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Experimental Ignition of Evolution on Fitness Landscapes

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Microbiologists are starting to revise the single cell centered view of evolution to a multicellular view, considering it at entire population scale, and even whole ecosystem. Indeed, as Darwin recognized on the Galapagos Island, evolution of a community of bacteria is strongly influenced by the global spatial stress and depends of the neighboring communities. This collective dynamical process can be studied using micro-nanofabricated landscape to create stressed conditions. Our microfluidic device consists of interconnected chambers in 2D hexagonal geometries. The design of our ecology enables to combine gradients of antibiotic and nutrient, thus generating population gradient and motion of bacteria across them. We study here evolution of resistance to the antibiotic ciprofloxacin in highly-stressed conditions. Non-random mutations are induced in the collectivity to develop resistance to the antibiotic. Channels between microhabitats allow motion of bacteria between different islands, and once evolution is ignited in a local metapopulation, a very fast spread through the collectivity happens. In such environments, evolution is observed in typical time scales of few hours. Knowing the complexity of natural world, we believe that our approach provide a model to understand the rapid emergence of resistance to antibiotic and its spread in the entire population.