Title
Enhancing Fertilization Success in Abalone for Recovery Efforts

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Publication Date
2007-03-01

Sea Grant California

Enhancing Fertilization Success in Abalone for Recovery Efforts

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Background

Abalone are broadcast spawners, but as this California Sea Grant research is showing, fertilization is more than just random collisions between gametes floating in the vast sea.

Biologists now know that red abalone eggs release beckoning "come hither" compounds that guide sperm. (Chemical signaling is part of mammalian reproduction, too.) Sperm navigate along gradients in these chemical clouds, similar to mountaineers charting their course with the help of topographic maps. Without chemical signaling, abalone fertilization rates would be lower and areas in which these unusual mollusks could live and reproduce would, therefore, be greatly restricted

Such discoveries and more to come may help determine abalone densities, spacing and sex ratios for maximizing reproductive success. This information, it is hoped, will lead to better strategies for restoring the state's depleted abalone populations through "outplanting" of cultured abalone or translocation of wild ones.

Project

California Sea Grant awarded UCLA biologists Richard Zimmer and Cheryl Zimmer a grant to study three processes, which they have since shown influence red abalone fertilization success. Ongoing research will refine their preliminary findings.

The first is the role of chemical signaling in attracting sperm to eggs; the second is consequences of different laminar shear flows on sperm-egg interactions; third, differences in viabilities and transport of egg and sperm plumes.

Findings

Chemical signaling is real. Chemicals released by eggs "fundamentally and decisively" direct translational and rotational velocities of swimming sperm, the biologists report. In red abalone, this attractant is the amino acid L-tryptophan. (L-tryptophan is critical in human nutrition and is a precursor for serotonin, melatonin and niacin.)

Sperm do more than merely "sniff" L-tryptophan. They actually use its concentration gradients to hone in on an egg's location. Of course, chemical signaling is of no use when flow speeds greatly exceed sperm swimming speeds. However, when there is no flow (still water), fertilization rates are also much reduced. An optimal flow is one that disperses chemical attractants so that sperm reach eggs quickly.

What flows do this? The scientists' laboratory experiments show that shear forces are key. In their experiments, fertilization rates were maximized at shears of less than .1/s for red abalone, reflecting their relatively weak propulsive forces, 1/s for red urchins, and 10/s for purple urchins, where "s" = seconds. Interestingly, shears maximizing fertilization success for red abalone in the lab were similar to those measured in the wild–a consistency that lends credence to their results.

Another finding: Eggs, not sperm, limit red abalone reproductive success. In lab experiments, egg viability decreased after 30 minutes, while sperm viability was about 3 hours. A notable difference: Egg suspensions were negatively buoyant and rapidly sank. Sperm suspensions were neutrally buoyant; they floated and hence were transported farther than eggs. (*continued*)

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Collaborators

NOAA Fisheries; Channel Islands Marine Resource Institute; The Cultured Abalone

Publication

Riffell, J.A. & R.K. Zimmer. The consequences of fluid shear for sperm-egg interactions. 2007. J. of Experimental Biology. In press.

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Presentation

Zimmer, R.K. 2006. "Mechanisms of sperm motility in flow." Boehringer International Conference on Sperm-Egg Interactions, Titisee, Germany.

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This publication is sponsored by a grant from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant number NA04OAR4170038, Project number C/P-1. The views expressed herein are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies. The U.S. government is authorized to reproduce and distribute for governmental purposes. *This document is available in PDF on the California Sea Grant website: www.csgc.ucsd.edu.*