How did birds get their wings? Bacteria may provide a clue, say scientists

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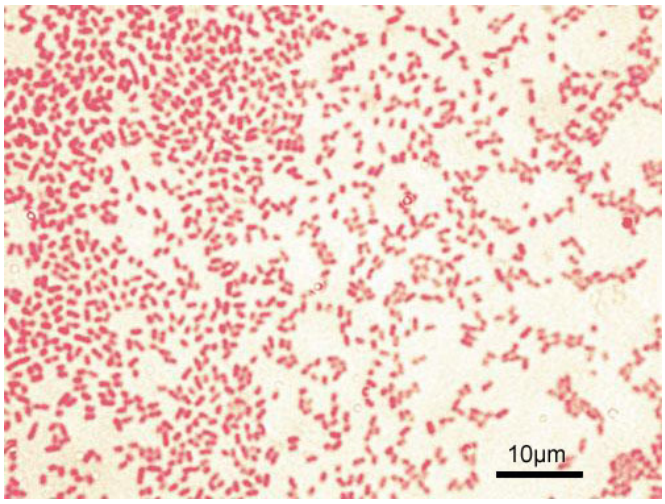

Gram-stained P. aeruginosa bacteria (pink-red rods)
Credit: Wikipedia

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The evolution of major novel traits - characteristics such as wings, flowers, horns or limbs - has long been known to play a key role in allowing organisms to exploit new opportunities in their surroundings.

What's still up for debate, though, is how these important augmentations come about from a genetic point of view.

New research from an international team of evolutionary biologists, led by the University of Oxford, has used bacteria to show that acquiring duplicate copies of genes can provide a 'template' allowing organisms to develop new attributes from redundant copies of existing genes.

Gene duplication has been proposed as playing a key role in innovation since the 1970s, but these findings add important empirical evidence to support this theory.

The study, which involved collaboration with researchers from the University of Zurich, is published in the journal *PLOS Genetics*.

Professor Craig MacLean, a Wellcome Trust Research Fellow in the Department of Zoology at Oxford University, said: 'The appearance of novel traits, such as wings and flowers, has played a key role in the evolution of biological diversity. However, it is usually difficult to understand the actual genetic changes that drive these evolutionary innovations.

'We have taken advantage of a simple bacterial model system, where bacteria evolve the ability to eat new food sources, to overcome this obstacle.'

The researchers allowed 380 populations of *Pseudomonas aeruginosa* bacteria to evolve novel metabolic traits such as the ability to degrade new sugars. This gave the researchers the opportunity to witness evolution happening in real-time.

After 30 days of evolution, they sequenced the genomes of bacteria that had evolved novel metabolic traits. They found that mutations mainly affected genes involved in transcription and metabolism, and that novelty tended to evolve through mutations in pre-existing duplicated genes in the P. aeruginosa genome.

Duplication drives novelty because genetic redundancy provided by duplication allows bacteria to evolve new metabolic functions without compromising existing functions. These findings suggest that past duplication events might be important for future innovations.

Professor MacLean added: 'The key insight of our study is that having redundant copies of genes provides bacteria with a template for evolving new

traits without sacrificing existing traits. In other words, redundant genes allow bacteria to have their cake and eat it.

'In higher organisms like animals and plants, duplicate genes arise from spontaneous duplication of existing genes. In contrast, bacteria tend to acquire duplicate genes from neighbouring bacterial cells through horizontal gene transfer, which is the bacterial equivalent of sex.

'These findings provide important empirical evidence to support the role of gene duplication in evolutionary innovation, and they suggest that it may be possible to predict the ability of pathogenic bacteria to evolve clinically important traits, such as virulence and antibiotic resistance.'

More information: Macarena Toll-Riera et al, The Genomic Basis of Evolutionary Innovation in Pseudomonas aeruginosa, *PLOS Genetics* (2016). DOI: 10.1371/journal.pgen.1006005

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