The brain's behind evolution's drive

The constantly changing earth puts pressure on all living species to evolve to take best advantage of their environment. But an additional factor — behavior — overshadows this external force in evolution of higher vertebrates, a biologist now proposes.

"The brain drives evolution," says Allan C. Wilson of the University of California at Berkeley. "Even in an environment that isn't changing, organisms with big brains find new ways of exploiting the environment," he told science writers this week at a meeting at the Cold Spring Harbor Laboratories in Cold Spring Harbor, New York. In human evolution, behavior may underlie 99 percent of the anatomical change, he says.

Wilson arrived at his hypothesis of "behavioral drive" from consideration of the rapid anatomical changes that have taken place in the evolution of humans and apes, and to a lesser extent in other mammals and birds, in contrast to lizards, frogs and salamanders. The rate of change in the DNA of all these animals is approximately the same.

The crucial difference between rapidly evolving mammals and birds and the more conservative reptiles and amphibians is the power of their brains, Wilson suggests. The brain is especially big, in relation to body weight, in humans, apes and songbirds, groups whose rates of anatomical evolution are particularly high, according to evidence Wilson, Joseph G. Kunkel and Jeff S. Wyles present in the July PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Number 14).

How can the brain drive evolution? Wilson proposes that an individual invents a behavior, which others then acquire by social, rather than genetic, means. For example, animals may observe and imitate others who perform a novel task. It is likely that some animals in a widespread population possess genetic mutations that make them more efficient than others in the new behavior. Thus the brain has provided a new set of selective pressures.

British songbirds who open bottles and drink the milk inside are an example of behavioral innovation and social transmission, Wilson says. A few of the birds, called tits, initiated the behavior and within decades most of Britain's million tits engaged in the practice.

In human evolution, Wilson points to the domestication of cattle and consequent milk consumption by adults, a behavior begun about 10,000 years ago in Northern European and some African populations. This habit may have produced selection pressure resulting in establishment in these populations of a gene for an enzyme that breaks down lactose (a sugar in milk) in the adult intestine.

Earlier views recognized that new behaviors produce selective pressures favoring complementary anatomical mutations. But Wilson says that there has not been an explicit hypothesis emphasizing the idea that nongenetic propagation of new skills in large populations will significantly accelerate anatomical evolution in vertebrates other than humans.

"If it was not explicitly formulated, it is implicit in work on cultural evolution," argues Stephen J. Gould of Harvard University. He says interaction of biological and cultural evolution is a familiar theme in anthropology.

"People have sent up trial balloons on this subject for many years," says Clayton E. Ray of the Smithsonian's Museum of Natural History in Washington. "The problem is, how do you get a handle on demonstrating it? Rates of anatomical evolution are very difficult to quantify."

Wilson and colleagues measure rates of anatomical change by comparing eight traits, such as head width and backbone length, originally chosen to discriminate among frogs. They find a composite morphological, or anatomical, distance between groups of animals that correlates with their distance in taxonomic classification. There is on the average the least morphological distance between members of a subspecies, and the distance increases with larger groupings going up to orders.

"This is a very simple method for evaluating anatomical differences," says Luigi L. Cavalli-Sforza of Stanford University in Stanford, Calif. "I am a little worried about what it leaves out, but as a first approximation it's not bad."

Wilson's hypothesis of behavioral selection applied to birds and mammals seems both reasonable and novel, Cavalli-Sforza says. "It is not easy to eliminate other hypotheses, but it's interesting as an idea."

—*J.A. Miller*

Who's the ancestral mother of modern man?

Biologists, studying DNA differences in individuals around the world, have now traced human lineage back to a common female ancestor. But they don't agree on who she was and when she lived. "We all go back to one mother living 350,000 years ago," says Allan C. Wilson of the University of California at Berkeley. Because this date is believed to fall in the transition period from *Homo erectus* to the current *Homo sapien* form, "she [the common ancestress] preceded our species," Wilson told science writers this week at a meeting at Cold Spring Harbor (N.Y.) Laboratory.

But another group of scientists using similar methods, also unpublished, has evidence that the shared predecessor of modern man was more recent; living only 50,000 to 100,000 years ago. This date, calculated by his research team, is more in agreement with those dates derived from other genetic approaches and fossil examination, Luigi L. Cavalli-Sforza of Stanford University said in a telephone interview.

The DNA samples examined by Wilson and by Cavalli-Sforza were taken from mitochondria, the power-producing structures of cells. These structures in the cell cytoplasm contain 35 genes that are passed directly from mother to offspring. Because sperm contribute no mitochondria to an embryo, there is no mixing of maternal and paternal DNA. The only changes in mitochondrial DNA are mutations that arise spontaneously with time, and thus should be easy to evaluate. These mutations alter about 2 percent of the mitochondrial DNA in a million years, according to experiments on rodents, horses and monkeys, Wilson says.

Wilson found 110 variations in the mitochondrial DNA of 112 individuals in a worldwide survey. (Last year he and colleagues found no variation among common strains of laboratory mice thought to be unrelated, and thus concluded these mice share a recent female ancestor [SN: 1/30/82, p. 71]). He constructed a human pedigree by finding the simplest pattern of changes to explain the differences observed. Exactly why Wilson's date for the common ancestress differs so greatly from Cavalli-Sforza's is unclear.

A somewhat surprising characteristic of Wilson's pedigree of the human race is that groups of closely related mitochondrial DNA include samples taken from individuals with different racial heritages. And individuals originating on a single continent, even one as remote as Australia, appear to have been founded by two or more mothers, not closely related. Some Australian aborigines, by this analysis, are more closely related to some Asians and Africans than to the other Australian aborigines sampled. Wilson comments on the pedigree, "You don't see race staring at you. There is racial intermingling mitochondrially."

To substantiate the accuracy of such an approach to evolution, scientists might examine some population known to derive from a single woman, but Wilson says it is difficult to find such a group. He and colleagues plan next to concentrate on people of European descent, especially the Jewish population where there are extensive historical records.

Meanwhile, examination of mitochondrial DNA is regarded generally as an intriguing but uncertain approach to human evolution. T. Dale Stewart of the Smithsonian's Museum of Natural History comments, "It's a pretty tricky business at this point." And Cavalli-Sforza says, "This method is a little more chancy than others. Mitochondria may have surprises in store."

—*J.A. Miller*