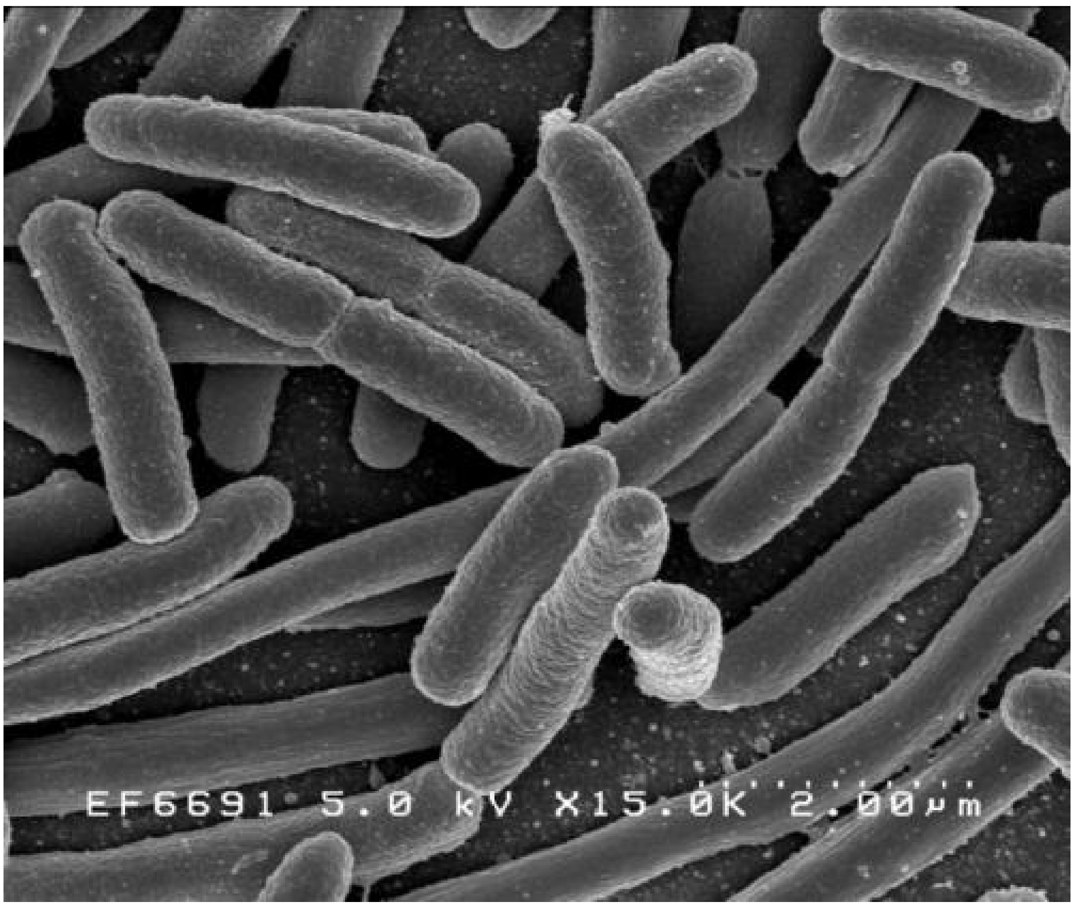
PHYS.ORG

Long term study shows bacteria continue to show sustained fitness in unchanging environment

December 16 2015, by Bob Yirka



Escherichia coli. Credit: Rocky Mountain Laboratories, NIAID, NIH

(Phys.org)—A team of researchers working on Michigan State

University's Long-Term Evolution Experiment (LTEE) has found that even after nearly thirty years living in an unchanging environment, generations of *Escherichia coli* continue to show improvements in fitness. In their paper published in *Proceedings of the Royal Society B*, the team describes the nature of their long term experiment and their surprise at the continual evolution of the simple bacteria.

One of the foundations of evolution is that organisms change due to challenges they face in their environment, as new challenges arise, those adaptations that best suit the situation are favored, leading to an improvement in fitness. Some prior research has suggested that such adaptations would follow a hyperbolic curve—evidence from this long term effort, suggests that a power-law curve might be more accurate, at least in one such case.

The LTEE began in 1988 when a team of researchers at the university, led by Richard Lenski, took a single sample of *e. coli,* separated it into 12 separate identical flasks held in identical environments and then watched and to see how they might evolve over the years. Periodically, samples have been removed and studied with some being put into deep freeze for later study. Over the past 27 years, the bacteria has produced thousands of new generations—one reached 50,000—offering the researchers a unique opportunity to see evolution in action.

In comparing the current generations with the thousands that came before them, the team acknowledged that they fully expected that increases in fitness would level off, and perhaps stop altogether because of the unchanging environment in which they lived—there were no new challenges and all of the samples lived almost exactly the same way. The team did note that there were differences in degrees of sustained fitness among samples in the flasks, but they were minor. They also noticed that while the increases in fitness had slowed over the years, it did not appear to be on a course that would show it stopping at any point. Thus, they suggest it appears to follow more of a power-law curve than anything else. For that reason, the researchers have advised that the experiment continue, allowing future researchers to see if the bacteria will offer any other surprises.

More information: Richard E. Lenski et al. Sustained fitness gains and variability in fitness trajectories in the long-term evolution experiment with , *Proceedings of the Royal Society B: Biological Sciences* (2015). DOI: 10.1098/rspb.2015.2292

Abstract
Many populations live in environments subject to frequent biotic and abiotic changes. Nonetheless, it is interesting to ask whether an evolving population's mean fitness can increase indefinitely, and potentially without any limit, even in a constant environment. A recent study showed that fitness trajectories of Escherichia coli populations over 50 000 generations were better described by a power-law model than by a hyperbolic model. According to the power-law model, the rate of fitness gain declines over time but fitness has no upper limit, whereas the hyperbolic model implies a hard limit. Here, we examine whether the previously estimated power-law model predicts the fitness trajectory for an additional 10 000 generations. To that end, we conducted more than 1100 new competitive fitness assays. Consistent with the previous study, the power-law model fits the new data better than the hyperbolic model. We also analysed the variability in fitness among populations, finding subtle, but significant, heterogeneity in mean fitness. Some, but not all, of this variation reflects differences in mutation rate that evolved over time. Taken together, our results imply that both adaptation and divergence can continue indefinitely—or at least for a long time—even in a constant environment.