

# From Bacteria to Lucy

MARCIN MACHALSKI  
Institute of Paleobiology, Warsaw  
Polish Academy of Sciences  
mach@twarda.pan.pl

**The exhibits of the Museum of Evolution highlight the most important stages in the long story of evolution – made all the more pertinent by this year's 150th anniversary of the publication of Darwin's theory**

In Darwin's times, the Earth was thought (following Lord Kelvin) to be 400 million years old at most. No Precambrian forms of life had yet been found, only a few species of dinosaur had been discovered, and the handful of known hominid fossil remains – such as the famous Neanderthal skull – were subjects of intense debate.

Nowadays, 150 years after the publication of Darwin's *Origin of Species*, we know that the Earth was formed 4.47 billion years ago, the oldest terrestrial rocks are 4 billion years old, and the oldest traces of life (fossilized bacteria from Austria) are 3.5 billion years old. We are familiar with hundreds of dinosaur species and – despite what opponents of the theory of evolution maintain – we have amassed an impressive set of fossil remains of man's ancestors.

## Stone pillows

Paleontologists have so far catalogued nearly 250,000 species that have inhabited the Earth in the past, but this is definitely just a small fraction – perhaps only 1% – of the “endless forms most beautiful and most wonderful” that Darwin described. The Museum of Evolution of the Polish Academy of Sciences has fossils and reconstructions of just several dozen extinct species on display, yet many of those exhibits represent milestones in the long and bumpy road from bacteria to Lucy.

While our museum does not have any fossilized bacteria, its collections do include stromatolites – stone “pillows” left behind by the blue-green bacteria that thrived in mass numbers on the floor of the pre-Cambrian seas. Blue-green bacteria are photosynthetic organisms, and oxygen is a byproduct of photosynthesis. Millions of microscopic oxygen bubbles emitted by such stromatolites, day after day for millions of years, oxygenated the Earth's oceans and atmosphere. As a result, the blue-green bacteria essentially killed off most anaerobic microbes and thus readied the planet to host more complex life forms.

The late pre-Cambrian (around 570 million years ago) saw the emergence of the Ediacaran biota (named after the Ediacara Hills in Australia, where the forms were first identified) – which paleontologists believe were a prelude to the subsequent Cambrian explosion, although the degree to which Ediacaran organisms are related to modern-day animals remains controversial. Our Museum is proud to display specimens of these mysterious organisms, brought back from the shores of the White Sea by Prof. Jerzy Dzik from the Institute of Paleobiology.

## Conquering land

Vertebrates emerged in the Cambrian age, but they did not leave the aquatic environment until the late Devonian era – when fish first came onto land, most likely “fleeing”



Marian Dzięwiński

**On the road to humankind: Marta Szubert's reconstruction of “Lucy,” the famous female *Australopithecus***

the ruthless predators that the Devonian lagoons were teeming with.

For many years, the ichthyostega, whose fossils were discovered in Greenland in the 1930s, was the animal seen as symbolic of this evolutionary fish-to-amphibian transformation. While the ichthyostega already had fully-formed legs, these limbs did not emerge from earlier fins just because its ancestors simply “decided” to take to the land. Evolution never thinks ahead, and the Cosmic Watchmaker is blind! The legs of the first tetrapods had developed back in the aquatic environment and initially served for crawling along the floor or gathering lush underwater vegetation. Without this natural “preparation” the Devonian conquest of land would have gone no further than the mudskipper, an animal still clumsily sloshing about tidal pools to this very day.

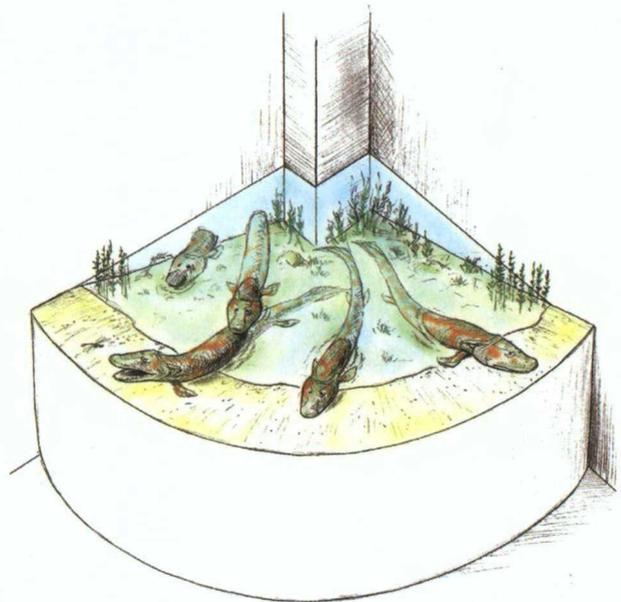
### Tiktaalik and other links

An animal significantly more primitive than the ichthyostega, however, has since been discovered in the titaalik, unearthed in the far north of Canada in 2006. The animal’s name means “big shallow-water fish” in the Inuit language and the tiktaalik was indeed a large fish with fins that already showed certain leg-like traits. Its body was flat dorso-abdominally, rather than laterally like most fish, and its head and sharp teeth were reminiscent of a crocodile’s. The tiktaalik preyed near the water’s surface yet also frequently came up onto land to hunt arthropods. Charles Darwin would have been delighted to study a tiktaalik skeleton, presumably seeing it as one of the sought-after missing links in his theory, comparable in significance to the now famous proto-bird, the archaeopteryx.

The Museum of Evolution in Warsaw has an ichthyostega skull and model on display, and is now working on developing a more precise reconstruction of the proto-amphibian plus a Devonian “scene” of tiktaaliks clambering out of the water. They will form part of a small exhibit on the conquest of land by vertebrate animals, to be opened on 24 November 2009, precisely 150 years after the publication of Darwin’s work. The grand opening will include a lecture by Jennifer Clack, a leading researcher on the earliest land-based vertebrates. The anniversary will also be commemorated by the publication of a new edition of the Museum of Evolution’s journal.

### Demise of the dinosaurs

In the Carboniferous period, amphibians gave rise to the primitive reptiles, from which dinosaurs and mammals later sprang. But the dinosaurs are not a missing link in the long chain of lifeforms running from bacteria to Lucy: in fact, for millions of years they posed an effective “barrier” to our own evolution. Both groups of animals, dinosaurs and mammals, arose in the Triassic, ca. 200 million years ago.



Design sketch of a pond with emerging tiktaaliks for the Museum of Evolution

The great lizards quickly entered their evolutionary heyday, while mammals remained in their shadow. For the next 135 million years, mammals were small creatures that lived nocturnal lives, whereas the dinosaurs ruled the Earth in the daytime. The dinosaurs’ tyranny would not be overthrown until a meteor smashed into the Yucatan region around 65 million years ago. The ensuing global catastrophe marked the end of the dinosaurs and cleared the way for the “explosive” evolution of our own ancestors. This catastrophic scenario – now accepted by most scientists – would presumably have given Darwin heart palpitations. The inventor of evolutionary theory was deeply convinced that earlier life forms died out only because of competition against new, better-adapted species or due to gradual environmental change, leaving no room for the kind of global catastrophes or mass extinctions now being posited by modern science.

### Mother of man

Molecular research indicates that the evolutionary lines of modern apes and human beings split apart around 7–8 million years ago. The fossil remains of the earliest known hominid, *Sahelanthropus*, date from that period. The true symbol of human evolution, however, is “Lucy” – the skeleton of a female *Australopithecus* dating back 3 million years, unearthed in Ethiopia. This “mother of man” already walked upright on two legs, yet still had a small brain. This discovery definitely would have taken Charles Darwin by surprise, as in his time the development of our ancestors’ brains was thought to have preceded the emergence of other “human” traits. A charming reconstruction of the famous “ape-woman” by Marta Szubert is the favorite exhibit of most visitors to the Museum of Evolution in Warsaw. ■