TRAILS IN THE TRACKLESS SEA

Look astern from the deck of a moving ship, and you may well see a paradox. In a ship's wake, you would expect the water directly astern—the water most roiled up by the propellers and by the passage of the hull—to remain unusually agitated. In fact, the water along the ship's path becomes smoother than the surrounding sea. In some cases this "smooth wake" forms a distinctive trail that extends for many kilometers behind the ship and persists for hours. The mechanism that gives rise to the smooth wake has lately come under investigation; surprisingly, the explanation seems to have much to do with events at a molecular scale at the water's surface.

The smooth wake shows up prominently in images made with synthetic-aperture radar operated from aircraft or spacecraft. Such instruments are sensitive to reflections from ocean waves, particularly when the wavelength of the water waves is near that of the radar beam. The smooth wake typically appears in a synthetic-aperture-radar image as a dark streak in a bright field, indicating that waves of the appropriate scale have been suppressed. The effect is most pronounced at shorter wavelengths—typically about a foot.

The mystery of the smooth wake is not so much how it forms as why it persists. Several factors contribute to the initial creation of calm water along a ship's path, starting with the mere presence of the ship itself, which obviously destroys the wave pattern within the area occupied by the hull. Turbulence caused by the motion of the ship and by the churning of the propellers also disrupts the prevailing waves. Still another possible influence, whose importance is not yet certain, is the bursting of bubbles when entrained air rises to the surface.

The cause of this odd behavior has lately been investigated by Jerome H. Milgram of the Massachusetts Institute of Technology, Rodney D. Peltzer and Owen M. Griffin of the Naval Research Laboratory, and Richard A. Skop of the University of Miami. In two papers to be published in Journal of Geophysical Research they present observations of wake proper.
ties measured at sea and devise a mathematical model meant to account for those observations.

The crucial finding to emerge from these investigations is the importance of surfactants, or surface-active molecules. It turns out that even an exceedingly thin film of such molecules—indeed, even a monolayer, a film one molecule thick—can have a significant effect on the growth and propagation of short-wavelength ocean waves. The effect is closely related to that of spreading oil on water to calm a stormy sea, a technique that has been known since antiquity. It may seem implausible that a molecular film could have much effect on waves a billion times larger in scale, but the phenomenon is well documented. The film modifies the boundary condition at the air-water interface and converts the energy of transverse water waves into the energy of longitudinal stretching and contraction in the film; much of this energy is then dissipated by viscosity in a thin layer of water just under the film. The shortest waves are damped the most by this mechanism, but longer waves give up some of their energy in regenerating the shorter waves, so that eventually the entire spectrum is damped to some extent.

What are the surfactant molecules responsible for the damping? Where do they come from? Molecules of biological origin are the leading candidates, most notably decomposition products of phytoplankton and other marine microorganisms. Some of these molecules, such as the phospholipids of cell membranes, have both hydrophilic and hydrophobic domains, so that they can form a stable layer at the air-water interface. Extensive chemical analyses of surface films, done by William R. Barger of the Naval Research Laboratory, have revealed a complex mixture of organic compounds, with a significant fraction of large-molecular-weight molecules that may include carbohydrates and proteins. Barger has found that every sample of seawater examined has a detectable quantity of surface-active material.

**COLEOPTERAN CHILD CARE**

The human species is not the only one that finds bearing and rearing children challenging. Imagine this prospect: Suppose that reproduction required first finding a large source of food, say a dead animal weighing up to 500 times your weight. Then suppose that you had to move the animal to a safe spot over a distance of perhaps 100 times your body length, and bury it at a depth six times your body length. Next you would have to copulate, produce eggs and feed and protect from predators the 30 or so children that would hatch. All this to take advantage of the one chance at procreation that is likely to come along in a lifetime.

Such is the reproductive struggle of a real species—and, surprisingly, an insect. In a class where parental care is a rare phenomenon, the burying beetles invest remarkable effort in becoming and being parents. Michelle Pellissier Scott, a zoologist at the University of New Hampshire, has been trying to understand why.

In the early 1980s Scott, an assistant professor of zoology at UNH, stumbled upon a burying beetle trying to stash a dead mouse in a wall of an old farmhouse that she was renovating in Jaffrey, New Hampshire. A few years later, Scott began investigating the reproductive behavior of these beetles.

Burying beetles belong to the family *Silphidae*, a group that feeds almost solely on carrion. They are large by insect standards—roughly one to two centimeters in length—and are common throughout the United States in both woods and suburbs. Scott began her work on the nocturnal