Abstract. This essay examines the origin(s) of genotype–environment interaction, or \( G \times E \). “Origin(s)” and not “the origin” because the thesis is that there were actually two distinct concepts of \( G \times E \) at this beginning: a biometric concept, or \( G \times E_B \), and a developmental concept, or \( G \times E_D \). R. A. Fisher, one of the founders of population genetics and the creator of the statistical analysis of variance, introduced the biometric concept as he attempted to resolve one of the main problems in the biometric tradition of biology – partitioning the relative contributions of nature and nurture responsible for variation in a population. Lancelot Hogben, an experimental embryologist and also a statistician, introduced the developmental concept as he attempted to resolve one of the main problems in the developmental tradition of biology – determining the role that developmental relationships between genotype and environment played in the generation of variation. To argue for this thesis, I outline Fisher and Hogben’s separate routes to their respective concepts of \( G \times E \); then these separate interpretations of \( G \times E \) are drawn on to explicate a debate between Fisher and Hogben over the importance of \( G \times E \), the first installment of a persistent controversy. Finally, Fisher’s \( G \times E_B \) and Hogben’s \( G \times E_D \) are traced beyond their own work into mid-20th century population and developmental genetics, and then into the infamous IQ Controversy of the 1970s.

Keywords: analysis of variance (ANOVA), biometry, developmental biology, eugenics, genetics, genotype–environment interaction (\( G \times E \)), IQ controversy, Lancelot Hogben, nature–nurture debate, population genetics, R. A. Fisher

Introduction

Genotype–environment interaction, or \( G \times E \), refers to cases in which different genotypic groups respond differently to the same array of environments. Such phenotypic responses are often visually displayed by means of reaction norm graphs.\(^1\) For instance, Figure 1 reveals

\(^1\) For histories of the reaction norm concept, see Griffiths and Tabery (Forthcoming) and Sarkar (1999).
phenotypic curves for various strains of *Drosophila* raised at different temperatures (x-axis) and graphed for viability (y-axis). Cases of G × C2E have important implications for the study of variation. First, if G × C2E exists for a particular trait in a population, then a scientist cannot assume that phenotypic variation for that trait in a population is simply the sum of genotypic differences and environmental differences (the “main effects”). The presence of G × C2E adds another source of variation which must be taken into consideration. If no G × C2E exists, then an “additivity relation” may be assumed, and the statistical analysis of variance (ANOVA) may be employed to partition the total phenotypic variance (V_P) into genotypic variance (V_G) and environmental variance (V_E):

\[ V_P = V_G + V_E. \]  

(1)

When additivity applies, scientists can also talk about the proportion of total phenotypic variation attributable to either genotypic variation or environmental variation. For example, the concept of heritability² (h²) is measured as:

² It is important to note here that this is the definition of heritability in the broad sense. Following Jay Lush’s distinction, this concept can be contrasted with heritability in the narrow sense, which only accounts for the proportion of total phenotypic variance arising from the additive genetic component of genotypic variation (Lush, 1943).