Thin view of Appalachian formation

Old theories often fall to new technology. In a recent example, reported at the AGU meeting, a powerful tool called deep seismic reflection profiling may have overthrown current beliefs about the formation of the Appalachian Mountains. The Appalachians, which run from Newfoundland to Alabama, were probably formed not by upward thrusting, as previously believed, but by a thick conglomerate of oceanic and continental rock that was shoved horizontally at least 250 kilometers over existing sediments, according to researchers from Cornell University and Florida State University.

Evidence for the hypothesis, reported by Fred A. Cook of Cornell, comes from a seismic profile that traverses the Blue Ridge, the Piedmont and the coastal plain from eastern Tennessee to Augusta, Ga. In deep seismic reflection profiling, signals of particular frequencies are vibrated into the crust by specially equipped trucks. The returning echoes are received by instruments similar to seismographs and are compiled in a computer, which then draws a profile of the crust.

The Tennessee-Georgia profile shows, as expected, that the upper 6 to 10 km of the crust is made of fragments of ocean floor, parts of island arcs and continental rock. But beneath that jumble of rock, says Cook, lies a younger, flat, thin (1 to 5 km thick) layer of sediments that "no one thought existed." The unbroken, wide extent of the layer—researchers estimate it covers 150,000 km² from near the coastal plain to the western edge of the Blue Ridge—and its similarity to sediments found on the East Coast indicate that the mountains "couldn't have been pushed up." More likely, the researchers suggest, the accordion-like conglomeration of rocks was bulldozed over the younger sediments by repeated collisions of Africa and North America between 450 million and 250 million years ago.

The finding may resolve a dispute between what have been called "thick-skinned" and "thin-skinned" geologists. Previously, "thick-skinned" geologists believed that when Africa and North America collided for the last time, about 250 million years ago, vertical faulting occurred, probably along a line called the Brevard zone, and the entire crust broke, thrusting the mountains upward and to the west. "Thin-skinned" geologists, on the other hand, believe the collision folded the upper crust but left the basement layers flat. Their profile, says Cook, tends to confirm this and shows that the Brevard zone, a straight fault that stretches from Maryland to Georgia, is a "minor feature" of the main two-degree horizontal fault beneath the Blue Ridge. □

Algae make abalone settle down

The free-swimming life of an immature abalone terminates suddenly. Abalone larvae settle to the ocean bottom and within a day lose their swimming cilia. They soon grow the rayed shell of an adult, and snail-like gliding replaces drifting and swimming. While this aging process may severely limit an abalone's lifestyle, continued immaturity would be far worse. Larvae that do not settle down and metamorphose become overgrown with microbes and die.

The signal that initiates the California red abalone's metamorphosis comes from three species of red algae that inhabit the ocean floor. Scientists at the University of California at Santa Barbara recently identified the signal and discovered, to their surprise, that the abalone larvae do not pick up the signal from afar but must actually collide with the algae.

Morse et al., Science

Abalone on left remains immature; sibling displays rayed shell after GABA exposure.

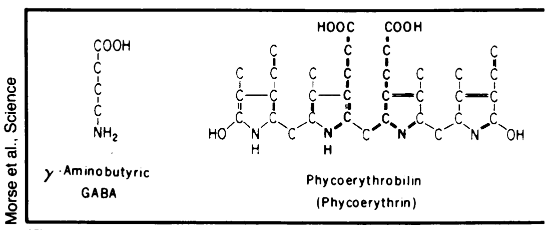
These findings are the first to reveal a substrate-specific chemical capable of inducing metamorphosis in swimming molluscan larvae, Daniel E. Morse told the Symposium on Chemical Signals in Vertebrates and Aquatic Animals in Syracuse, N.Y. This discovery should aid dramatically commercial cultivation of abalone and related mollusks, an important food source in many areas of the world.

The chemical signal that compels abalone larvae to settle and begin metamorphosis was found to be a simple amino acid that is a potent neurotransmitter in the human brain and other animal tissues. This chemical, gamma-aminobutyric acid (GABA), and chemicals containing GABA-like regions are found in the algae. In fact, the red pigment that gives the algae its color includes two sections homologous to GABA. When GABA or the pigment is added to the surrounding water, larvae will even settle on a glass surface.

Although the metamorphosis inducers can act when they are in solution, in the algae they are bound to proteins and to other large molecules. Morse has found that the algae do not lure the abalone larvae by releasing chemicals. The larvae do not orient their swimming toward algae, but instead randomly sample the bottom as they repeatedly swim up, then stop swimming, drift and sink, then swim upward again. Morse believes the sensory organ for inducers is located superficially on a larva's head between its eyes.

The association of the abalone and the algae benefits both parties, Morse says. The larvae are guaranteed a suitable habitat with adequate nutrition and protective coloration and, Morse suggests, abalone eat a mucous exudate of the algae or microorganisms that may inhabit the algae surface.

Several other ocean organisms are also associated with these algae. Morse has found that free-swimming larvae of a chiton and green abalone are induced by red algae and by GABA to settle and undergo metamorphosis.



The potent inducers: Pigment phycoerythrobilin has areas homologous to GABA.

In a related finding, environmental stress has been shown to affect the settling behavior of abalone larvae. In the April 27 SCIENCE, Morse and collaborators report that several pesticides at sublethal concentrations completely prevent GABA-dependent settling. This finding, they suggest, may lead to a rapid assay for pollutants. □