The Pteropod Mollusk *Clione limacina*, called the sea butterfly, is an inhabitant of the colder oceans of the northern hemisphere. About an inch long, it spends its entire life in the water column, living at about 100 meters during the day and migrating upward, near the surface at night.

When Mollusks Fly

What can a lowly marine mollusk tell us about how our nervous system controls our legs during walking and how it controls the switch from walking to running? This problem is difficult to address in humans or even in other vertebrates. We know from the post-chopping block chicken that the circuitry controlling alternate movements of the two legs is located in the spinal cord, not the brain, but beyond that, not much is known about the connections between neurons that produce the rhythmic activation of muscles that we know as walking or running.

Our immediate vision of a marine mollusk takes one of two forms: a slow-moving creature cruising on the ocean bottom or a sleek squid or octopus jetting through the water. Neither has much in common with our bipedal locomotion. We have to go to the mid-water depths to find a specialized mollusk whose locomotory system shares features with ours. The pteropod mollusk, *Clione limacina*, never goes near the ocean bottom, but rather flies through the water by flapping a pair of wings, hence its common name, the sea butterfly. *Clione* not only shares neuromuscular features with higher animals, it can change swimming speed in a way that is similar to the way we change gait, from walking to jogging and jogging to running. Best of all, *Clione* has a relatively simple, accessible nervous system with neurons large enough in which to insert tiny microelectrodes so their electrical activities can be measured.

Richard Satterlie, UNCW's Frank Hawkins Kenan Distinguished Professor of Marine Biology, has been working on the neural circuitry underlying locomotory speed changes in *Clione* since the mid-1980s, and the emerging picture is going beyond the simple control of limb movements. The little animal, only about an inch long, is providing insights into the neural substrates of those "mysterious" behavioral states called arousal and motivation—what we refer to when we say that we are in the mood, or not in the mood, to do something.

Can the sea butterfly help paraplegics walk? Not directly. But the neurobiological rules discovered in the locomotory system of *Clione* have been found to apply to higher animals, whose complex circuits use the same basic circuitry found in this marine mollusk. Furthermore, knowledge of adaptable rhythmic circuits is essential for the design of devices used for electrical stimulation of muscles in spinal injury patients, with similar applications to the field of robotics.

Richard A. Satterlie, Ph.D., UNCW's Frank Hawkins Kenan Distinguished Professor of Marine Biology and professor, biological sciences
satterlier@uncw.edu