Smithsonian

Spotlight on Science at the Smithsonian

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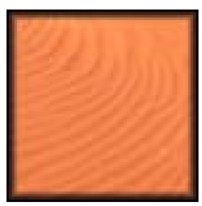

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Spotlight on Science at the Smithsonian

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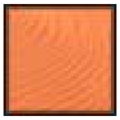
Molluscan Macroevolution



The Sands of Mars: Size Matters

Multiple Pathways for Parasites

Introduction from the Under Secretary for Science

In this installment of Spotlight on Science we first look at a controversial theory in evolutionary biology known as species selection. Is there a kind of natural selection among species over geologic time analogous to “the struggle for existence” among individual organisms described by Darwin? It’s a question that requires a perspective that only a paleontologist can provide. Next, we go to Mars where much of the surface is covered by deposits laid down by wind and water. How can scientists tell the difference? A geologist at the Air and Space Museum is working on a method that uses the sediment’s thermal properties. And, finally, a Smithsonian ecologist uses genetic markers to follow the path of an invading species and its parasites.

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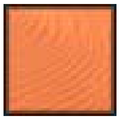

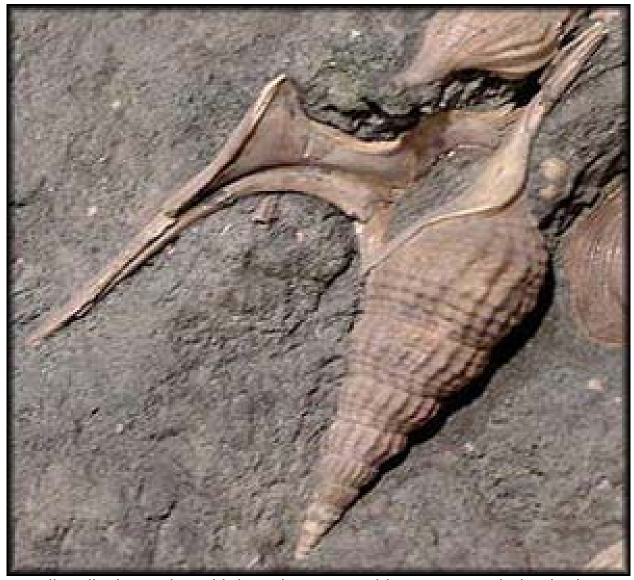

Fossil mollusk species with broader geographic ranges tended to be longer-lasting than those with narrow geographic ranges. According to the controversial theory of species selection, this implies that species should evolve in the direction of expanded ranges. The gastropod species *Anchura substriata* shown here is from the Cretaceous in Mississippi. Photo by Joe Koniecki, © 2006.

Molluscan Macroevolution

Reference

David Jablonski and Gene Hunt. 2006. Larval ecology, geographic range, and species survivorship in Cretaceous mollusks: organismic versus species-level explanations. *American Naturalist*, v.168 (4): 556-564.

When we think of evolution by natural selection, we usually think of individual plants and animals struggling to survive, competing against other members of their species to produce the next generation of offspring. But can natural selection also happen on a larger scale? Some species succumb to extinction while others survive; some species generate evolutionary offspring in the form of new species, while others are less prolific. Could this drive a kind of natural selection among species?

"Species selection" is a controversial idea, but Gene Hunt, a paleontologist at the Smithsonian's National Museum of Natural History, and David Jablonski of the University of Chicago have marshaled evidence that it does indeed occur. Twenty years ago Jablonski published a groundbreaking paper arguing that during the Cretaceous, marine mollusks along the Atlantic and Gulf Coasts of North America showed a pattern of evolution fitting the model of species selection. The species-level trait that appeared to be evolving was geographic range. Some species had restricted ranges, while others had ranges that extended thousands of miles along the coast. Because geographically widespread species were more resistant to extinction, mollusk species on the whole range still should evolve toward larger geographic ranges.

But species selection only works if the trait—geographic range in this case—is heritable. That is, if it is passed on from one species to its descendants. Some critics wondered if the pattern might be more simply explained by conventional natural selection on a trait that just happened to correlate with geographic range. For mollusks, one such trait is the mode of larval development. Some have a long-lasting larval phase in which the larvae can drift for weeks or months before settling. Others have a far shorter larval phase, rarely traveling far before settling. Could the extinction-resistance be the result of larval adaptations, while expanded geographic range is just an evolutionary side-effect?

Hunt and Jablonski examined an updated version of Jablonski's data with these questions in mind and published their results in the October 2006 issue of *American Naturalist.* They confirmed that geographic range does seem to be heritable – closely-related species tend to have similar-sized geographic ranges. They also found that even when larval ecology was held constant, geographic

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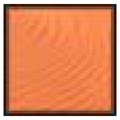

gave species an edge in evading extinction.

This research suggests that natural selection is a multi-level process, and evolutionary trends can have complicated causes. In the long run, survival of evolutionary lineages may be a matter of both species-level and individual-level traits.

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Researchers examining windblown sand in Australia's Simpson Desert, where geologic conditions resemble Mars in many respects. Photo by Stephen Tooth, courtesy of Robert Craddock.

The Sands of Mars: Size Matters

In the search for life on Mars, a guiding principle has been: Follow the water. Water is essential for life. But on Mars the water is long gone. And even in the gullies and channels carved by its ancient streams, the water-laid deposits where evidence for life is most likely to be found are often covered by a blanket of wind-blown sediment.

Robert Craddock of the Center for Planetary Studies at the National Air and Space Museum and Marsha Presley of Arizona State University are working to find ways to identify exposed water-laid sediment on Mars. For geologists on Earth, distinguishing water-laid from wind-blown sand is relatively easy. Under a microscope the grains differ in shape and surface characteristics. But geologists studying Mars generally can't take such a close look at things; they have to rely on remote sensing. That's where another property of sediment can help: grain size. Wind-blown sediment – especially in the thin Martian atmosphere – tends to be uniformly fine-grained, while water-borne sediment can be coarser and more mixed.

Sediment grains aren't visible from space, of course, but coarse and fine-grained deposits have different thermal properties. And heat variations of surface deposits can be measured from spacecraft using infrared spectrometers.

To put this idea into practice, Craddock and Presley headed for Australia's Simpson Desert where dry conditions and the natural mingling of deposits from water and wind approximate the situation on Mars. Previous studies had used glass beads as standards, but natural sediments are more directly comparable to Martian deposits. Craddock and Presley collected sediment samples with different mixtures of grain-sizes and measured their thermal properties in the laboratory under a simulated Martian atmosphere. They found that the thermal response of the samples was sensitive to the presence of coarse grains in the sediment, not just a reflection of the average grain size. This may make it easier to spot water-laid sediments on Mars, even where differences in average grain size are subtle.

Reference

Marsha A. Presley and Robert A. Craddock. 2006. Thermal conductivity measurements of particulate materials: 3. Natural samples and mixtures of particle sizes. *Journal of Geophysical Research*. V. 111, E09013.

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The invasive Asian mud snail, *Batillaria attramentaria*, surrounding another exotic species, the reef-building tube worm, *Ficopomatus enigmaticus*, at Elkhorn Slough, California. Inset: Cryptic trematode parasite species introduced from Japan now infects *B. attramentaria* in North America. Credit: Mark E. Torchin, inset: Todd C. Huspeni.

Multiple Pathways for Parasites

Species invading a new habitat often leave their enemies behind. With fewer predators, competitors, and parasites to impede them, some invasive species can be explosively successful in their new home— just like kudzu and zebra mussels. But sometimes old enemies can catch up with invading species. Sometimes they are already there waiting when the species arrives.

Mark Torchin, an ecologist at the Smithsonian Tropical Research Institute in Panama, is part of team led by Osamu Miura of the University of Tohuku in Japan that used genetic markers to follow the fortunes of the Asian mud snail, an invasive intertidal species. The snails were inadvertently brought to North America from Japan in the early 1900s when estuaries were seeded with Pacific oysters to boost the seafood industry. In their native range, mud snails are commonly infected with parasitic flatworms called trematodes. The North American immigrants have them too, but to a much lesser extent. Like many parasites, the flatworms have a complex life cycle, involving several host species. Even if the imported snails had been infected with a full complement of trematode species, many would not have been able to reproduce because of missing additional hosts that they require in the environment.

The scientists found that the North American snails were infected with two common trematode species. The snails and one of the trematode species had reduced genetic variation compared to the native populations in Japan. This was expected: The small numbers of individuals that make up founding populations will represent just a fraction of the genetic variation in the home range. The researchers were able to use the genetics to pinpoint where in the original range the snails and flatworms came from.

Reference

Osamu Miura, Mark E. Torchin, Armand M. Kuris, Ryan F. Hechinger, and Satoshi Chiba. 2006. Introduced cryptic species of parasites exhibit different invasion pathways. *Proceedings of the National Academy of Sciences*, v.103 (52):19818-19823.

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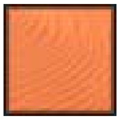
Molluscan Macroevolution



The Sands of Mars: Size Matters

Multiple Pathways for Parasites

The other flatworm species, however, did not fit the pattern. Its genetic variation was undiminished, and its genes also seemed to indicate a broad source region. Because trematode flatworms often infect birds as well as snails in their life cycle, Torchin and his colleagues hypothesize that these flatworms crossed the ocean not with the snails, but with migratory shorebirds. If that's the case, then the flatworms would have already been present in the North American environment when the snails arrived.

This was surely bad news for the snails. But does it matter to human beings? Yes it does, the researchers explain in a recent paper published in the *Proceedings of the National Academy of Sciences*. As the world becomes increasingly interconnected, we need to better understand the dynamics of how diseases and parasites of humans, livestock, and wildlife are spread by introduced species. This study shows how outbreaks can arise not by the arrival of a new parasite or pathogen, but by the arrival of a key host in its life cycle. The more new species arrive in a region, the higher the chances that infectious agents that were formerly tourists will become pervasive residents.

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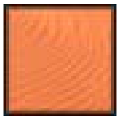

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