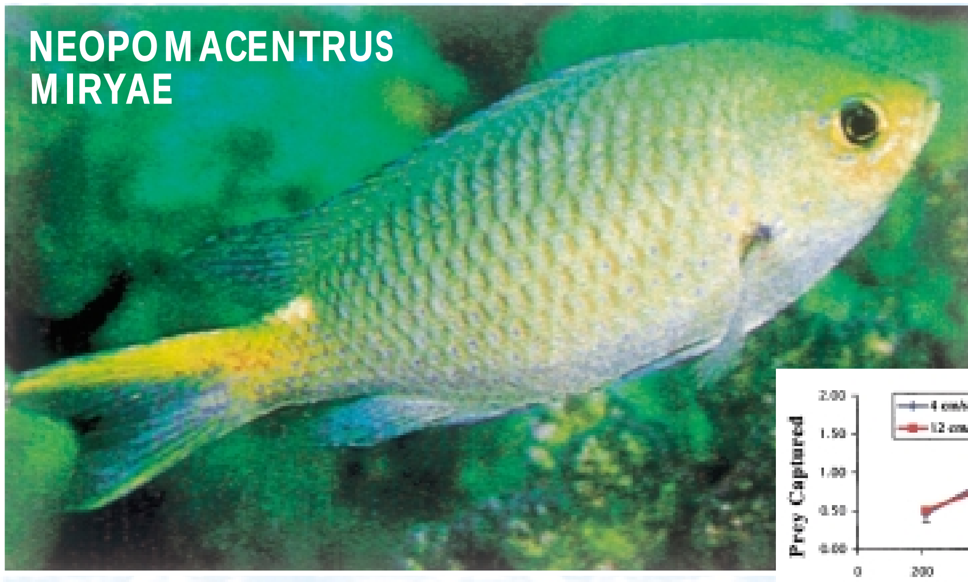
REEF FISH GO WITH THE FLOW

he teeming world of the coral reef is largely maintained by the never-ending flow of almost microscopic animals and plants (zooplankton and phytoplankton) swept along by local currents. Many plankton-eating fish forage just upstream of their coral-reef shelters, getting first-crack at the rich current-borne smorgasbord. Efficient foragers, they can remove more than half of all the zooplankton passing their collective way. This effect is sufficient to lower zooplankton concentrations 10-fold near the reef itself, particularly that of the larger (~1 mm) prey, which is more readily consumed.



Dr. Amatzia Genin and his colleagues have been studying the linkages between currents, hydrodynamics and behavior in this enticingly beautiful, increasingly endangered, underwater ecosystem. Cross-shore currents, deliver new zooplankton to the reef's feeding grounds. Using a unique high-frequency (1.6 MHz) multi-beam sonar, the researchers have followed some 200,000 individual zooplankton, mostly copepods, where cross-shore currents induce vertical water flows. The animals' tracks showed that these minute animals can actively swim against such vertical flows to retain their preferred depth. Consequently, the zooplankton become aggregated and actively targeted by their fish predators.

The predation rate (P), the number of zooplankton eaten per second, is found to be proportional to the prey density (D) for all fish studied, and does not level off even at high densities. In contrast, increasing the current flow speed (S) has little effect on predation, even in the more "hydrodynamic" fish with long, narrow bodies. This is surprising, since increasing S actually increases the flux (F) of prey passing by the fish (F=S*D). The predation efficiency (P/F) thus remains constant as D increases, but drops almost linearly with flow speed. However, more hydrodynamic fish do have absolute feeding rates 2-3 times higher than flatter, wider and squatter ones.

The maximal distance at which prey was detected was dependent on light-levels, but not current speed, up to some saturation light-level. It was about 11 cm for 0.6-0.7 mm size prey at saturation. The fish noticed and attacked only prey within a cone-shaped area in front of them, the angular width of which decreased almost exponentially with the current flow speed, regardless of the fish's shape.

As flow speed increases, foraging fish also have to invest more energy in overcoming pressure drag. This requires more nutrient intake (feeding) and more quickly becomes a losing proposition for less-hydrodynamic fish. In their survey of seven coral reef communities located along the southern coast of the Sinai Peninsula, the investigators found that coral reefs exposed to strong currents were inhabited almost solely by hydrodynamic species. Reefs protected from strong currents were inhabited by wider, less current-adapted species. Surprisingly, there was little overlap between the two types of species, with dramatic shifts sometimes occurring over just a few hundred meters. This is apparently the first documented ecological-niche separation based on current flow, and a recurrent reminder of the mutual shaping of the physical and biological worlds.