ScienceNews
MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC
http://www.sciencenews.org/view/generic/id/71318

In evolution, last really can be first

Bacteria experiments show how underdogs can end up on top

By Tina Hesman Saey
Web edition : Thursday, March 17th, 2011

In an evolutionary equivalent of *Revenge of the Nerds*, bacteria that once seemed destined for loserdom can eventually use their hidden potential to overtake the competition.

Researchers led by Richard Lenski of Michigan State University in East Lansing have been watching *E. coli* bacteria evolve since 1988 (over more than 50,000 generations) and are doing experiments that replay that evolution to settle a debate about whether natural selection produces the same outcome every time or if surprises can happen along the way (*SN: 1/31/09, p. 26*). The experiments are also aimed at understanding the genetic mechanisms that drive evolution.

In a new study published in the March 18 *Science*, Lenski and his colleagues address a new concept in evolutionary biology. The issue is whether some changes in DNA give organisms differing evolutionary potential, or evolvability.

The rise of the nerds seems to indicate that evolvability is a reality. A mutation that gave some bacteria an early advantage turned out to be their downfall, the researchers discovered. But the nerd bacteria carried a different mutation that interacted with later genetic changes, increasing the microbes' evolutionary fitness.

The findings are some of the first experimental evidence for evolvability, says Massimo Pigliucci, an evolutionary biologist and philosopher of science at the City University of New York. Theorists have devised many models to show that changes in DNA ought to interact with each other to shape a species' evolution and that some mutations allow for greater adaptability over time. But until now, there has been little hard data to support the claims. "There's not many examples out there, but this one is a spectacular one," Pigliucci says. "This is an elegant demonstration of evolvability and its molecular underpinnings."

Eventual winners in this laboratory experiment didn't start out that way. In fact, the population of nerdly bacteria that eventually evolved into top dogs was at one point in danger of extinction. Those bacteria carried a mutation in the *topA* gene, which makes a protein that winds up a bacterium's circular chromosome like a twisted rubber band. Winding the DNA can change how easy it is to turn genes on and off.

Strangely enough, the eventual winners' rivals — the eventual losers

— also carried a mutation in the *topA* gene, but one that alters the next link down in the chain of amino acids that makes up the protein. In the first 500 generations of the experiment the eventual losers were riding high. They dominated laboratory flasks early on because their version of *topA* helped the bacteria make better use of limited nutrients than the competition.

But a few hundred generations later the situation was reversed. By generation 883, the eventual winners were growing 2.1 percent faster than the eventual losers, an indication of fitness. And by generation 1,500, the eventual losers had gone extinct in the flasks.

To find out how the eventual losers went from hero to zero, the researchers replayed the evolution experiment over and over using frozen samples taken from generation 500. In general, the eventual winners managed to overtake the eventual losers, but not every time. That finding indicates that chance is at play in evolution, Pigliucci says.

The researchers looked more closely at the DNA of the eventual losers and winners and found that the eventual winners' version of *topA* combined with changes in other genes, such as one called *spoT*, to increase fitness. But although the eventual losers' *topA* gave them a huge advantage early in the game, it didn't interact as favorably with later mutations, leading the eventual losers down an evolutionary cul-de-sac, if not exactly a dead end.

"Evolution is a mindless process. It has no foresight," says Jeffrey Barrick, an evolutionary genomicist at the University of Texas at Austin and a coauthor of the study. "So it's not immune from making these short-term gains, but losing in the end."

SUGGESTED READING :

T.H. Saey. Molecular Evolution. Science News, Vol. 175, January 31, 2009, p. 26. Available online:

P. Barry. Replaying evolution. Science News online, June 2, 2008. Available online:_

CITATIONS & REFERENCES :

R.J. Woods, et al. Second-order selection for evolvability in a large Escherichia coli population. Science, Vol. 331, March 18, 2011, p. 1433 . doi: 10.1126/science.1198914