University of Michigan evolutionary theme semester

Geneticist Svante Pääbo speaks on chimpanzee genome

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18 January 2006

In the latest of several major advances in the field of biology and genetics, Svante Pääbo and his fellow researchers in Germany have performed a comparative analysis of the chimpanzee and human genomes. Their work further advances our knowledge of those genetic elements which may distinguish humans from other animals. His most recent data, first published in a paper last year, was presented on January 13 at the opening lecture of the University of Michigan's "Distinguished Speaker Series," a lecture series oriented to the public and part of Michigan's "Evolution Theme Semester."

The theme semester comes at a time of an escalating attack upon scientific understanding, of which the attack on evolutionary theory is a critical component. A section of the American ruling class has sought to cultivate a base of support by promoting and appealing to religious ignorance on issues such as abortion, stem cell research and the teaching of evolution. This attack on science is closely connected with an agenda aimed at undermining social programs and living standards. Only last year President Bush declared that he thought the theory of Intelligent Design should be taught alongside evolution in public schools.

Within this context the University of Michigan's decision to choose evolution as its semester theme should be welcomed. The decision was no doubt partially intended to oppose the ongoing attempts to undermine the teaching of evolution and question the legitimacy of its conclusions. The lectures and courses that are part of the theme semester are accompanied by an "Explore Evolution" museum exhibit, also hosted in five other major universities. Events scheduled almost every day for the next four months include symposiums on the origins of life in the universe, workshops for undergraduates explaining the nature of scientific thought, and a film series that will show, among other movies and documentaries, the 1960 film classic on the Scopes Monkey Trial, *Inherit the Wind*.

The events showcase a number of University of Michigan professors who have contributed to the recent advances in genetics and evolutionary biology. Among them are included geneticists like Jianzhi Zhang, who has helped demonstrate how genes can diversify to create new information through gene duplication, speeding the process of evolution. Another professor is Philip Gingrich, a renowned paleontologist whose work has helped establish a nearly complete fossil record documenting the evolution of whales from their terrestrial ancestors.

The student body has also been involved in the events. Randa Tao, president of the University of Michigan's Society of Biology Students, expressed to the WSWS her excitement at the prospect of students being exposed "to the cutting edge of research and ideas in many interdisciplinary fields, all asking various questions fundamental to the study of life." In her view, the theme semester might challenge sometimes "uncritical or irrational worldviews" held by so many students and professors, and will help promote scientific understanding. "I think that the evolution theme semester will be one of the most intellectually stimulating events in my undergraduate experience at Michigan," she said.

The "Distinguished Speaker Series," for which Pääbo spoke, may be the Evolution Theme Semester's greatest accomplishment, allowing, in the next few months, scientific minds from across the country and globe to address the Ann Arbor public. Eugenie Scott, of the National Center for Science Education, will tackle Intelligent Design head-on and explain the continuity between ID and the religious creationist movement as a whole. David Pilbeam, acclaimed anthropologist of Harvard, will review the changes in scientific thought on human evolution since Lucy and the decoded Human Genome. Later speakers will include primatologist Richard Wrangham, evolutionary biologist W. Ford Doolittle, expert on biological aging Linda Partridge, authors of "Evolution in Action" Peter and Rosemary Grant, as well as evolutionary theorists Daniel C. Dennet and Richard Lewontin.

As Svante Pääbo's lecture demonstrated, the work of each of these speakers, from the University of Michigan or elsewhere, embodies a degree of cooperation, dedication and an accumulation of knowledge that is spectacular, given the relative youth of biological thought. Using the recent sequencing of the human and chimpanzee genomes, Pääbo was able, with the help of coworkers, to begin analyzing the genetic differences that distinguish human beings from their closest ancestors, chimpanzees.

Early decoding of human and chimpanzee DNA sequences—the molecular encyclopedias that contain blueprints for the building of any living organism—has substantiated the belief of biologists that chimpanzees are the closest relatives to humans. It has also allowed us to begin to examine the subtle molecular changes in our evolution that have led us down such a biologically unique path.

At first glance, we seem quite distinct from our closest relatives. Our bodies and behaviors, or "phenotype," which includes upright walking, naked skin and greater intelligence, seem to separate us quite obviously from the phenotype of chimpanzees. But our genetic code, or genotype, is so similar to that of chimpanzees as to frustrate attempts to find a genetic basis for human uniqueness. "How do we say what is uniquely human," Pääbo asked of the audience, "in a way that will allow us to find genetic correlates to these differences?" The increasingly sophisticated understanding of chimpanzee behavior, which includes elementary tool-making and some linguistic capacity, has blurred the line between their behavior and our own, making a more precise specification of phenotypic differences an important area of future research.

Pääbo and the Chimpanzee Sequencing and Analysis Consortium, of which he is a part, have attempted to address these similarities and differences in a series of recent publications. Comparative analyses of the entire chimpanzee and human genomes reveal a relatively low level of single-nucleotide differences between chimpanzees and humans. (A nucleotide is a "letter" in the DNA blueprint.) Only about 1.2 percent of our genomes, or 35 million "nucleotide substitutions," differ out of 3 billion base pairs. Such substitutions occur when one DNA nucleotide replaces another.

Single nucleotide differences can also result from "nucleotide deletions" or "insertions," whereby a letter is added or dropped from the genetic code at random. Such changes have also been relatively limited since the human and chimpanzee lineages diverged, and amount to about 1.5 percent of the DNA regularly used by our bodies.

By contrast, greater changes have occurred through duplications or deletions of entire segments of DNA. Conservative estimates conclude that between chimpanzees and humans, approximately 2.5 percent of heavily used genetic material has experienced segmental duplications or deletions within one species or the other, but not both.

Of course, researchers are not merely interested in overall molecular trends: specific genetic causes for human characteristics, such as cognitive and linguistic ability, are important subjects of inquiry. Pääbo mentioned "genome-wide" and "candidate gene" analyses as two basic scientific approaches used to identify the genetic correlate of differences between humans and other animals, including chimpanzees.

On a genome-wide level, geneticists can examine the extent to which genes, the long strands of DNA containing directions for the construction of the proteins used in the cell, are used in one species or another. Using microarray technology, geneticists have examined and compared the extent to which this genetic expression in a number of tissues differs between humans and chimpanzees. Interestingly, Pääbo said that the greatest differences were found to have arisen in the testicles, which play a major role in sexual reproduction, and in the brain. In the brain, the low genetic variation among humans suggests that our brains have been under recent, powerful selection for change, Pääbo said.

Searching for specific differences between individual genes may also yield telling results. The gene FOXP2, thought to be associated with fine motor control of vocal muscles, has undergone recent evolutionary change in the human lineage, and Pääbo stressed the possibility that such a gene might have influenced the emergence of human language in the last 150,000-200,000 years. New analysis indicates that the gene has undergone a "selective sweep," whereby a particular variant of the gene rapidly spread to the entirety of the modern human species. This is in general an indication that the variant was selected because of some beneficial trait it conferred.

Geneticist Jianzhi Zhang, who first published on FOXP2, spoke to the WSWS regarding the gene's evolution. "I think the two amino acid changes in human FOXP2 [since the divergence with the last common ancestor with the chimpanzee] may have played a key role in the emergence of human language or speech," he said. "But," he cautioned, "the evidence so far available is circumstantial, not direct. Certainly more studies are needed."

The work in analyzing the chimpanzee genome is ongoing, and no doubt will continue to produce fruitful findings in the coming years.

Svante Pääbo concluded his lecture by announcing that his continued study of DNA taken from Neanderthal bones may help shed light on their relationship to modern humans. If genes thought to be determinants of human ability and behavior are found in the bones of extinct human lineages, our conception of modern humanity might be broadened to include Neanderthals as well.

The University of Michigan's theme semester web site *contains useful information on evolutionary principles alongside a schedule of events for the upcoming months.*