

Can non-genetic heredity be important for Evolution?

Etienne Rajon

UMR CNRS 5558 – LBBE "Biométrie et Biologie Évolutive"

UCB Lyon 1 - Bât. Grégor Mendel

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69622 VILLEURBANNE cedex

One of the main characteristic of non-genetic inheritance is its instability relative to genetic inheritance – non-genetic media generally “mutate” more frequently than DNA. Such high mutation rates should generally enhance phenotypic Evolution, but only insofar as non-genetic mutations contribute significantly to the phenotype. Because the magnitude of non-genetic phenotypic contributions may itself evolve, natural selection could set boundaries to the adaptive potential of non-genetic inheritance media due to their higher mutability. I will present theoretical results relying on a very simple and general model where the genetic and epigenetic contributions to a non-neutral phenotype are controlled by an epistatic modifier locus, which evolves under the combined effects of drift and selection. A pure genetic control evolves when the environment is stable, provided that the population is large, such that the phenotype becomes robust to frequent epimutations. When the environment fluctuates, however, selection on the modifier locus also fluctuates and can overall produce a large non-genetic contribution to the phenotype, especially when the epimutation rate matches the rate of environmental variation. One important and unexpected result is that selection on the modifier locus is generally insensitive to recombination, contrary to modifiers of mutation rates. These results suggest that unstable inheritance media might significantly contribute to fitness variation of traits subject to highly variable selective pressures, but little to traits responding to scarcely variable aspects of the environment. I will then conclude that this study is far from fully addressing the question asked, especially because it considers that genetic and epigenetic mutations navigate in similar phenotypic spaces.