Siberian Rocks Clock Biological Big Bang

The first U.S. geologists granted access to work in a remote corner of northeast Siberia have succeeded in dating the evolutionary explosion at the beginning of Earth's Cambrian period — a biological burst that produced almost all major groups of modern animals in an astonishingly short span of time.

Prior to the so-called Cambrian explosion, animals had simple body plans lacking hard parts, and worm-like organisms ranked as the most complex creatures. The Cambrian period brought a leap in innovation with the appearance of animals sporting novel features such as shells, skeletons, legs, and antennae. That event transformed life. The Cambrian marked the birth of most complex animal phyla on Earth today, including the arthropods, mollusks, echinoderms, and our own group, the chordates. Since then, advanced animals have stuck with those same basic body plans; no new ones have evolved.

While charts of geologic time generally show the Cambrian beginning around 570 million years ago, research in the last decade has revealed that date as too early, making it difficult to pin down the length of the explosion. The new dating work suggests the peak evolutionary frenzy actually began 530 million years ago and lasted only 5 to 10 million years.

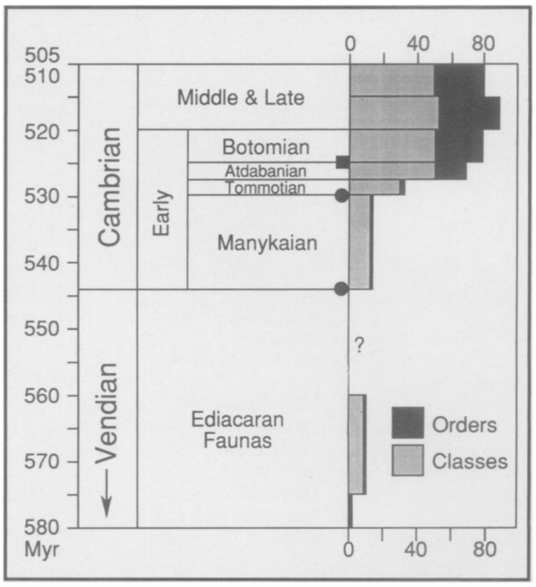
"People have thought that it was fast, but the timescale was so poorly calibrated that nobody could begin to think about [evolutionary] rates," says geochronologist Samuel A. Bowring of the Massachusetts Institute of Technology. Bowring and his colleagues from MIT, Harvard University, and the Yakutian Geoscience Institute in Yakutsk, Russia, report their findings in the Sept. 3 SCIENCE.

The researchers collected rocks from the early Cambrian period at several sites near the mouth of Siberia's Lena River. They dated zircon crystals within the rocks using a method that relies on the radioactive decay of uranium to lead. When zircons form in underground magma chambers, they incorporate uranium atoms and exclude lead atoms. As the uranium decays, though, lead accumulates in the crystals. By measuring the ratio of remaining uranium to lead, researchers can judge the zircons' ages.

Bowring's group determined the Cambrian started 544 million years ago, a date much later than the traditional one but within the range hinted at by previous measurements. While some creatures appeared for the first time in the fossil record during this primary stage of the Cambrian, the diversity of known fossil groups jumped most dramatically during the period's next two stages, the Tommotian and the Atdabanian.

From their work on the Siberian rocks and those found recently in New Brunswick, Canada, Bowring and his colleagues dated the beginning of the Tommotian at approximately 530 million years ago. Work by other researchers has suggested the Atdabanian ended 525 million years ago. Because of uncertainties in the dates and the starting point of the stages, Bowring judges that the Cambrian explosion lasted at most 10 million years and as little as 5 million.

Interest in the Cambrian has surged in recent years, in part because of remarkable fossil discoveries made in southwest China and northern Greenland, which coincided with a reevaluation of fossils found early this century at Canada's Burgess Shale (SN: 7/11/92, p.22). The new dating work will help researchers trying to understand what caused the flowering of new phyla and why it never recurred. Some scientists think the explosion followed an environmental change, such as a rise in the oceanic oxygen concentration. Others suggest that genetic or developmental innovations within organisms allowed them to form new types of body architecture.



Animal orders and classes surged in number during the early Cambrian's Tommotian and Atdabanian stages.

"If we try to find out what mechanisms — ecological or genetic — caused this rapid diversification, then surely the absolute rates are very important because they put some limits on what you can suggest," says Stefan Bengtson, an expert in Cambrian fossils at Sweden's Uppsala University. — *R. Monastersky*

'Knockout' ties cancer gene, kidney growth

Current dogma in cancer biology holds that tumors can arise when certain "tumor-suppressor" genes malfunction and allow cells to grow and multiply rapidly, much the way cells do when an organ first forms.

"We always talk about cancer as abnormal development," says Jordan A. Kreidberg, a molecular geneticist at the Whitehead Institute for Biomedical Research in Cambridge, Mass. In support of that idea, Kreidberg and his colleagues have demonstrated that one gene implicated in Wilms' tumor — a type of kidney cancer that afflicts mainly infants — plays an essential role in kidney development in the embryo.

For their experiments, Rudolf Jaenisch, Kreidberg, and their fellow Whitehead scientists created a special "knockout" mouse strain in which offspring carried one or two faulty copies of a gene that normally "suppresses" the development of Wilms' tumor. They did this by implanting the faulty gene into cells taken from very early mouse embryos, Kreidberg explains. As these cells divided, the inserted mutant gene sometimes "knocked out" the normal gene by switching places with it on the chromosome. Then the researchers placed these altered cells into other embryos. The cells became part of the resulting mice, which then transmitted the altered genes to some of their descendants.

Kidneys do not develop in mouse embryos containing two copies of this faulty suppressor gene, Kreidberg and his colleagues report in the Aug. 27 CELL. "You might think you'd get uncontrolled cell growth," Kreidberg told SCIENCE NEWS. "Instead, you get no kidney at all." Also, the heart, lungs, and gonads are abnormal, causing the embryos to die at about two weeks.

"This [work] has provided some very clear evidence that [the normal gene] is absolutely essential for early kidney development," comments Bryan R.G. Williams, a molecular biologist at the Cleveland Clinic Research Institute.

Typically, human kidneys begin to form when a knob of epithelial cells makes contact with a nearby patch of mesodermal cells and causes them to become epithelial cells. The knob develops into