New System Traces Origins of Marine Creatures

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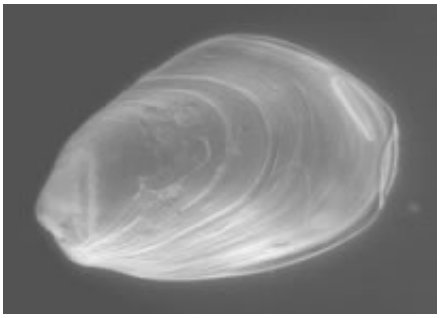

A juvenile mussel imaged through an analytical laser instrument.

Tracing the origins of marine animals can be extremely difficult, especially in the free-flowing, soup-like conditions of the ocean, but obtaining this information is vital not only for understanding these organisms but for managing and conserving them as well. Scientists at Scripps Institution of Oceanography at UC San Diego have developed a novel approach for tracing the life roots of marine larvae, some of the most difficult organisms to track due to their microscopic sizes.

In a study published in the *Proceedings of the National Academy of Sciences*, Bonnie Becker, Lisa Levin, Joel Fodrie and Pat McMillan describe a new process for studying mussel larvae through “elemental fingerprinting,” a method in which chemical signatures in ocean water are used to construct geographical birthplace maps and baseline profile information about the tiny creatures.

Elemental fingerprinting is a sort of natural tag," said Levin, a professor in the Integrative Oceanography Division at Scripps. "Basically, the water itself creates a chemical tag and we use that information to figure out where larvae come from."

Developing the new approach involved several labor-intensive steps, including establishing—or "outplanting" as Becker calls it—a series of larval "homes" made of PVC pipe and mesh in 18 locations off San Diego's beaches and bays. Each home contained approximately 100,000 mussel larvae. After a week, the homes and larvae were retrieved along with water samples from each site.

The chemical composition of the minuscule larval shells, roughly 100 microns in diameter, was then examined using a powerful analytical instrument (called a "laser ablation inductively coupled plasma mass spectrometer") housed at Scripps Oceanography's Unified Laboratory Facility. By analyzing the chemical makeup within the shells in each larval home and the corresponding seawater, the researchers were able to construct a reference map in which each of the locations could be individually identified with a distinct chemical signature.

Several weeks later the researchers returned to each site and collected week-old juvenile mussels, typically less than two millimeters in size, in an effort to investigate whether they traveled there from near or far sites. Because mussels retain their larval shells after settling, the scientists were able to establish the chemical fingerprint of each shell and thereby trace its geographic origin. In doing so they could then say whether mussels traveled far from their birthplaces or stayed closer to home.

For much of the 20th century, marine ecologists have believed that mussel larvae are transported long distances and dispersed broadly across the marine environment because of ocean currents and the larvae's poor swimming abilities. Different populations of mussels, it was thought,

would be well mixed in the ocean “blender” and relational ties would span vast regions.

The new study found the opposite. Rather than mixing throughout San Diego’s beaches and bays, the mussels stayed within 20 to 30 kilometers (12 to 18 miles) of their point of origin, with many typically keeping to a mostly northern or mostly southern source.

One surprise emerged in that the two closely related mussel species studied, Mytilus californianus and Mytilus galloprovincialis, were shown to have somewhat different movement patterns.

The researchers say that elemental fingerprinting can be a way to develop “high resolution” information about larval sources, including where populations thrive and fail. It opens the door to studying other organisms with free-floating planktonic larvae, whereas previous approaches limited studies to species with more static ocean bottom broods.

A challenge remains, however, in integrating this approach for the management and conservation of coastal resources, including the establishment of marine protected areas and understanding how habitats are connected.

“This result will affect our understanding of how species evolve, interact and are distributed and alter our strategies to protect them effectively,” the authors note.

“This research also holds important implications for the basic science of evolution, including how populations come to differ, because we don’t know a lot about how populations are connected,” said Levin.

Future studies using chemical fingerprinting will include collaborations

with Scripps physical oceanographers who model ocean circulation to more deeply probe how physical processes influence larval development.

Source: Scripps Institution of Oceanography