Technical tests of biodiversity: Physicists play with the genetics of populations

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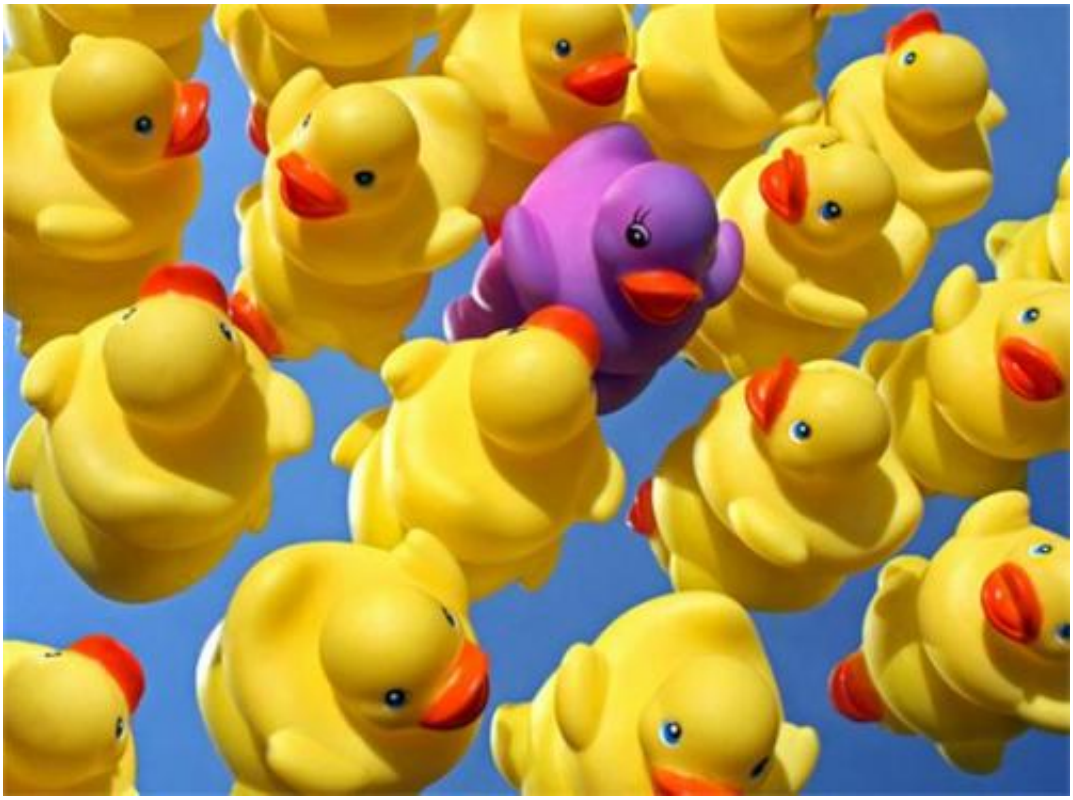

A team of physicists from SISSA and the Polytechnic University of Turin has developed and analysed a model that simulates the effect of migration on the genetic biodiversity of populations, and discovered that the effect is all but trivial.

What happens when physicists play (using mathematical instruments) with the genetics of populations? They may discover unexpected connections between migration and biodiversity, for example, as recently done by a group of researchers from the International School for Advanced Studies (SISSA) in Trieste and the Polytechnic University in Turin in a study published in the journal *Physical Review Letters*.

The effect of migration on biodiversity (intended as the coexistence of different genetic traits) is an open question: does migration increase or decrease the genetic variability of populations? Or is the relationship more complex than that?

Imagine a population that lives subdivided among several "islands" separated by stretches of sea. On each island live two groups, A and B, which differ in one genetic trait, for example the individuals in group A have blond hair and those in group B have brown hair. If there is no migration between the two islands the biodiversity on each can only vary based on "stochastic" dynamics (i.e., with a random component), related to the progression of generations. However, if a certain degree of mobility is ensured within the group of islands, that is, if some individuals travel and migrate, then the biodiversity comes out of its "isolation" and is influenced by this migratory phenomenon.

The researchers reproduced this situation in a mathematical model and monitored changes in biodiversity with varying rates of migration, exploiting certain analogies with physical phenomena of a totally different nature.

"We started with simple 'pen and paper' calculations which took into account the known 'rules' of population genetics. However, as we proceeded with our work, the complexity of the model forced us to use a computer simulation of the system" explains Pierangelo Lombardo, a SISSA PhD student and first author of the paper. "In actual fact, we

expected a different result from what we obtained. Even looking at the data reported in previous studies, the most commonly held view is that the higher the migration rate the lower the biodiversity."

"Our model, on the other hand, provided a very different result," says Lombardo. "The function that relates the two variables is a curve, where with higher migration rates biodiversity can be seen to reach a minimum before starting to grow again."

"This means that if we want to increase a population's biodiversity, under the conditions described above, we could increase the migration rates above the value that makes biodiversity fall to a minimum" explains Andrea Gambassi, the SISSA professor who coordinated the study. "Ours is clearly a simplified model, but it does take into account the essential mechanisms underlying the genetics of migrations."

"Our findings may prove useful in guiding field research," concludes Gambassi. "Our model can in fact be used to guide the planning of experiments aiming to monitor the relationship between migration and biodiversity. And should experimental observations confirm our model, then we could further refine it and use it to make predictions and control the behaviour of simple populations, for example, colonies of bacteria."

More information: "Nonmonotonic Effects of Migration in Subdivided Populations." Pierangelo Lombardo, Andrea Gambassi, and Luca Dall'Asta
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