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News

Slow evolvers win in the end

In bacterial populations, speed kills.

Joseph Milton

Slowly evolving bacteria eventually outcompete their quicker colleagues.

Ashway / Alamy

In Aesop's fable about the tortoise's victory over the hare, a slow, steady approach trumps a fast and impulsive one. And when it comes to evolution — for bacteria, at any rate — a leisurely pace may also be the best strategy for long-term survival.

Research carried out in Richard Lenski's lab at Michigan State University in East Lansing, and published today in *Science* [1], shows that rapidly evolving 'hare' bacteria were eventually wiped out by their more sluggish rivals.

The reason was that the 'tortoise' bacteria had a higher 'evolvability', or a greater potential to take advantage of future beneficial mutations, than their speedier competitors, despite a tendency to accumulate such mutations at a slower rate.

Long haul

"It all depends how long the race is," says Tim Cooper, an evolutionary biologist at the University of Houston in Texas, a co-author on the study. "Tortoises don't win over 100 metres but they might win a marathon."

Cooper and his colleagues looked at two *Escherichia coli* clone lineages, sampled after 500, 1,000 and 1,500 generations of evolution. They came from a long-term bacterial evolution experiment running in the lab.

By looking for the presence of five beneficial mutations, the researchers found that 'hare' bacteria had more advantageous genetic changes than 'tortoises' after 500 generations, suggesting they were more likely to go on to successfully survive and reproduce, and to eventually wipe out their competitors altogether.

But looking at the later generations, the team found that 'tortoises' had overtaken 'hares' and gone on to dominate the population.

Importantly, by the 500th generation both bacterial lineages had acquired beneficial mutations in a gene involved in coiling up DNA to fit into cell nuclei called *topA*, but these mutations differed slightly between the two.

The *E. coli* were then allowed to evolve for a further 883 generations, and the team looked to see which mutations had accumulated by that point. This time they found a mutation in a gene called *spoT*, conferring an advantage to the 'tortoises' that was absent in the 'hares'.

But the previous *topA* mutation in the 'hares' had rendered the potentially beneficial *spoT* mutation useless, because of interactions between genes.

Late domination

The advantage conferred by *spoT* meant the 'tortoises' were now fitter than the 'hares', explaining why they went on to dominate the population.

"It's exciting because it was generally thought that an increased mutation rate meant you were more evolvable," says Daniel Rozen, an evolutionary biologist at the University of Manchester, UK. "This shows genetic background is another really important aspect of evolvability."

However, Ed Feil, an evolutionary biologist at the University of Bath, UK, is more sceptical. "I'm not sure they've shown selection for evolvability," he says, adding that he thinks the tortoises may have been fitter all along. "It's hard to explain why the 'hares' are fitter at 500 generations — the *topA* mutation actually confers higher fitness to the 'tortoises', and that's one of just two mutations we know about."

But Cooper is confident the fitness calculations are accurate, and says there are other mutations in play by the 500-generation point. "The 'hares' have at least four mutations," he says, "It's the whole package that makes them fitter, not just *topA*."

The next step, says Cooper, is to look more closely at exactly why the 'hare' *topA* mutation interferes with *spoT*, and to investigate practical applications of their findings. "In an industrial setting we could encourage evolvability to get bacteria that reach higher end-points," he says, "and in a clinical setting we could discourage it so we end up with bacteria that are easier to treat."

References

1. Woods, R. *et al. Science* **331,** 1433-1436 (2011).

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