

Breakthrough of the Year

Equipped with genome data and field observations of organisms from microbes to mammals, biologists made huge strides toward understanding the mechanisms by which living creatures evolve

Evolution in Action

The *big* breakthrough, of course, was the one Charles Darwin made a century and a half ago. By recognizing how natural selection shapes the diversity of life, he transformed how biologists view the world. But like all pivotal discoveries, Darwin's was a beginning. In the years since the 1859 publication of *The Origin of Species*, thousands

BREAKTHROUGH ONLINE

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of researchers have sketched life's transitions and explored aspects of evolution Darwin never knew. Today evolution is the foundation of all biology, so basic and all-pervasive that scientists sometimes take its importance for granted. At some level every discovery in biology and medicine rests on it, in much the same way that all terrestrial vertebrates can trace their ancestry back to the first bold fishes to explore land. Each year, researchers worldwide discover enough extraordinary findings tied to evolutionary thinking to fill a book many times as thick as all of Darwin's works put together. This year's volume might start with a proposed rearrangement of the microbes at the base of the tree of life and end with the discovery of 190-million-year-old dinosaur embryos.

Amid this outpouring of results, 2005 stands out as a banner year for uncovering the intricacies of how evolution actually proceeds. Concrete genome data allowed researchers to start pinning down the molecular modifications that drive evolutionary change in organisms from viruses to primates. Painstaking field observations shed new light on how populations diverge to form new species—the mystery of mysteries that baffled Darwin himself. Ironically, also this year some segments of American society fought to dilute the teaching of even the

basic facts of evolution. With all this in mind, *Science* has decided to put Darwin in the spotlight by saluting several dramatic discoveries, each of which reveals the laws of evolution in action.

All in the family

One of the most dramatic results came in September, when an international team published the genome of our closest relative, the chimpanzee. With the human genome already in hand, researchers could begin to line up chimp and human DNA and examine, one by one, the 40 million evolutionary events that separate them from us.

The genome data confirm our close kinship with chimps: We differ by only about 1% in the nucleotide bases that can be aligned between our two species, and the average protein differs by less than two amino acids. But a surprisingly large chunk

of noncoding material is either inserted or deleted in the chimp as compared to the human, bringing the total difference in DNA between our two species to about 4%.

Somewhere in this catalog of difference lies the genetic blueprint for the traits that make us human: sparse body hair, upright gait, the big and creative brain. We're a long way from pinpointing the genetic underpinnings of such traits, but researchers are already zeroing in on a few genes that may affect brain and behavior. This year, several groups published evidence that natural selection has recently favored a handful of uniquely human genes expressed in the brain, including those for endorphins and a sialic acid receptor, and genes involved in microcephaly.

The hunt for human genes favored by natural selection will be sped by newly published databases from both private and public teams, which catalog the genetic variability among living people. For example, this year an international team cataloged and arranged more than a million single-nucleotide polymorphisms from four populations into the human haplotype map, or HapMap. These genetic variations are the raw material of evolution and will help reveal recent human evolutionary history.

Probing how species split

2005 was also a standout year for researchers studying the emergence of new species, or speciation. A new species can form when populations of an existing species begin to adapt in different ways and eventually stop interbreeding. It's easy to see how that can happen when populations wind up on opposite sides of oceans or mountain ranges, for



Chimp champ. Clint, the chimpanzee whose genome sequence researchers published this year.

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