

SCIENCE

How population size shapes evolution patterns in *E. coli*

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Large populations tend to evolve into exercising fitness trade-offs

Studying cultures of *E. coli* bacteria, a group of evolutionary biologists from Indian Institute of Science Education and Research (IISER), Pune, has found that the population size determines the kind of fitness trade-offs the microbes adopt. Fitness trade-off may be understood in the following manner: Organisms do not have the capacity to maximise all their functions at the same time. Often when they enhance one function, another function suffers, or when they adapt to survive well in one environment, they cannot survive or reproduce well in another environments. This is called a fitness trade-off. This concept has been used by evolutionary biologists to explain why species prefer one environment to another.

There are several ways in which the concept of fitness trade-off originates. Evolution causes some organisms to be generalists, by which it is meant that they can survive in different environments, and basically they will have an tolerable level of fitness in all environments. The other option is they evolve into specialists, where the organism will have a high degree of fitness in a particular environment while having low fitness in other environments. An example of this is in the context of antibiotic resistance – generalists tolerate a wide range of distinct antibiotics (for example, multidrug resistant bacteria). On the other hand, specialist bacteria have to show a fitness trade-off. They resist one antibiotic (for instance, rifampicin) but become susceptible to another (for instance, tetracycline). From the example itself, it is clear that understanding how evolution brings about difference between specialists and generalists, for instance, is very important.

The study shows that large populations tend to evolve into specialists, exercising fitness trade-offs, whereas small populations evolve into generalists.

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Environmental changes

“Ours is the first study to demonstrate a relationship between population size and fitness trade-offs and the results are important in understanding the population genetics of ecological specialization and vulnerability to environmental changes,” says Sutirth Dey of IISER Pune’s Department of Biological Sciences and the corresponding author of the paper published in the journal *Heredity*.

The study experimentally affirms the link between population size and evolution of fitness trade-offs. Apart from this there are practical implications. An example is described by Prof. Dey: “Owing to their higher extent of specialisation, larger populations can become more vulnerable to sudden changes in the environment.”

If the environment abruptly shifts between two states that show fitness trade-offs with each other, then populations with a history of evolution at larger numbers would be at a

antimicrobial resistance are expected to check the spread of resistant microbes if

antimicrobials are removed abruptly from the environments. Moreover, pathogens are also expected to experience fitness trade-offs when they migrate across different hosts," explains Prof. Dey.

The group next plans to study the response in fluctuating environments. "We are now studying more complex links between population size and trade-offs, combining fitness data with population genomics, in both constant and fluctuating environments," says Prof. Dey.

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