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Chicken study reveals that environmental factors, not just chance, could drive species evolution

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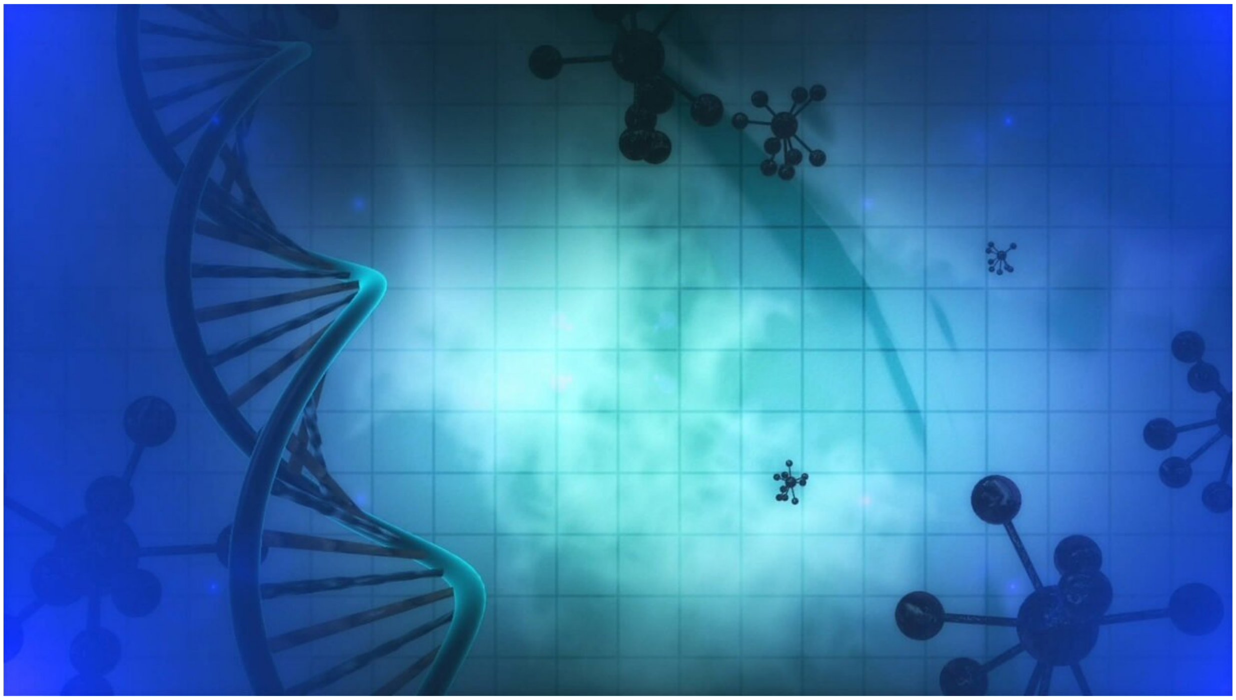

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In the version of evolutionary theory most of us are familiar with, randomly occurring variation in traits, caused by mutations in our DNA, can be fixed in a population through natural selection. However, writing in *Epigenetics* journal, a team of Swedish researchers from Linköping

University suggests that mutations that can be caused by environmental changes, not just random chance, might be responsible for species diversity.

Until quite recently, it was assumed that DNA mutations causing new gene variations occurred more or less randomly. While random mutations do occur, recent research has shown that genes can be altered by environmental influences too. According to a study published in *Epigenetics* journal, a particular type of mutation, linked to epigenetic changes, has, over time, led to new animal breeds—and could be responsible for whole new species.

Genetic mutation leads to variation

DNA is made up of a long sequence of four chemicals (bases), represented by the letters A, T, C, and G. The order of this 'genetic code' determines the traits that define species and makes organisms individual from each other.

Mutations in the genetic composition can cause variations in genes. In humans, this can lead to—for example—different hair or eye colours, and even genetic diseases.

Mutation is not always random

Mutations can occur more often at certain places in the genome than others, as explained by Dr. Carlos Guerrero-Bosagna, Assistant Professor at Linköping University and last author of the *Epigenetics* study.

"A "CpG' site is where you get a C base and a G base next to each other on a strand of DNA. These sites are much more susceptible to epigenetic methylation than other two-base sequences," he said.

Epigenetic modifications, such as DNA methylation, do not mutate genes, but they may affect gene activity; for example, how proteins interact with DNA to switch a gene on or off. They can also occur in response to environmental changes. In a plant study, for example, epigenetic modifications were found to be responsible for delaying flowering during the cold winter months, until spring, when temperatures are more favourable.

"At a CpG site, a methylated "C' is only one chemical reaction away from becoming a "T'—a different base entirely. So, while environmentally induced epigenetic modifications do not cause mutations per se, the chance of a permanent C-to-T mutation is much greater at CpG sites."

Such 'single nucleotide polymorphisms," or SNPs for short, can change the function of a gene or even lead to genetic diseases. The so-called "breast cancer gene" BRCA1, for example, is linked to mutation at a CpG site.

But are environmentally driven CpG-site mutations responsible for evolution?

According to this study, that's entirely plausible.

"That's why we used chickens as a model for our study," says Dr. Guerrero-Bosagna.

The many varieties of domesticated chicken existing today have mostly been bred in a relatively short period of time from a common ancestor: the Red Jungle Fowl, which still exists in parts of Asia today.

"By analyzing the mutation dynamics of CpG sites in the genomes of Red Jungle Fowl and several domesticated chicken varieties, we found that CpG-related mutations have played an important role in diversifying the chicken genome. Furthermore, we found that the further away from the Red Jungle Fowl a chicken breed is—evolutionarily speaking—the more CpG-related genetic variation they have."

Dr. Fábio Pértille, a postdoctoral researcher in the lab, added: "A strength of our study is that we used a combination of techniques to examine both the genomic composition and DNA methylation in the same samples."

The results of the study strongly suggest that the increased frequency of mutation occurring at CpG sites—potentially driven by increased environmental epigenetic activity—leads to permanent, heritable changes in the genome. Over time, this is likely to have made a significant contribution to species diversification.

More information: Pértille F et al. Mutation dynamics of CpG dinucleotides during a recent event of vertebrate diversification. *Epigenetics*. 2019 Jul;14(7):685-707.

Provided by Linköping University

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