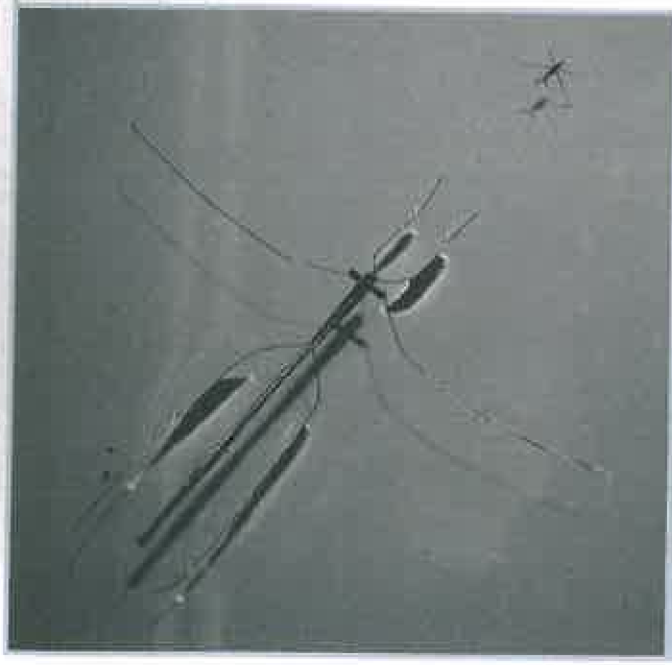
Making strides

Residing on the surface of ponds, rivers and oceans, insects called water striders, or *Gerridae*, propel themselves across the water in a sculling motion, driving their hydrophobic legs against the water during their rowing stroke without penetrating the surface. Although previous studies suggest that their hydrodynamic propulsion relies on surface waves, results from an investigation conducted at Massachusetts Institute of Technology in Cambridge suggest otherwise.

Gerris remigis, the adult water strider, sits on water without breaking the surface. Distortion of a free surface generates the curvature force that supports the insect's weight. All images are reprinted from Nature *with permission of the researchers.*



The adult water strider (upper right) faces off against Robostrider, the mechanical device developed by researchers from MIT. Featuring proportions consistent with its natural counterpart, the robot measures 9 cm long and is made of 0.2-mm-gauge stainless steel wire, hydrophobic legs and a lightweight aluminum body.

Using a high-speed video camera, the researchers filmed *Gerris remigis* from freshwater ponds, collecting images at a rate of 500 fps and digitizing and analyzing them with Midas motion-analysis software. They performed particle tracking, where same-density particles are suspended in the water to indicate its motion, using 50- to 100-µm-diameter Kalliroscope or Pliolite particles. They then conducted dye studies with food coloring and thymol blue, generating the surface structure wrapped up by the insects' vortical motions.

The waves and vortices produced by the strider motion were imaged from above and from the side, and the insects' form and speed were measured right after the stroke. The results showed that the insects' momentum is transferred through hemispherical vortices shed by their driving legs.

Based on these findings, the researchers created Robostrider, a mechanical water strider that mimics the motion of its natural counterpart. An elastic thread-and-pulley design ensures that the force per unit length along the driving legs does not exceed twice the surface tension and that the device does not break the surface despite leg speeds of 18 cm/s. Traveling at half a body length per stroke, the robot generates capillary waves and vortices, and its principal momentum transfer is in the form of vortices shed by the rowing motion. □

Convection prompted by thymol blue on the surface results in the ambient texture. The starburst pattern results from the reduction of the local surface tension and the associated divergence that sweeps away the dyed surface layer. The fluid is illuminated from below, attracting the light-seeking water strider to the starbursts.

Disturbance of a 2- to 5-mm layer of thymol blue on the water surface by the leg stroke reveals the vortical footprints of the water strider.