# Survival of the flattest and its relevance for conservation biology

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**Introduction**

Loss of genetic diversity through inbreeding is well known for small populations, but our recent theoretical findings (Aston et al. 2013) suggest that there may be another genetic threat to small populations – from mutation itself. In large populations, damaging mutations are readily removed by selection – only at unrealistically high mutation rates would mutation swamp an existing fit allele. At such high mutation rates, a high narrow peak in the fitness landscape may be lost in favour of a lower broader adaptive peak – so called 'survival of the flattest' (Wilke et al. 2001). It seems that the mutation rate above which this can happen drops drastically at low population sizes (Aston et al. 2013). This brings it into the range of biologically realistic mutation rates, meaning that survival of the flattest could be happening in threatened species. i.e. Small populations could be cryptically losing fit alleles.

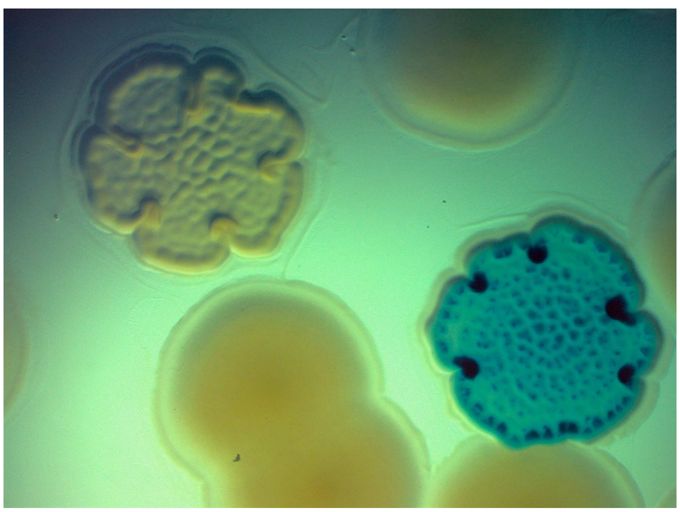

**Figure** Experimentally evolved colonies of the bacterium *Pseudomonas fluorescens* (wrinkled colonies, one marked blue) grow alongside their ancestors (smooth colonies). These differ by only a single nucleotide change that gives them access to an, environmentally dependent, adaptive peak. We don't yet know whether these peaks will be maintained at low population sizes © Sam Farrell, Knight lab.

To test this hypothesis requires experiments where we can manipulate fitness landscapes, population sizes and monitor evolution experimentally. With microbes we can do this reproducibly in the lab (). This project will take an experimental approach to ask whether real biological fitness landscapes have the features that will enable survival of the flattest can occur and whether it is a real issue in practice. This will complement our on-going experimental approaches to mutation rates themselves (Krašovec et al. 2014).

**Project Summary**

The student will initially use experimental evolution to test whether the combination of high sharp peaks and low broad peaks required for survival of the flattest do in fact occur in realised fitness landscapes. They will go on to test whether this does in fact occur, using experimental manipulations, phenotypic tests and whole genome sequence analysis. Several appropriate microbial systems, both eukaryotic and bacterial, are available in the Knight and Delneri laboratories. The ideal student will have a background in evolutionary biology and genetics, be willing to learn a range of experimental and analytical techniques and to interact with the theoretical developments in building a cutting edge project. Experience of microbiology and statistical/computing skills plus an interest in conservation biology would all be advantageous

**References**


Aston, E. *et al.* (2013) **Critical Mutation Rate Has an Exponential Dependence on Population Size in Haploid and Diploid Populations**. *PLoS ONE*, 8, e83438.
Buckling, A. *et al.* (2009) **The Beagle in a bottle**. *Nature*, 457, 824-829.
Krašovec, R. *et al.* (2014) **Mutation rate plasticity in rifampicin resistance depends on *Escherichia coli* cell–cell interactions**. *Nature Communications*, 5:3742
Wilke, C.O. *et al.* (2001) **Evolution of digital organisms at high mutation rates leads to survival of the flattest. *Nature*, 412, 331-333.**