



On the Importance of Scientific Collections

A Series by Natural Science Collections Alliance

Celebrating the Knowledge and the Mystery of Fossils

By Eve S. McCulloch

Fossils reveal the story of five billion years of history for Earth's geology, climate, and life forms. Fossils range in size from microscopic bacteria to giant redwood trees. They can be seen in the trail of footprints left by dinosaurs, the imprints of flower petals, and mineralized bones or shells on what was once the sea floor. Simply, fossils are the preserved remnants of living things, and they tell a story of the rise and fall of species through time.

Organisms have been diversifying and going extinct for millions of years, and the fossil record is pivotal for scientists' understanding of the how, when, and why of evolution. "Fossil collections are extremely important for those of us who study evolutionary biology because 99 percent of species lived in the past, by some estimates," explains Dr. Judith E. Skog, professor emeritus at George Mason University. "If we did not understand these organisms and their environments, we would have a skewed view of evolutionary processes."

Fossils fill missing links in today's lineages. Few fossils are more famous as snapshots of evolution in action than those documenting the transition from dinosaurs to birds. *Archaeopteryx lithographica* and *Caudipteryx zoui*, approximately 150 million years old and considered probably the earliest "birds," share a combination of dinosaur and bird features. These fossils were the first to demonstrate that modern birds are the descendants of small meat-eating dinosaurs.

Fossils help scientists understand the importance of extinction events in shaping the diversity of life. Jim Holstein of Chicago's Field Museum discovered something amazing on a dig in Nevada a few years ago: *Thalattoarchon saurophagis*, or the "lizard-eating ruler of the seas." *Thalattoarchon* was a massive marine predator living 245 million years ago, which may have preyed on its fellow ichthyosaurs. That *Thalattoarchon* existed at all is exciting. Such an enormous predator could only have existed in an ecosystem that had reached a high level of productivity with diverse species. This reveals something important about the tempo of evolution after a natural disaster, because *Thalattoarchon* lived only about five million years after the worst mass extinction in the history of our planet. Likely triggered by massive volcanic outpourings, this catastrophic event eliminated as much as 95 percent of known marine species — and yet the oceans recovered and gave rise to *Thalattoarchon*, ruler of the seas.



Fossil of Archaeopteryx lithographica, one of the earliest known birds. Photo: H. Raab.

In seemingly desolate Patagonia, researchers from the Natural History Museum of Los Angeles County discovered a site with hundreds of thousands of 80-million-year-old dinosaur eggs. Incredibly, the embryos were preserved as fossils inside the eggs. This amazing find tells a story of thousands of titanosaurs — some of the largest dinosaurs to ever walk the Earth — that nested at the site eons ago. Though the collection resides in Argentina, the eggs and fossilized dinosaur embryos have been featured in national exhibitions, most recently in 2012 at the American Museum of Natural History (AMNH) in New York City. Exhibitions give people a window into the process of discovery — a taste of a paleontologist’s life — and inspire future generations of scientists and natural history enthusiasts.

Certainly few species are of more interest than our own: *Homo sapiens*. The evolution of humans and closely related species is a source of fascination and sometimes controversy. The fossil record is central to uncovering the secrets of our own complicated past, from understanding the origins of bipedalism and big brains to studying behavior.

Fossils document life’s history, and they may also contribute to a revolutionary future: bringing back extinct species. On rare occasions, fossils still contain tissue. Scientists have even found soft tissue in the hind-limb of a 68 million year old *Tyrannosaurus rex*. Such finds are surprising and exciting, although reviving extinct species is controversial and practical issues remain unresolved, particularly with ancient tissues. Nevertheless, in the not-too-distant future, recently extinct species such as the imposing Saber-toothed Cat, Dodo, and Passenger Pigeon, represented by specimens at the AMNH, could be realistic candidates for revival.



Fossilized kangaroo teeth. Photo: Dr. Shaena Montanari.

Much of the history of Earth’s climate is written in its fossils. The fossils in natural history collections help scientists reconstruct what processes were associated with periods of major cooling or warming, and their consequences on living organisms. Dr. Shaena Montanari at the AMNH unveiled new evidence about Australian climate based on geochemical analyses of three million year old kangaroo teeth. Today, the giant kangaroos and wallabies that once roamed Australia are extinct, and the reason remains unknown. “Obtaining detailed environmental records from this time can help us find the drivers of the subsequent extinctions,” Dr. Montanari explained in an interview with AMNH. Her analyses revealed a surprisingly tropical Australia. Such reconstruction of ancient habitats opens new windows into evaluating the past.

Fossils educate, entertain, and enlighten. Take a moment today appreciate the many wonders of natural history located in museums near you!

About NSCA

The NSC Alliance is a nonprofit association that supports natural science collections, their human resources, the institutions that house them, and their research activities for the benefit of science and society. Our 100 institutional members are part of an international community of institutions that house natural science collections and utilize them in research, exhibitions, academic and informal science education, and outreach activities.