<< The Runners-Up

Family feud. DNA confirms that Neandertals split from modern humans 450,000 years ago.

2 DIGGING OUT FOSSIL DNA. This year, on the 150th anniversary of the discovery of the Neandertal type specimen, researchers in Europe and the United States transformed the study of this ancient human by sequencing more than 1 million bases of Neandertal DNA. In November, two groups, one decoding 65,000 Neandertal bases and the other a million bases, showed that researchers can now find sequence changes between modern and ancient humans, differences that may reveal key steps in our evolution. The studies concluded that Neandertals diverged from our own ancestors at least 450,000 years ago—approximately the time suggested by fossil and mitochondrial DNA studies. One group's data also suggest that Neandertals and modern humans may have interbred. In the works are a very rough draft of the complete Neandertal genome sequence and, as more fossils become available to sequencers, the development of bacterial libraries containing DNA from several Neandertals.

This breakthrough owes a large debt to earlier sequencing feats that demonstrated the potential of a new approach called metagenomics for deciphering ancient DNA, both human and nonhuman, and of faster sequencing technologies. For metagenomics, a technique developed for assessing microbial diversity, all the DNA in a sample is sequenced, and then sophisticated computer programs pull out only the target DNA based on its similarity to the sequence of a closely related extant organism.

In January 2006, researchers combined metagenomics with a new rapid sequencing technique called pyrosequencing, which uses pulses of light to read the sequence of thousands of bases at once, to get a whopping 13 million bases from a 27,000-year-old mammoth. The same sample also yielded another 15 million bases from bacteria, fungi, viruses, soil microbes, and plants—DNA that will provide clues about this giant mammal's environment. With those two advances, ancient DNA sequencing is off and running.

3 SHRINKING ICE. Glaciologists nailed down an unsettling observation this year: The world's two great ice sheets—covering Greenland and Antarctica—are indeed losing ice to the oceans, and losing it at an accelerating pace. Researchers don't understand why the massive ice sheets are proving so sensitive to an as-yet-modest warming of air and ocean water. The future of the ice sheets is still rife with uncertainty, but if the unexpectedly rapid shrinkage continues, low-lying coasts around the world—including New Orleans, South Florida, and much of Bangladesh—could face inundation within a couple of centuries rather than millennia.

This disturbing breakthrough rests on decades of measurements by airborne laser altimeters and orbiting radars, and, more recently, by a pair of satellites that measure ice mass directly by its gravitational pull. Different techniques and even different analyses of the same data disagree about just how much ice volume is changing. All of them, however,

Bye-bye. The great ice sheets are losing ice to melting and icebergs faster than it forms.

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Scorecard 2006

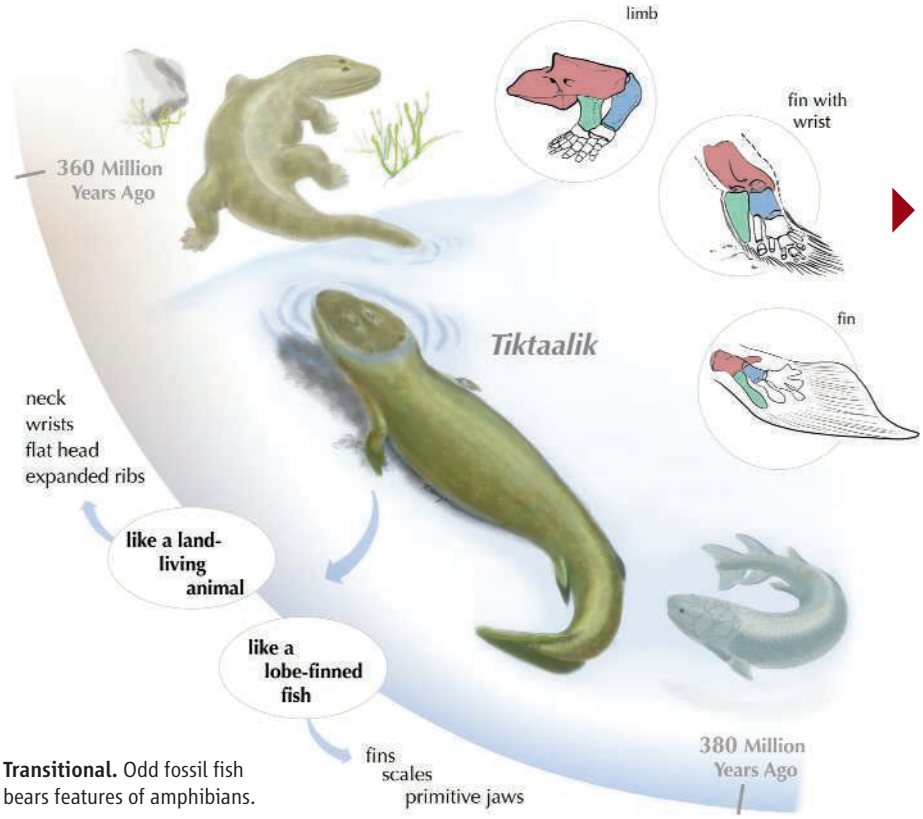
How well did the editors forecast the year's Areas to Watch? The record shows that some of their crystal balls were clouded by wishful thinking.

Avian influenza. Research on flu drugs, vaccines, and epidemiology flourished in 2006, as did studies of the genetic changes that might turn avian influenza into a pandemic. But tracking the worldwide H5N1 outbreak is still difficult because researchers and countries hoard field samples and viral sequences.

Gravity rules. Gravitational-wave fans will have to wait. The Laser Interferometer Gravitational-Wave Observatory in the United States and the smaller GEO-600 facility in Germany won't publish results until early 2007. Not bad news—just no news.

RNAi-based treatments. The gene-silencing technology boasted promising clinical-trial results in macular degeneration and respiratory syncytial virus, won a Nobel Prize, and enticed drug giant Merck to pay $1.1 billion for a small biotech company focused on RNAi treatments. But safety worries still loom: A hepatitis B study of RNAi in mice reported that dozens of animals died from treatment.

Catching rays. The massive Pierre Auger Observatory in Argentina seems sure to answer fundamental questions about the highest-energy cosmic rays, such as whether their interactions with the afterglow of the big bang limit their energy and whether they originate from point sources in the sky. But not in 2006, as we predicted. Some answers will likely come at a major conference in Merida, Mexico, in July.



Transitional. Odd fossil fish bears features of amphibians.

CREDIT: KALLIOPI MONOYIOS

now show that both Greenland and Antarctica have been losing ice over the past 5 to 10 years. In the north, Greenland is shedding at least 100 gigatons each year. In the south, the figure is less certain but lies in the range of tens of gigatons per year or more.

Current ice sheet losses aren't raising sea level faster than 0.1 meter per century, but researchers fear that the rate could rise to a meter per century or more in the near future. As recently as 5 years ago, they assumed that global warming would simply melt more and more ice from the ice sheets, as it is melting mountain glaciers. But it turns out the ice isn't just melting faster, it is moving faster. Radar mapping shows that in recent years, glaciers carrying ice away from the sheets have sped up by as much as 100%. In West Antarctica, warming ocean waters seem to have attacked the floating tongues of ice that hold back the ice sheet's outlet glaciers. Around southern Greenland, something else seems to be quickening the pace of outlet glaciers, perhaps lubrication by increasing amounts of surface meltwater seeping to a glacier's base.

Now glaciologists are wondering how the next chapter will play out. Will the relatively strong warming around the ice continue, or will it be weakened by natural variations of climate? Will the ice sheets adjust to the new warmth by eventually slowing their ice loss? And will more glaciers succumb to the spreading warmth? A few more breakthroughs are definitely in order.

SPECIAL SECTION

4 NEITHER FISH NOR FOWL.

Paleontologists made a major splash this year with the debut of a fossil fish that long ago took a deep breath and made some tentative but ultimately far-reaching steps onto land. With its sturdy, jointed fins, the 375-million-year-old specimen fills an evolutionary gap and provides a glimpse of the features that helped later creatures conquer the continents.

All limbed vertebrates, known as tetrapods, evolved from lobe-finned fishes some 370 million to 360 million years ago. Many of these sophisticated fishes had skeletons with modifications, such as enlarged bones in their fins, that would ultimately prove useful for weight-bearing limbs. The new species is the most tetrapodlike fish yet discovered.

Three specimens were found during a 2004 field expedition to Ellesmere Island in the far north of Nunavut, Canada. They were named *Tiktaalik roseae* for "large freshwater fish" in the Inuktitut language and a donor who helped fund the expedition, respectively. With fins and scales, the 3-meter-long *Tiktaalik* is clearly a fish. It had a flat head with eyes on top and lived in shallow streams.

What makes *Tiktaalik* unique among fish is that each of the front fins has a wrist and elbow, providing flexible motion. Also unlike other fish, *Tiktaalik* sported a neck—the oldest one known in the fossil record—and could move its head. Achieving that flexibility required losing a bone called the operculum, which modern fish use to pump water over their gills. *Tiktaalik* still had well-developed gills, and it probably used its neck and stout limbs to push its head above water to inhale.

Another feature that makes *Tiktaalik* close kin to tetrapods is its robust, overlapping ribs.

Small worlds. As predicted, microbial evolution and ecology emerged among the most exciting areas of biology. Researchers got a better grasp of what a prokaryote species might be, despite promiscuous lateral gene transfer. And it became clear that symbioses involving microbes (bacteria in the human gut, for example) are pervasive and sometimes extreme.

Seconding supersolidity. Two groups reproduced the subtle signal that could be evidence that crystalline helium flows—as predicted. But one group reported that the effect disappeared if the frigid crystal was gently heated and cooled to remove imperfections. That suggests that the crystal itself doesn't budge, but thin layers of liquid flow between crystalline grains. The upshot: *Something* is happening, but what?

Homing in on high T_c. We can dream, can't we? The 20th anniversary of high-temperature superconductivity passed without any consensus being reached on how the materials carry electricity without resistance at temperatures as high as 138 kelvin. Experimenters are producing exquisitely precise data, but it seems that every theoretical concept has data pointing in its direction.

Bird to watch for. We hoped new sightings would prove that the ivory-billed woodpecker is alive and pecking. But indirect evidence from trees in Florida failed to sway the skeptics, and the original Arkansas sightings of the bird are looking increasingly shaky. Maybe it drowned in a rogue gravitational wave.