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Evotourism

The Evolutionary Secrets Within the Messel Pit

An amazing abundance of fossils in a bygone lake in Germany hints at the debt humans owe to animals that died out 48 million years ago

A time capsule of life in the Eocene: Ailuravus, a three-foot-long, squirrel-like rodent (Berthold Steinhilber)

By Andrew Curry
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In the middle of a forest about 20 minutes from the city of Darmstadt in central Germany is a decommissioned strip mine half a mile wide. Today scrubby bushes cover the bottom, where dirt paths wind past rainwater ponds filled with bright-green algae. A gaping 200-foot-deep gouge in the forested countryside, the Messel Pit doesn't at first glance seem worth preserving, never mind visiting, but since 1995 it has been a Unesco World Heritage site, thanks to a series of unfortunate events beginning some 48 million years ago.

The world was a very different place then, during the period known to scientists as the Eocene. The levels of carbon dioxide in the atmosphere were higher than today (at least, for the time being), producing a greenhouse effect of soaring temperatures. In the Arctic, giant crocodilians swam in warm waters among the ferns. A tropical rainforest covered Antarctica. The shapes of the continents would be mostly recognizable, though India was still on the collision course with Asia that would form the Himalayas. Sea levels were about 150 feet higher than today, so Europe wasn't a largely continuous landmass but a vast archipelago.

The spot now occupied by the new, conspicuously sleek, concrete and glass Messel Pit visitor center—which includes a trip back in time through a virtual borehole—was, in the Eocene, near a deep lake that at its peak was around two miles across. The lake became a deathtrap for countless animals, and geochemistry in concert with millions of years of accumulating plant and mineral sediments would preserve features of the sunken carcasses to an astonishing degree.

Decaying animal and vegetable material buried and squeezed under tremendous pressure over millions of years yields, every school kid knows, fossil fuel, in this instance primarily oil shale—layers of soft gray stone impregnated with oil. Those deposits attracted miners from the late 1800s to the 1970s, when the open-pit mine closed down and was forgotten by all but a small group of people bent on extracting not the fuel but the fossils.

Word of amazing finds spread fast. And aside from a perhaps understandable bout of civic shortsightedness when the local government considered turning the giant hole in the ground into a garbage dump—a proposal that paleontologists and others sharply opposed for 20 years, prevailing in 1992—the site has been cherished as the greatest fossil trove of its kind. "Everyone in vertebrate paleontology knows Messel," says Johns Hopkins University paleontologist Ken Rose. "There's really no place in the world that compares. A great deal of what we know from that time period is from there."

The Eocene, from 56 million to 34 million years ago, was a crucial turning point in the history of life on Earth, a time to which we ourselves owe a considerable debt, for that's when mammals came into their own and evolved to occupy the ecological niches vacated by the extinction of the dinosaurs. At Messel Pit, mammal skeletons galore are preserved intact, often with the outlines of fur and flesh still visible in the surrounding rock. Primitive opossums, horses the size of fox terriers, an anteater, eight bat species and a lemur-like primate that could be an early branch on humanity's family tree—these and many more fossils provide glimpses of the distant ancestors of species we know today.

While paleontologists often frown at the prospect of visitors tromping around their digs, Messel Pit, which is run by the Senckenberg Research Institute in Frankfurt, is open to the public for guided tours. One fall day I follow geologist Marie-Luise Frey from the $6.5 million visitor center, opened in 2010, to the bottom of the pit. She leads me off the paved path onto the gentle slope of a recently closed excavation. Flakes of dried-out oil shale crunch under my boots. A sharp corner reveals where paleontologists cut through layers of shale with a chain saw, removing large blocks before carefully prying them apart to look for hidden fossils.

The edges of the excavation resemble the pages of a burned book. Even today, the oil shale is mostly water. As it dries, Frey explains in German, the oil shale turns as flaky as phyllo dough and eventually crumbles to dust. I'm trying to imagine the place as it was before, but the chill fall air, the turning leaves, the rumble of machinery at a nearby gravel plant aren't helping me put myself in a jungle 48 million years ago.

I notice some suspiciously round pebbles and pick one up. It's about the size of a praline. "*Das ist ein Koprolith*," Frey tells me brightly—a "coprolite," paleontologist-speak for a chunk of fossilized poop. This one was likely produced by a very big fish, she says: "You can still tell what they ate by examining them." I follow Frey farther into the pit, eager to understand how this place came to be.

At some point around 50 million years ago, underground water came into contact with a vein of molten rock. High-pressure steam erupted, forming a crater with steep sides. As water seeped in, it created a lake shaped more like a drinking glass than a soup bowl. Any animal that fell in sank quickly to the bottom.

Still, that alone doesn't explain why so many land mammals—not to mention birds, bats and insects—perished here. One theory is that carbon dioxide periodically bubbled up from deep beneath the lake bottom, smothering animals near the shore. Another possibility is that some of the summer algae blooms were toxic, poisoning animals that had chosen the wrong time and place to slake their thirst. Or perhaps smaller animals died nearby and were washed in by small floods or rushing streams.

The lake was so deep that oxygen didn't circulate near the bottom, which meant that there were no bottom feeders around to consume the dead and dying animals. Year after year, algae scumming the lake surface bloomed and died, and so layers of fine clay and dead micro-organisms drifted to the bottom. Each layer was as thick as a strand of hair. It took 250 years to build up an inch of mud. Over millions and millions of years, plants and animals were preserved like flowers pressed between the pages of a book, and the algae and other organic matter turned into oil shale.

Among the thousands of fossils that paleontologists have recovered at Messel Pit are specimens representing nearly 45 different mammal species. Those finds are critical to understanding how warmblooded creatures evolved. Mammals and dinosaurs appeared at nearly the same time around 200 million years ago. But dinosaurs were so well suited to the environment that they crowded out any competition. Mammals lived on the margins, mostly tiny creatures eking out a living by eating insects under the cover of darkness. "They just tried to stay out of the way," says Thomas Lehmann, a Senckenberg Research Institute paleontologist. And so it went for nearly 150 million years.

Then, in an instant, everything changed, apparently when an asteroid or comet struck Earth 66 million years ago and dramatically altered the climate, eventually wiping out the giant reptiles. The diversity of species found among the Messel Pit fossils reveals that mammals rushed to fill every empty ecological nook and cranny they could find. "They really tried everything—flying, jumping, running, tree-dwelling, ant-eating," says Lehmann. "From the point of view of evolution, Messel is a fantastic laboratory to see what life might have given us."

Might have, but in many cases didn't. Messel's most fascinating specimens may be those species that have no living relatives, though they look jarringly familiar. In the visitor center, kids crowd around to watch as a conservator armed with toothbrushes, dental picks and scalpels cleans layers of oil shale away from a fossil unearthed just a few weeks earlier. To me, the skeleton of *Ailuravus macrurus* looks like that of a giant squirrel. It's three feet long, including its bushy tail. Near the ribs a black stain traces the creature's fossilized digestive tract. Despite its tail, *Ailuravus* is no squirrel ancestor. It's an evolutionary dead end; *Ailuravus* and all of its relatives died out more than 37 million years ago. Why? Maybe they fell victim to climate changes, or a better-adapted competitor, or disappearing food sources, or simple bad luck.

Ailuravus' resemblance to a modern squirrel is an example of evolutionary convergence. Given enough time, adaptations may lead to nearly identical solutions—bushy tails, say, or powerful, kangaroo-like hind legs—popping up in different species. "It's like using the same Legos to build different forms," says Lehmann.

And there are forms aplenty at the Messel Pit. The exquisitely preserved fossils have provided paleontologists with unprecedented insights into the adaptive strategies—some successful, others not—adopted by mammals for feeding, movement and even reproduction. For instance, the contents of the tiny prehistoric horse's stomach—fossilized leaves and grape seeds—indicate that the animal was not a grazer but a browser, eating what it found on the forest floor. The paleontologists also found eight fossilized specimens of pregnant mares, each carrying a single foal. That discovery suggests that the early horses had already adopted herd behavior, since joint care would be the best way to guarantee the survival of small numbers of offspring.

Such findings make the place feel less like a graveyard than a time capsule encompassing a 48 million-year-old ecosystem. "It's not only paleontology, it's biology," says Jens Lorenz Franzen, a retired paleontologist who worked at the Senckenberg Research Institute and helped excavate some of Messel's most remarkable finds. "We can reconstruct the living world of that era."

About Andrew Curry

Andrew Curry is a Berlin-based journalist who writes about science and history for a variety of publications, including *National Geographic*, *Nature*, and *Wired*. He is a contributing editor at *Archaeology* and has visited archaeological excavations on five continents. (Photo Credit: Jennifer Porto)