Breakthrough model reveals evolution of ancient nervous systems through seashell colors

January 12 2012

Determining the evolution of pigmentation patterns on mollusk seashells—which could aid in the understanding of ancient nervous systems—has proved to be a challenging feat for researchers. Now, however, through mathematical equations and simulations, University of Pittsburgh and University of California, Berkeley, researchers have used 19 different species of the predatory sea snail *Conus* to generate a model of the pigmentation patterns of mollusk shells.

"There is no evolutionary record of nervous systems, but what you're seeing on the surface of seashells is a space-time record, like the recording of brain-wave activity in an electroencephalogram (EEG)," said project coinvestigator G. Bard Ermentrout, Pitt Distinguished University Professor of Computational Biology and a professor in the Kenneth P. Dietrich School of Arts and Sciences' Department of Mathematics.

Seashells differ substantially between the closely related *Conus* species, and the complexity of the patterns makes it difficult to properly characterize their similarities and differences. It also has proven difficult to describe the evolution of pigmentation patterns or to draw inferences about how natural selection might affect them. In a paper published in the Jan. 3 issue of the *Proceedings of the National Academy of Sciences* (*PNAS*) Online, Ermentrout and his colleagues attempt to resolve this problem by combining models based on natural evolutionary relationships with a realistic developmental model that can generate pigmentation patterns of the shells of the various *Conus* species.

In order for UC Berkeley scientists to create simulations, Ermentrout and his collaborators developed equations and a neural model for the formation of the pigmentation patterns on shell surfaces. With the equations in hand, Zhenquiang Gong, a UC Berkeley graduate student in engineering, used a computer to simulate the patterns on the shells, hand fitting the parameters to create a basic model for the patterns of a given species.

The results of this study have allowed the researchers to estimate the shell pigmentation patterns of ancestral species, identify lineages in which one or more parameters have evolved rapidly, and measure the degree to which different parameters correlate with the evolutionary development and history of the organisms. Since the parameters are telling the researchers something about the circuitry of the mollusks' nervous system, this is an indirect way to study the evolution of a simple nervous system.

"We've found that some aspects of the nervous system have remained quite stable over time, while there is a rapid evolution of other portions," said Ermentrout.

"In the future, we hope to use similar ideas to understand other pattern-forming systems that are controlled by the nervous system," Ermentrout added. "For instance, we would really like to develop models for some of the cephalopods like the cuttlefish and the octopus, which are able to change patterns on their skin in an instant."

Provided by University of Pittsburgh