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# Journal Club

GENETIC VARIATION

## VAVILOV'S LAW AND PHENOTYPES ACROSS SPECIES

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In 1922, the Russian geneticist and plant biologist Nikolai Vavilov published a seminal paper highlighting his interests in understanding species diversity and his practical aim of helping agricultural progress. This publication contained two key ideas — the importance of studying intraspecific phenotypic variation and a new law of genetics — that would provide key evolutionary insights and later help guide molecular genetic investigations.

His first insight was understanding that the study of biological diversity needed to transcend traditional taxonomic species and had to encompass phenotypic variation observed within species themselves. The centrality of the study of population variation was a hallmark of the neo-Darwinian synthesis in the coming decades, and provided the basis for his goal of collecting traditional varieties of crops and their wild relatives for use in genetic studies and plant improvement.

The second insight was the law of homologous series in variation, which stated that if one species displayed phenotypic variation in a particular trait, the same variation would be observed in related species (and possibly even between remote taxa). Vavilov's law provided an organizing basis for identifying different varieties within a species: if species 1 had varieties with phenotypes A and B, and species 2 only presented varieties with phenotype A, then his law predicted there must exist in the latter species a heretofore unknown variety with phenotype B. Vavilov's insight was similar in spirit to the periodic law proposed by fellow Russian scientist Dmitri Mendeleev, which helped guide chemists in identifying undiscovered elements. Vavilov's law also suggests that conservation of the genetic basis for homologous traits across species, as well as similarities in selective forces, may underlie parallel and/or convergent evolution of traits between species.

The impact of these ideas reverberates to this day. Although collecting plant varieties for crop improvement predated Vavilov, he was the one scientist to set the ambitious goal of developing large-scale global crop seed collections. This vision led to its ultimate fruition in the Global Seed Vault, inaugurated in Svalbard, Norway in 2008, with its collection of >1 million seeds from all major crop species, as humanity's backup collection of crop diversity.

Modern genetic studies have since provided the molecular basis for Vavilov's law. For example, fruit colours are remarkably similar across species, with multiple species having both yellow/green or red/purple fruit; it has since been established that mutations in homologous *myb*-like transcription factors underlie this polymorphism. Similarly, animal coloration polymorphisms have been attributed to variation at the *MC1R* locus. Indeed, identification of genes has been partly facilitated by homologous functions across species, which in many cases yield similar phenotypes across disparate taxa.

In its time, Vavilov's law was hailed as a fundamental genetic law on par with those of Mendel. Over the years it has been largely forgotten, remembered only by those studying crop genetics, who continue to appreciate Vavilov's impact on the field. Today, there is an increased interest in this law, spurred by advances in molecular genetics and genomics that provide greater insight into the nature of homologous variation, and what it can tell us about evolutionary change.

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**Competing interests**
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**ORIGINAL ARTICLE** Vavilov, N. I. The law of homologous series in variation. *J. Genetics* **12**, 48–89 (1922)
**RELATED ARTICLE** Purugganan, M. D. Evolutionary insights into the nature of plant domestication. *Curr. Biol.* **29**, R705–R714 (2019)