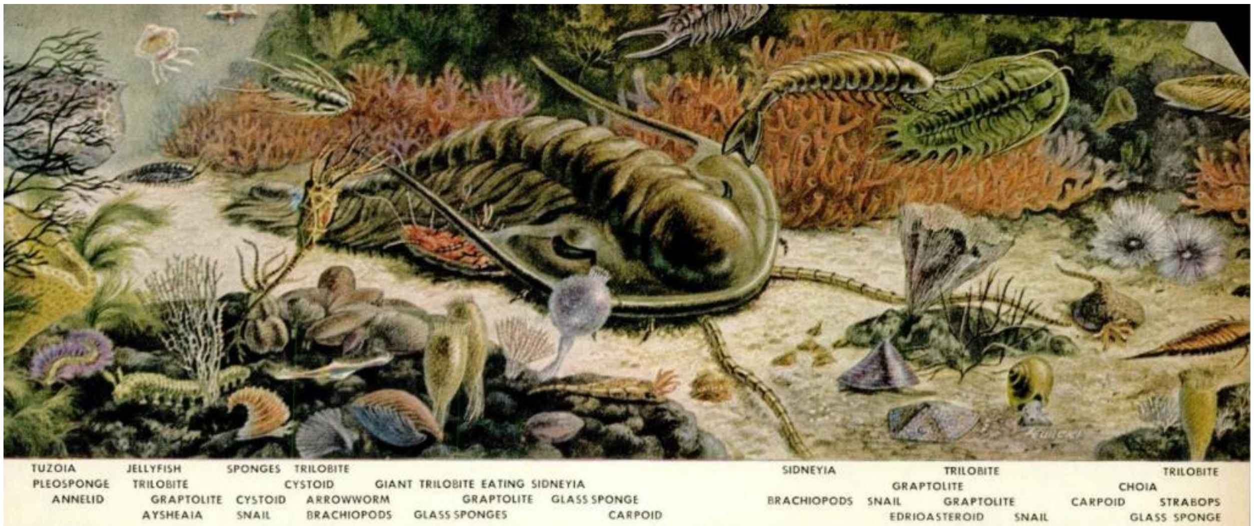


from The World We Live In, published by LIFE magazine, 1955

My favorite book when I was a child was a large, canvas-covered volume elegantly titled The World We Live In. Published by LIFE magazine in the 1950s, it contained evocative (if at times inaccurate) prose and beautiful illustrations of prehistoric life from the first planktonic forms of over 1 billion years ago through to modern day; hypotheses of how the world we live in looked through eons of geological change. I spent wide-eyed hours poring over the peculiar, hard-shelled forms of the ancient trilobites and woke to more than a few nightmares inspired by *Tyrannosaurus Rex* and *Elasmosaur*. These images captivated me then, and remain some of the most vivid memories of my childhood. Haven't *you* ever wondered how artists came up with some of these bizarre and fantastical images? It turns out that fossils (and undoubtedly some artistic license) are the key.

There are few more striking displays of geologic time than the Grand Canyon of the Colorado. It is estimated that the Colorado River carved the Canyon as recently as 6 million years ago (that's roughly when hominid and chimpanzee lineages split from a common ancestor), revealing an 8,000-foot-high cross-section of geologic time. The fossil record therein has helped researchers interpret the environmental history of the continent.

What it takes to become a fossil

To understand what fossils can tell us about the environment their living counterparts inhabited, we have to get some facts straight about them: the fossil record is incomplete; that is, not everything that was living at a given time—not even close to everything—is immortalized in fossil form. An organism typically needs to be hard-shelled, small, and be in the right place at the right time; that is, buried quickly and completely, and left undisturbed for millennia. Soft-bodied organisms typically never fossilize, which is why the fossil record begins for the most part with the **Cambrian Era**, which we know was an explosion of animal diversity in the shallow seas beginning 544 million years ago.

Following the Canyon walls from the Cambrian explosion to the Permian floodplains

In the Grand Canyon, the fossil record begins in the "Tonto Group," which is comprised of Tapeats sandstone (suggesting a sandy shore), Bright Angel Shale, and the Muav Limestone (both representative of an off-shore continental shelf) of the mid-canyon. The Tonto Group is what remains of shallow oceanic life in the Cambrian. Trilobites, which are "invertebrates that look like a cross between a horseshoe crab and a roly poly," says UC-Davis geologist Kait Livsey, are abundant in these layers. Trilobites are the first preserved evidence of eyes known to us—which suggests that the ocean in which they lived was at least shallow enough for light to penetrate it. Imprints of ancient sponges and burrows from other invertebrates are also found here.

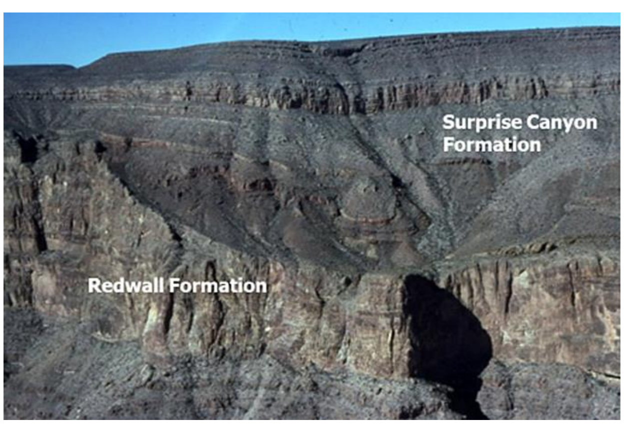
Evidence of compound eyes on a Cambrian-age trilobite fossil

Unconformities

Like the fossil record, the geologic record is not complete—local erosion of soils can wipe entire eons off the walls of the canyon. Carbon dating methods and comparing geological layers in different areas help researchers identify these **unconformities** or missing layers. In the Grand Canyon, there is no evidence of the Ordovician or Silurian eras, which were the culminating periods of the Cambrian era when arthropods (hard-shelled, insect-like organisms) and molluscs reigned.

The Age of Fish: The Devonian Period

The Mississippian Redwall limestone (washed red from runoff of the iron-rich Supai group sitting on top of it) suggests that the continent was a very shallow tropical sea during the Devonian period. Fossil evidence of fish appears, as well as a proliferation of corals, starfish, brittle stars, and gastropods (snails). Context is everything when interpreting the fossil record, and the rock types in which they are encased provide it. Geologists can tell what the water depth was based on the grain size of the rock. The small grain size of Surprise Canyon formation, pictured to the left sitting above the Redwall Formation, suggests that it was a silty tidal estuary around 325 million years ago.



Life Reaches Land: The Pennsylvanian and Permian Periods

The red, slanted walls of the iron-rich Supai rock suggest further recession of the ocean: ferns and pelycosaur footprints have been preserved in its layers. Further up, the iconic towering walls of glowing Coconino sandstone are home to fossils of reptile tracks—evidence of a vast desert-like ecosystem—a sea of sand—with swampy floodplains where early reptiles left their footprints in the mud.

The Toroweap and Kaibab formations comprise the rim of the canyon, and are remnants from the late Permian period. Mineral deposits, as well as fossil evidence of shallow sea organisms like corals, sponges, and brachiopods (an extinct group of mollusk-like creatures). The majority of tourists to Grand Canyon National Park, who snap a photo standing on the South Rim, probably have no idea that they may be standing on 250-million-year-old fossils buried beneath their feet. In my opinion, this knowledge only enhances the grandeur of the view of the canyon, if such a thing is even possible. The fossil record in the Grand Canyon before the age of dinosaurs, due to erosion of the rock layers from those time periods—you'll have to travel north to Zion and Bryce Canyon to visit Jurassic Park.

I have no doubt that these fanciful mid-century illustrations influenced my career path. Though they steered me to the study of living animals and the relationships between them (I am an ecologist), rather than the fossils upon which they were based, I consider myself lucky to have been exposed to such mesmerizing conceptualizations of geologic and evolutionary time at such a young age. Though we will never know exactly how much artistic license our renderings of the past contain, the fossil record has been an indispensable key to understanding our multi-million year ancestry, as well as the changing environment throughout the evolution of life.