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.

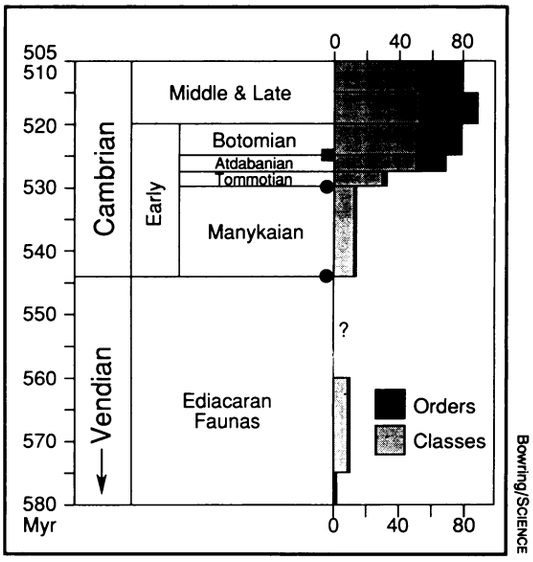
"People have thought that it was fast, but the timescale was so poorly calibrated that nobody could begin to think about [evolutionary] rates," says geochronologist Samuel A. Bowring of the Massachusetts Institute of Technology. Bowring and his colleagues from MIT, Harvard University, and the Yakutian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

the urethra and the kidney's major collecting duct, while the newly induced epithelium becomes the organ's plumbing. In the knockout mice, this transformation did not occur, and the knob eventually shrank, Kreidberg says.

The Wilms' tumor-suppressor gene directs the production of a protein whose molecular structure suggests it binds to DNA, either activating or suppressing gene activity. "But how that contributes to kidney development is really unknown," says Kreidberg, who hopes the mouse strain will provide researchers a way to study this process.

"Now people can look at particular target genes for Wilms' tumor gene regulation, and it provides a model system for testing various mutants," Williams says.

The Whitehead group would also like to use the mouse as a model for studying how these faulty suppressor genes lead to Wilms' tumor. Children who inherit one good and one bad copy of the gene can develop kidney cancer if the good copy gets destroyed or misplaced somehow in one cell, which then multiplies out of control. That one bad gene can also lead to malformed genitals and urinary tracts, the scientists note.

But, unlike people, mice do not develop the tumor, even if they're born with just one copy of the suppressor gene, says Kreidberg. So the researchers hope to figure out a way to disable both copies of the normal gene after the kidneys form. Then perhaps these mice would get cancer. — *E. Pennisi*

Mars Observer: The sounds of silence

Acknowledging that the first U.S. mission to Mars in 17 years is almost certainly a failure, NASA has appointed a task force to find out what went wrong. Engineers lost contact with the Mars Observer spacecraft on Aug. 21, just three days before it was to begin orbiting the Red Planet. NASA scientists say they now have little hope of regaining communication with the craft.

"I think it's lost," says Glenn E. Cunningham, project director for the Mars Observer at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

Because of the craft's silence, no one knows whether Mars Observer fired its thrusters on Aug. 24 as planned and entered an orbit around Mars or if it simply flew past the planet. The $980 million space vehicle might also have been blown to bits shortly after ground controllers commanded it to pressurize its fuel tanks. That normally routine procedure, which requires the craft to detonate a gas valve, may have fatally jarred electronic equipment or caused an explosive leak in the fuel system.

NASA scientists now theorize that a master clock, the timekeeper for most of the craft's computers, may have contained a faulty pair of transistors, each of which controls a duplicate timer. If both failed after the tanks were pressurized, the craft's computers could not function and the Observer would remain lost in space.

That explanation, researchers note, is only one of many under investigation by the NASA task force, headed by Timothy Coffey, director of the Naval Research Laboratory in Washington, D.C. The theory came to the fore because of problems discovered in a similar master clock before the launch of the NOAA-13 weather satellite. During testing last June, researchers found that the satellite's master clock failed to operate. They traced the problem to a faulty weld in a transistor and replaced the defective parts before the Aug. 9 launch of the weather satellite, which has since failed for other reasons (SN: 8/28/93, p.134).

The finding came too late for the Mars Observer, launched in September 1992 with a master clock containing transistors from the same troublesome lot. However, Charles Thienel at NASA's Goddard Space Flight Center in Greenbelt, Md., says it's unlikely that two transistors failed on the Observer, because testing revealed only a few defective transistors in the manufacturing lot.

Thienel said that an earlier weather satellite, NOAA-8, had a problem with its master clock in 1984. But only one of its two timing devices was affected. After about eight months, an interval during which the satellite remained silent for weeks at a time, NOAA-8 finally switched to its backup timekeeper. It remains unclear whether the experience with NOAA-8 warrants a glimmer of hope that Mars Observer might eventually resume useful communication with Earth.

This week, NASA began considering several strategies for carrying out some of the studies that would have been conducted by Mars Observer. NASA manager Wesley T. Huntress says that spare parts from the Observer might be assembled into another craft, possibly as early as 1994. However, a limited supply of the costly rockets needed to launch the craft and transfer it into a Martian orbit could hamper such efforts, notes John Logsdon, a space policy analyst at George Washington University.

Scientists are also considering using small satellites originally intended for defense research to study Mars. One such craft, known as Clementine, is scheduled for launch in January to explore the moon. But at least one researcher expressed concern that NASA may be grasping at straws in an effort to salvage some of the scientific treasures the agency had hoped Mars Observer would radio home. — *R. Cowen*

1976 dioxin accident leaves cancer legacy

Next week in Arlington, Va., the Environmental Protection Agency will hold a workshop to review human data on the toxicity of dioxins. One sure topic for discussion will be a paper, published this week, reporting elevated cancer rates among adults near Milan, Italy. All had lived in areas downwind of a 1976 chemical accident in Seveso that resulted in the highest documented human exposures to TCDD, the most potent dioxin.

In the September EPIDEMIOLOGY, Pier Alberto Bertazzi of the University of Milan and his co-workers describe how they tracked down nearly all 20- to 74-year-olds who had resided in one of three areas through 1986: about 550 people from neighborhoods nearest the Seveso accident; roughly 4,000 from a less contaminated zone; and some 26,000 persons from areas with low and patchy dioxin tainting. They identified cases of cancer from area hospitalization records.

Few cancers turned up among people who had lived nearest the accident—even in those who had developed a disfiguring acne from their initial, heavy dioxin exposure. However, with so few people in this group and the short follow-up, this "cannot be taken as sound indication of a lack of carcinogenicity," Bertazzi's team says—especially in light of a numerically small but statistically significant excess of cancers in the next-most-exposed region.

Here, the scientists found a quintupling in the expected incidence of gallbladder and bile duct cancers among women and a more than doubling in men. They also observed about double the expected rate of cancers in blood-forming tissues, but which cancers predominated differed between men and women. An apparent excess of certain soft-tissue sarcomas showed up in both sexes, and among men, the researchers saw twice the expected rate of liver cancer.

Even in the patchy-exposure zone, Bertazzi's team observed a slightly elevated incidence of some of these cancers.

The incidence of estrogen-dependent cancers, such as those of the breast and uterus, by contrast, were strikingly lower than expected in the two most exposed zones. Similar trends, seen in dioxin-exposed rats, have been explained by TCDD's ability to decrease the number of estrogen receptors in some tissues and to interfere with the hormone's metabolism.

In an accompanying editorial, Olav Axelson of University Hospital in Linköping, Sweden, concludes that these Seveso data "certainly represent sound epidemiology and are crucial contributions to the elucidation of the relations between dioxin-related exposures and cancer risk." — *J. Raloff*