* **215**, 785, 2012; image submitted by George Lauder.)

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