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LONG-TERM EPIGENETIC INHERITANCE AND PHENOTYPIC DIVERSITY IN NATURAL POPULATIONS

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Genetic variation is regarded as a prerequisite for evolution. Theoretical models suggest epigenetic information inherited independently of DNA sequence can also enable evolution. However, whether epigenetic inheritance mediates phenotypic evolution in natural populations is unknown, in part because the timescales over which epigenetic inheritance can operate remain mysterious. I will present recent results that show epigenetic fluctuations create DNA methylation variation in gene bodies of Arabidopsis thaliana on thousand-year timescales. We also find that natural epigenetic DNA methylation variation in gene bodies regulates genes expression, and thereby influences the natural variation of complex traits in Arabidopsis. Notably, the effects of methylation variation on phenotypic diversity and gene expression variance are comparable with those of DNA sequence polymorphism. We also identify methylation epialleles in numerous genes associated with environmental conditions in native habitats, suggesting that intragenic methylation facilitates adaptation to fluctuating environments. Our results demonstrate that methylation variation fundamentally shapes phenotypic diversity in natural populations and provides an epigenetic basis for adaptive Darwinian evolution independent of genetic polymorphism.