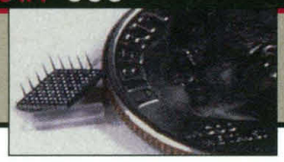
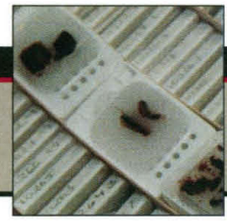




expressed interest in teaming up with Mammuthus. They aren't the only ones interested in resurrecting a mammoth: A Japanese team hopes to pull off a similar feat with mammoth remains it unearthed this summer in another region of Siberia.

Even if the Jarkov mammoth yields subpar tissue, scientists expect to learn more about the mammoth's habitat from plant material found underneath the permafrost block. And by keeping the remains at subzero temperatures for as long as possible, scientists hope to extract pathogens that could have contributed to its death. "People will speak of this discovery 100 years in the future," predicts Mol. Provided, that is, something emerges from the ice when the dryers are turned off.

–RICHARD STONE

EVOLUTIONARY GENETICS

The Why Behind The Y Chromosome

The human Y chromosome may be best known as a champion testosterone booster, but its functional powers are puny compared to those of its partner, the X chromosome: It is only one-third the size of the X and has only 1/100th as many genes. Despite this mismatch, scientists have long suspected that the X and Y were once equals, but they gradually diverged over time. Now, on page 964, two researchers report evidence for how this split occurred.

In a kind of molecular-scale fossil dig, geneticists David Page of the Whitehead Institute for Biomedical Research at the Massachusetts Institute of Technology and Bruce Lahn, now at the University of Chicago, analyzed genetic "fragments of history"—genes still found on both chromosomes that have remained relatively unchanged for millennia. They used these genetic relics to piece together a rough history of how the chromosomes drifted apart. The distinctions between X and Y didn't happen gradually, they concluded, but in a stepwise fashion, implying that at least four distinct events—most likely rearrangements of the Y chromosome—drove the chromosomes apart over hundreds of millions of years.

"It's fascinating work," says geneticist Huntington Willard of Case Western Reserve University School of Medicine in Cleveland. "It gives us an intriguing glimpse" into the evolution of the human sex chromosomes. The work may also shed light on the evolution of the sex chromosomes of birds and insects, which developed independently of the mammalian system.

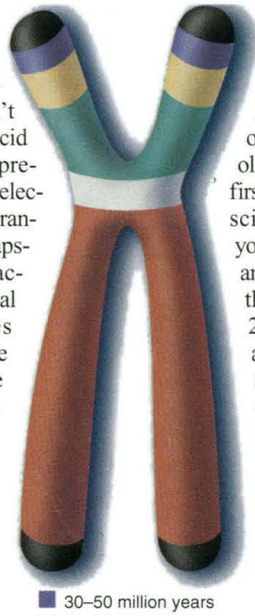
The mismatch between the X and Y chromosomes creates some unusual biology. During the specialized cell division that creates sperm and eggs, most chromosome pairs are able to line up and swap pieces, a process called recombination. Like two friends who keep in touch despite being separated by long distances, this occasional exchange keeps the pairs up to date with each other. It also creates beneficial combinations of genes that can spread throughout the population. But recombination won't work if the pairs are a poor match, and in humans, the X and Y chromosomes recombine only at their tips.

Although X and Y look very different, in recent years geneticists have turned up at least 19 genes that are present on both—all of them leftovers from the days when the chromosomes were kept similar by recombination. Lahn and Page scored each gene pair for sequence similarity, focusing on the number of "synonymous" gene differences between them—changes in DNA that don't change the protein's amino acid sequence. These mutations presumably are subject to little selective pressure and accumulate randomly. Thus, as more time elapses, more mutations should accrue. If so, the number of actual synonymous gene changes should offer a rough estimate of the length of time that the genes have been evolving independently, Page explains.

When the researchers looked at this value for different parts of the chromosomes, they were "stunned," says Page. He wasn't expecting a clear pattern, but in fact the values for genes on the X chromosome grouped into four "strata" neatly arrayed along the chromosome's length. The genes on the chromosome's long arm were most different from their Y counterparts, and as the scientists examined the opposite end of the chromosome, the genes became more and more similar to their Y doubles.

To explain this pattern, Lahn and Page propose that the Y chromosome was reshuffled four times, perhaps through a process called inversion, in which a piece of chromosome breaks off, flips over, and reattaches so the order of the genes in that stretch is inverted. Each inversion prevented a stretch of the Y from aligning and exchanging pieces with the matching piece on the X. After all four inversions, the X and Y can now recombine only at their tips.

To get a rough estimate of when these inversions occurred, the scientists used divergence times that are known from fossils and genetic evidence. For example, two gene pairs in the fourth "stratum" of the X chromosome are still able to recombine in prosimians but have diverged in both Old and New World monkeys, so Lahn and Page estimated that the most recent reshuffling happened between 30 million and 50 million years ago, after monkeys diverged from prosimians but before New and Old World monkeys split. In a similar way, they estimate that the third inversion happened between 80 million and 130 million years ago and the second between 130 million and 170 million years ago. But because only a few genes remain similar in the oldest "layer," estimating the age of the first rearrangement was tougher. So the scientists used the ages of the three youngest strata as a rudimentary clock and concluded that the oldest section of the chromosomes diverged between 240 million and 320 million years ago—shortly after birds and mammals are thought to have split from their common, reptile-like ancestor.



Layers of meaning. The X chromosome diverged from the Y in four stages, as reshuffling on the Y prevented the exchange of genes between the X and Y. Colors indicate when each section diverged.

Such a scenario fits with the biology of animals today: Many reptiles lack specific sex chromosomes (depending instead on temperature differences during development to modulate individual sex-determining genes), and presumably the reptilian ancestor of birds and mammals lacked sex chromosomes, too. In birds, the avian sex chromosomes, W and Z, seem to be derived from the chromosome pair that is today number nine in humans.

Indeed, "everything seems to fit together," says evolutionary biologist Brian Charlesworth of the University of Edinburgh. The result is "really pleasing," agrees evolutionary biologist James Bull of the University of Texas, Austin,

SOURCE: MODIFIED FROM B. LAHN AND D. PAGE; ILLUSTRATION: C. CAIN

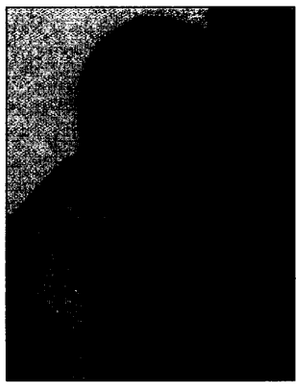
and offers a surprisingly clear evolutionary record. Says Bull: "This is the study that's going to go into the textbooks."

–GRETCHEN VOGEL

FORMER SOVIET SCIENCE

Ukrainian KGB Puts Heat on Researchers

In an episode that is rekindling memories of Soviet-era repression, Ukrainian security agents last week accused three marine scientists of crimes against the state: shipping sensitive data out of the country and illegally accepting Western currency for research. The unprecedented post–Cold War investigation has stirred an international effort to persuade the Ukrainian government to rein in its version of the KGB before formal charges are brought. Prosecuting the researchers, observers in the West say, could put scientific collaboration with Ukraine into a deep chill.



Price of success? Piontkovski's grants could land him in jail.

Like many talented scientists who have chosen to stay put in the former Soviet Union, Sergey Piontkovski and his team at the Institute of Biology of the Southern Seas (IBSS) in Sevastopol, Ukraine, have supplemented their meager state salaries with grants from Western organizations. Piontkovski has been more successful than most, pulling in grants in recent months from the U.K. government's Darwin Initiative; a European Union agency called INTAS that supports former Soviet scientists; and the U.S. Office of Naval Research (ONR). According to several Ukrainian scientists, jealous co-workers at the institute may be trying to take Piontkovski down: "As far as I know, these people wrote a letter to the local KGB," says Alexei Mishonov of the Marine Hydrophysical Institute (MHI) in Sevastopol, now a visiting scientist at Texas A&M University in College Station.

Whatever aroused their interest, on 16 October Ukrainian security bureau (SBU) agents raided the homes and offices of Piontkovski; his former wife, Galina Piontkovskaya, who is also an IBSS scientist; and IBSS deputy director Yuri Tokarev. They seized the researchers' scientific papers, computers, money, and passports. "They confiscated everything," says Piontkovski, who when contacted at his home by *Science* claimed that the SBU was monitoring his telephone calls. If convicted of illegal funds transfers, he says, all three scientists could face steep fines and up to 8 years in prison. Tokarev, Piontkovski says, was also accused of passing Soviet-era data to the West. The SBU investigation has since expanded to target MHI scientists also funded by the three grants, says Mishonov.

Work under the grants involves analyzing and digitizing a wealth of data on plankton bioluminescence collected by over 50 Soviet ocean expeditions from 1970 to 1990, as well as voyages undertaken by Ukraine and Russia after the Soviet Union dissolved. The grants call for making the information, a measure of the ocean's total biomass, available to the scientific community on CD-ROM. "I can hardly see how this kind of plankton studies can represent a risk to the national security of any nation," says marine biologist Luis D'Croz of the Smithsonian Tropical Research Institute in Panama. "This is simply absurd." The data "were not classified in any way," adds marine biologist Robert Williams of the Plymouth Marine Laboratory in the United Kingdom, a co–principal investigator on the ONR and Darwin grants, although he points out that the National Academy of Sciences of Ukraine prohibited the release of Soviet acoustic data that might give insights into submarine movements.

Ukraine's Byzantine currency laws make it hard for Western officials to evaluate the allegations of illegal funds transfers. "We have told the Ukrainian government time and again that they are creating a hostile environment for investment," says Gerson Sher, director of the U.S. Civilian Research and Development Foundation. Sher estimates that three times as many tax-free dollars for science would flow into Ukraine if the legal situation were clarified. "It's like the IRS [Internal Revenue Service] in our own country—if they want to get you they'll find a way," he says. Mishonov agrees: "It's very easy to find a currency law that's broken." INTAS director David Gould, however, says his agency has abided by the law in funding scientists under a program sanctioned by the Ukrainian government.

To send a signal that the SBU's own steps are being monitored, the European Union's representative in Kiev has taken up the matter with Ukraine's Ministry of Foreign Affairs, while Piontkovski's colleagues at IBSS and at foreign institutions have appealed to Boris Paton, the powerful academy president, to bring his influence to bear. If the SBU is preparing a broader campaign against Western-funded Ukrainian scientists, warns Williams, he and others who wish to sustain their colleagues may have to keep them at arm's length, for "fear of placing them in jeopardy."

–RICHARD STONE

CREDITS: (LEFT TO RIGHT) A. MISHONOV; SAM KITTNER

ScienceScope

Beijing Brouhaha Brushing aside last-minute objections from an influential congressman, the National Science Foundation (NSF) last week gave the green light to a science policy meeting in China involving officials from both countries. Representative James Sensenbrenner (R–WI, right), chair of the House Science Committee, was supposed to deliver the keynote address at the 3-day Beijing conference organized by Thomas Ratchford, a senior science official in the Bush Administration who now teaches at George Mason University in Fairfax, Virginia. Ratchford has a $325,000 NSF grant to explore U.S.–Chinese roles in a "borderless, knowledge-based 21st century economy."

But Sensenbrenner pulled out on 20 October, blasting China's "repeated efforts to obtain or misuse sensitive military technologies," and urged NSF to cancel the meeting. Ironically, he broke the news to NSF director Rita Colwell in a call that interrupted a meeting with reporters in which she and presidential science adviser Neal Lane had heaped praise on Sensenbrenner and his Republican colleagues for their help in passing the just-signed 2000 budget for NSF and NASA.

Colwell spent the next day conferring with Lane and other scientists before deciding that the meeting should go on. The seminar "is not linked to [Sensenbrenner's] specific concerns" and upholds "the principle of free circulation of scientists," she says. Sensenbrenner released a statement expressing disappointment with NSF's decision, which he said "prompts further questions about the Administration's handling of S&T issues involving China."

Opinion-Makers How do British scientists think they rate with the public? The Wellcome Trust aims to find out. Next month, with support from the government's Office of Science and Technology, the biomedical research charity will begin face-to-face interviews with a "nationally representative" sample of 1600 U.K. scientists in a bid to discover—among other things—how they see their role in society and how the fuss over genetically modified foods has shaped their attitudes toward the media. Preliminary results of the survey, to be conducted by the market research firm MORI, will be available next spring, with a final report in July.