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NEW INSIGHTS INTO THE RESISTANCE OF SEA URCHINS TO OCEAN ACIDIFICATION

Do marine animals harbor enough genetic variation to withstand the acidification of the ocean? Ocean acidification (OA) results from the production of carbonic acid when carbon dioxide from the atmosphere reacts with seawater. OA could cause the decline of many marine species because it reduces the availability of calcium carbonate, which is used to build animal shells and skeletons. It is important to understand whether this reduction in a critical building material will cause the loss of marine species or whether they have the ability to adapt and survive.

Evolution can enable populations to respond to an environmental change only if they have enough genetic variation for traits that resist the change. Dr. Robert Podolsky, a researcher at the College of Charleston's Grice Marine Laboratory, has been investigating whether the Atlantic purple sea urchin, *Arbacia punctulata*, shows genetic variation for resistance to OA. This information will allow us to better predict the ability of these populations to persist in the face of this environmental threat.

Hailey Conrad, an intern at the Grice Marine Lab, spent this summer tackling one part of this problem. OA could affect every stage of sea urchin development. Conrad's project focused on the pluteus larval stage (pictured below), which has arms covered in cilia that they use to collect suspended food. A depletion of calcium carbonate caused by OA might stunt the growth of these arms and reduce their feeding. She studied a population from near Woods Hole, Massachusetts, an area that is naturally low in calcium carbonate. She spawned animals and reared larvae in the laboratory to measure larval skeletal growth and development.

By carefully cross-breeding animals with multiple partners she sought to determine whether the population contained genetic variation in resistance to OA. For each male/female cross, she reared half of their offspring in water aerated with a current atmospheric CO2 concentration of about 400 ppm and half in water aerated with 1000 ppm CO_2. Then, she examined the larvae under a microscope to measure their three-dimensional skeletal size and compared offspring from different parents.

She found that OA decreased overall skeletal size, particularly in the two longest arms that provide the most food (see picture). Skeletal size is critical because it affects not only larval feeding but also adult size, which is correlated with reproductive success (Marshall and Keough 2007, Levitan 1991). In addition, this reduction in growth could cause the plutei to take longer to develop, increasing their risk of being eaten (Rumrill 1990; Allen 2007).

She also found that OA made skeletons more asymmetric, a sign of stress during development. Asymmetry could cause the plutei to swim more erratically, potentially attracting the attention of predators and reducing their ability to catch food. According to National Atmospheric and Oceanic Administration climate projections, atmospheric CO2 could be as high as 950 ppm by the year 2100 (NOAA), so plutei of *Arbacia* could experience reductions in skeletal growth and increases in asymmetry relatively soon.

However, Conrad also found heritable genetic variation for resistance to OA in the growth of the primary feeding arms. Particular parents consistently produced offspring with greater skeletal growth and lower asymmetry. This result means that this population of *Arbacia* has some potential to evolve and withstand OA.

Further studies are needed to measure resilience in different populations. Discussing how these results fit into his continuing research, Dr. Podolsky stated that "*Arbacia punctulata* populations may face different levels of risk depending on their location and history. It is important to identify variation in resilience within and between populations." Waters near his laboratory in Charleston, South Carolina, for example, are more saturated with calcium carbonate. He will be comparing Conrad's dataset to one he previously collected on the population of *Arbacia* near Charleston to see if this species exhibits geographic differences in resistance to OA.

Atlantic purple sea urchin, *Arbacia puntulata*, (left) and pluteus larva with four arms (right).

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