Looking at Limpets

Top: Graduate student Sara Boles is securing electrodes to limpets in order to measure changes in heart rate as temperature is increased. Bottom: Dr. Todgham is currently using Dr. Jonathon Stillman's heart rate set-up at the Romberg Tiburon Center for Environmental Studies (RTC).

Right: Fingered limpets, *Lottia digitalis*, aggregating on rocks in the laboratory at RTC.

by Dr. Anne Todgham

One of the current research projects in the Todgham lab is investigating the vulnerability of intertidal limpets (a type of marine snail) to future global warming. Limpets are important intertidal species in coastal California's wave-swept rocky shores, acting as major competitors for space in the upper to lower intertidal, maintaining a garden of algae free of other invertebrate species. Their habitat alternates between a terrestrial and marine environment with the coming and going of tides. As a result, it has been fruitful to study intertidal limpets to examine how animals are adapted to tolerate variable temperatures and other widely fluctuating environmental conditions.

We and others predict that rocky intertidal organisms will be very vulnerable to global climate change; living in such a productive, but otherwise environmentally stressful, marine ecosystem has already "stretched" their adaptive physiological tolerances to the limit. The additional environmental change predicted by climate change scenarios is forecast to push these organisms past their existing tolerance limits. Thus ironically, because of their ability to occupy a highly variable thermal environment, limpets are good indicator species for quantifying how much thermal change will affect the population and thus the organism's ecology.

Global climate change is predicted to increase both mean temperatures and the frequency of extreme high-temperature events within the next 90 years. We already have direct evidence from polar, temperate, and tropical ecosystems that plant and animal distribution and abundance have already begun to move poleward in response to increases in global temperature. It is urgent to understand whether contemporary organisms that lack the ability to move to cooler environments have the physiological capacity to tolerate this unprecedented rate of environmental change. The impact of extreme high temperature on an animal's performance depends not only on the organism's ability to turn on protective physiological mechanisms but also on the organism's ability to recover from one stressful event before the onset of the next high temperature event. The interval between extreme high temperature events, combined with the time it takes for an organism to recover from a stressful event, therefore will likely be important determinants of species' resilience in the face of global climate change.

Currently, one of Todgham's graduate students, Brittany Bjelde, is looking at how limpets perform when exposed to increases in temperature indicative of global warming scenarios. Bjelde is specifically looking at how heart rate and metabolic rate change with increasing temperature; her goal is to to determine the upper temperature tolerance of different limpet species that live along our California coast. By characterizing an animal's ability to tolerate the future ocean conditions geoscientists predict in their various global warming scenarios, and by identifying those organisms that will be particularly sensitive to elevated temperatures, Todgham says we can begin to forecast how our marine ecosystems might look by the end of the century.