Sea urchins point the way

by Monica Harrington

SCIENTIFIC NAME

Arbacia punctulata

TAXONOMY

PHYLUM: Echinodermata

CLASS: Echinoidea

ORDER: Arbacioida

FAMILY: Arbaciidae

Physical description

Arbacia punctulata, the purple-spined sea urchin, is native to the western Atlantic Ocean along the eastern coast of the US and the Gulf of Mexico, where it usually lives on rock or shell substrates. It is spherical in shape and bristled with long, slender, dark purple spines, which are shorter on the lower aspect of the urchin, surrounding the oral apparatus. The test, or shell, of the urchin can reach 3–5 cm in diameter and has holes through which the urchin's tube feet extend. It uses its spines and tube feet for locomotion. *A. punctulata* is primarily herbivorous, consuming algae and other organisms that grow on the rocks around it using a specialized structure called Aristotle's lantern, which is comprised of five hard plates that move together like a beak, to scrape food off the rocks.

Reproduction

During reproduction, a female urchin releases up to several million large, transparent eggs that lack shells or other coatings. Fertilization is external, and the gametes are large and divide synchronously and rapidly. Their size and abundance allow for easy observation, manipulation and sampling, facilitating the use of sea urchins in research.

Research résumé

Sea urchins have served as experimental models for more than 100 years. In an early example, Warburg measured oxygen consumption in sea urchin eggs, leading to his report in 1908 that respiration rates increase up to six times after fertilization¹. Several years later, Kite analyzed the fertilization membrane of the sea urchin egg², and Glaser examined early post-fertilization development³.

Examination of *A. punctulata* helped researchers develop an understanding of cell-mediated immune system responses⁴. Sea urchin embryos have also been instrumental in elucidating the processes of fertilization, cell division, cell-cycle regulation and embryonic development^{4,5}. For example, cyclins, the proteins that regulate the cell cycle, were first identified in sea urchins⁴. The mechanism of embryonic gastrulation, or the formation of three germ layers, was diagramed based on observations of sea urchin embryos⁵.

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Intracellular signaling is another research area that has relied heavily on *A. punctulata*⁴. Changes in calcium concentration are signals for many essential cellular responses, and the receptors that help to mediate these changes were identified by analyzing sea urchin eggs⁴.

More recently, *A. punctulata* has contributed to our understanding of sperm chemoattraction and chemotaxis^{6–8}. And because of its sensitivity to environmental pollutants, *A. punctulata* is used to assess ecotoxicology and embryological toxicity of marine sediment⁹ and aquatic contaminants^{10,11}.

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